

SYNTHESIS OF WARM MIX ASPHALT
PAVING STRATEGIES FOR USE IN
MONTANA HIGHWAY CONSTRUCTION

FHWA/MT-09-009/8117-38

Final Report

prepared for
THE STATE OF MONTANA
DEPARTMENT OF TRANSPORTATION

in cooperation with
THE U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

November 2009

prepared by
Steven W. Perkins

Western Transportation Institute
Montana State University - Bozeman



RESEARCH PROGRAMS

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by

Steven W. Perkins

of the

Western Transportation Institute
College of Engineering
Montana State University – Bozeman

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Research Programs

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16. Abstract Warm Mix Asphalt (WMA) used as an alternative to conventional Hot Mix Asphalt (HMA) has gained national prominence. WMA uses technological advances that reduce the temperature needed to produce and compact asphalt for the construction of pavements, which results in lower costs, improved worker health, increased safety and reduced environmental impacts. Twelve WMA technologies are currently identified. Significant work has been conducted to demonstrate construction practices and to develop mixture design procedures. Twelve states currently have specifications for WMA. This report summarizes work performed to date that is pertinent to Montana DOT's desire to move forward with implementation of WMA. Recommendations are given for research and implementation activities that should be followed to more broadly employ WMA technologies as a standard paving practice in Montana.			
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EXECUTIVE SUMMARY

Warm Mix Asphalt (WMA) used as an alternative to conventional Hot Mix Asphalt (HMA) has gained national prominence. WMA uses technological advances that reduce the temperature needed to produce and compact asphalt for the construction of pavements. It offers the potential to reduce construction costs by lowering energy use, improving quality and efficiency of construction, improving environmental stewardship through decreased air emissions and creating a healthier work environment.

WMA technologies fall broadly into one of four categories based on the type of additive used, namely, those having water-based additives, water-bearing additives, chemical additives and organic additives. At the time of this report, 12 WMA technologies are identified. Many of these technologies involve relatively simple plant and mix design modifications to introduce the temperature-reducing additive in the mixture stream. Other technologies, particularly those involving water-based foaming techniques, require more substantial modifications.

NCHRP Project 9-43 has been tasked with developing a mix design methodology for WMA. Phase I of this study is complete and was concerned with developing a draft standard of practice for mix design of WMA, which is further evaluated and updated with work being performed under Phase II. Phase II is expected to be completed by March 2010. The draft standard of practice follows a framework established for HMA with the following modifications: 1) to account for reduced aging during production due to lower production temperatures, guidelines are given for increasing the high temperature stiffness of the binder; 2) practices for evaluating workability at lower production temperatures are given; 3) short term aging of mixtures prior to gyratory compaction and material used for performance tests is recommended; and 4) use of higher percentages of RAP is encouraged.

Construction practices with WMA are not greatly different from those for HMA, with the greatest differences being the need for plant modifications for certain technologies. An informal survey of state DOTs produced 12 states having specifications for WMA use.

A number of demonstration projects have been conducted and the majority has shown good success. The most significant concern with WMA appears to be with premature rutting and stripping of mixtures. Hamburg wheel tracking device tests have demonstrated both favorable and unfavorable rutting and stripping results. Issues that may be pertinent in these studies involve the presence of excessive moisture in the aggregate that may not be driven off at the lower production temperatures and the need for short term aging to simulate realistic field conditions.

Based on the results of this study, it is recommended that MDT undertake research and implementation studies to allow WMA to be used in practice on Montana roadways. In particular, it is recommended that a comprehensive mixture design study be undertaken using the

majority of WMA technologies and aggregate and binder materials common to Montana's regions. This study should use draft recommendations contained in NCHRP Project 9-43. The influence of RAP, cure time, aggregate water adsorption rates and lime should be examined to see if these variables can be used to address rutting and stripping issues. Practices for reheating bulk field specimens for laboratory testing should be evaluated. An approval system for existing and future WMA technologies needs to be established. Based on the above work, a specification for WMA needs to be established. Finally, field trials should be constructed according to this specification to evaluate the long-term performance of WMA in Montana.

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1 INTRODUCTION

1.1 Background

Warm Mix Asphalt (WMA) used as an alternative to conventional Hot Mix Asphalt (HMA) has gained national prominence. WMA uses technological advances that reduce the temperature needed to produce and compact asphalt for the construction of pavements. It offers the potential to reduce construction costs by lowering energy use, improving quality and efficiency of construction, improving environmental stewardship through decreased air emissions and creating a healthier work environment. These benefits make WMA technologies appealing to highway agencies and the asphalt paving industry given increased energy costs, reduced highway construction and maintenance budgets, and tighter environmental expectations and regulations.

WMA is produced at temperatures that are 50°F to 120°F lower than typical HMA temperatures of 300 to 350°F. Owing to the lower required temperature, one primary benefit of WMA is a significant reduction in fuel consumption when compared to the energy needed to produce traditional HMA. WMA production lowers the viscosity of asphalt binder, which slows cooling rates and reduces aging. This results in better compaction, the ability to haul the mix for longer distances, and is speculated to improve pavement durability due to decreased aging. Because the cooling time of WMA is extended, paving and patching at cooler temperatures may be more successful during the early and late construction seasons in Montana. Finally, emissions are reduced both at the plants and around the paving sites due to the lower temperature at which the mixes are produced.

Despite these promising benefits, numerous experimental studies and construction projects using WMA have demonstrated varying levels of performance. Several problems have been identified in California related to increased and premature rutting of surface asphalt concrete courses, while other studies have found moisture damage to be an increasing concern when WMA is used. Moreover, different WMA technologies have been reported to lead to various types of pavement distresses. Although there are considerable benefits such as reduced thermal cracking, reduced fatigue cracking, and prevention of tender mixes due to minimized oxidative hardening of binder at lower operating temperatures, the overall trade-off of using WMA in Montana conditions is not yet clear. Within this context, research is needed to investigate the potential use of WMA on Montana highways.

WMA was first introduced in Europe in the late 1990's. In 2007, FHWA sponsored a SCAN project to examine WMA projects in several European countries. Since this time, a significant number of research projects have been started in the US to examine this technology. In particular, two NCHRP projects (9-43 and 9-47) are ongoing, with Phase I of project 9-43 now completed and Phase II scheduled to begin shortly. The Minnesota Road Research Project (MnROAD) staff is planning to construct WMA sections soon. In the Western US, Colorado and

Wyoming have constructed experimental sections using WMA. WMA has been used in Yellowstone National Park and is scheduled for use in Glacier National Park in fall 2009. MDT has recently conducted mix design experiments to evaluate various WMA technologies.

MDT has expressed an interest in examining WMA technologies for use in Montana. Given the rapid and high level of national interest in this technology, the technical panel for this project has concluded that this Phase I project should be conducted, involving a synthesis of the technology and a set of recommendations for steps that MDT should pursue to implement WMA technologies in Montana.

1.2 Benefits

A number of benefits have been identified with the use of WMA and fall into the categories of environmental, product and process improvements and worker health. Benefits in the area of environmental aspects include the reduction in energy use and the reduction of emissions. Reduction in energy use is typically in the area of the fuel needed to operate burners and has been shown to be reduced by about 20-35 % with 50 % being possible for some technologies (D'Angelo et al. 2008). Emissions such as CO₂ and dust are reduced when lower temperatures are used in the plant. Reductions of CO₂ can range from 15-40 % and are very dependent on production temperature. Dust can be reduced by 25 to 50 %.

Product and process benefits include the ability to pave in cooler temperatures, haul the mix longer distances, compact with less effort, and the ability to incorporate higher percentages of recycled asphalt pavement (RAP) (Chowdhury and Button, 2008). RAP percentages in the mix can increase due to fractioning the RAP into smaller sized aggregate, which is a part of some WMA processes and may also be done to benefit RAP use in HMA, and the foaming and/or decrease in viscosity that improves mixing. Since compaction effort is reduced, additional energy savings are realized. Lower production temperatures result in less binder aging, which reduces susceptibility to fatigue and temperature cracking.

Worker health benefits result from a reduction of fumes and aerosols during placement and compaction. Reductions from 30 to 50 % have been noted (Button et al. 2007). Reduced temperatures also result in an improved working environment, which may lead to greater productivity and worker retention.

1.3 Objectives and Scope

The objective of this research project was to review available literature, current initiatives, research and programs related to WMA with a focus on information that provides insight into how WMA may be implemented and how it may perform in Montana. An outcome of this project is recommendations for steps that MDT should follow to implement WMA technologies. These steps involve further research and direct implementation on experimental projects. This

review provides an understanding of where the technology sits in the US, how it pertains to the state of Montana, and whether and how MDT should move forward with steps necessary to implement WMA technologies.

2 WARM MIX ASPHALT TECHNOLOGIES

2.1 Introduction

WMA technologies fall broadly into one of four categories based on the type of additive used, namely those having water-based additives, water-bearing additives, chemical additives and organic additives. At the time of this report, 13 WMA technologies were identified by the Warm Mix Asphalt Technical Working Group (WarmMixAsphalt.com). These 13 technologies are listed below with the company name given first and followed by the product/technology name:

- Advanced Concepts Engineering Co.: Low Energy Asphalt
- Akzo Nobel: Rediset™ WMX
- Arkema Group: CECABASE RT®
- Astec Industries: Double Barrel Green®
- Eurovia Services, GmbH: Aspha-Min
- Gencor Industries: Ultrafoam GX™
- Maxam Equipment Inc.: Aquablack WMA
- McConnaughay Technologies: Low Emission Asphalt
- MeadWestvaco Asphalt Innovations: Evotherm®
- PQ Corporation: Advera
- Sasol Wax Americas, Inc.: Sasobit®
- Shell Bitumen: WAM Foam
- Terex Roadbuilding: Warm Mix Asphalt System

In this section, these technologies are described with particular emphasis on the additives and processes used to manufacture the mix and whether any plant modifications are required. Table 1 provides a summary of information presented in the following sections. From this table, it is seen that the majority of technologies fall within the “water-based additive” category. Mix design process modifications are only required for foaming technologies. The production temperatures listed are taken, where possible, from manufacturer’s literature and should be used only as a guide. The two temperatures listed for Low Energy Asphalt and Low Emission Asphalt are for the two different stages associated with these technologies. Plant modifications needed for these technologies are discussed in more detail in Section 4.1.

Table 1: Summary of WMA technologies

Technology	Category	Production Temperature (°F)	Modifications to Plant Required
Aquablack WMA	Water-based	NA*	Yes
Double Barrel Green®	Water-based	255	Yes
Low Energy Asphalt	Water-based	255/220	Yes
Ultrafoam GX™	Water-based	NA*	Yes
WAM Foam	Water-based	145	Yes
Warm Mix Asphalt System	Water-based	NA*	Yes
Advera	Water-bearing	200	Some
Aspha-Min	Water-bearing	215	Some
Evotherm®	Chemical	195	Minor
Low Emission Asphalt	Chemical	275/215	Yes
Rediset™ WMX	Chemical	260	Minor
CECABASE RT®	Organic	215	Not Known
Sasobit®	Organic	235	Minor

*NA: Information not available

2.2 Water-Based Additives

Water-based additives rely upon a foaming action when water is introduced to a warm mix. When small amounts of water are added to a warm mixture, the water vaporizes and is encapsulated in the binder. This produces a foaming action in the binder and temporarily increases the volume of the binder and decreases viscosity, which improves coating and workability. Water-based additives must add enough water to cause foaming without adding so much that stripping problems are created.

2.2.1 Foaming Technologies

Double Barrel Green, Ultrafoam GX, Aquablack WMA and Warm Mix Asphalt System all use some type of a nozzle to inject water into an asphalt binder stream. WAM Foam differs slightly from these technologies as it uses a two component binder system that introduces a soft binder and a hard foamed binder at different times in the mixing cycle. Each technology uses equipment developed by the individual company. Relatively significant plant modifications are

necessary to incorporate these technologies. In addition, the mix design process needs to be altered to include water injection and foaming action steps.

2.2.2 Low Energy Asphalt

In the Low Energy Asphalt (LEA) process, the coarse aggregate and a portion of the fine aggregate are heated to normal HMA temperatures and mixed with the binder. A coating and adhesion additive (0.5 % by weight of binder) is added to the binder in the asphalt supply line to the plant. After the heated portion of the aggregate is coated, cold, wet fine aggregate is added. The wet portion has a moisture content of 3 to 4 %. When heated, this moisture is liberated as steam and causes the asphalt coating to foam and encapsulate the uncoated fine aggregate. The final discharge temperature is around 210°F, which allows the steam to condense into water and aids in the workability and compaction of the mixture.

2.3 Water-Bearing Additives

At present, two types of water-bearing additive WMA technologies are available. Both technologies consist of a synthetic zeolite (sodium aluminum silicate hydrate) that has been hydro-thermally crystallized. The percentage of water held internally by the zeolite is between 18 to 21 % by mass and is released at elevated temperatures. When this is added to the mix at the same time as the binder, water is released as a fine mist, which foams the binder. These materials are purported to not change the performance grade of the binder.

2.3.1 Advera

Advera is a manufactured zeolite that is released at a temperature of 210°F. Advera is typically added at 0.25 % by total weight of the WMA mix. The technology allows for a 50° - 70°F temperature reduction.

2.3.2 Aspha-Min

Aspha-Min is a finely powdered synthetic zeolite. The material is released in the temperature range of 185° to 360°F. Aspha-Min is typically added at 0.3 % by total weight of the WMA mix. The technology allows for a 54°F temperature reduction.

2.4 Chemical Additives

Three chemical additive technologies are described below. Pure chemical additive systems are generally simple from the standpoint that the chemical package may be added to the asphalt binder at the terminal. This results in only minor modifications needed to the asphalt plant or to the mix design process. One technology discussed below (Low Energy Asphalt) is more of a combination of chemical and water-based foaming technology and does require plant and mix design process modifications.

2.4.1 Evotherm

Three technologies are currently produced by Evotherm (Evotherm ET, Evotherm DAT and Evotherm 3G). Evotherm ET contains a chemical package of emulsification agents and anti-stripping agents. During production, the asphalt emulsion along with the chemical package, is used in place of the traditional asphalt binder and is mixed with the aggregate in the traditional HMA plant. Water in the emulsion vaporizes to facilitate mixing. The mixture is purported to provide aggregate coating, workability, adhesion, and improved compaction with no change in job mix formula. The technology allows for a 100° - 130°F reduction in production temperature and no modifications to the plant are required.

Evotherm DAT differs from Evotherm ET in that an emulsion is not used. In this case, the chemical package is injected directly into the asphalt binder line at the plant and results in much less water being added. Evotherm DAT has evidently replaced Evotherm ET.

Evotherm 3G is a relatively new product marketed as REVIX. At present, detailed information concerning this product is not available. Like the other two Evotherm products, the material can be added at the asphalt terminal or at the plant.

2.4.2 Low Emission Asphalt

Low Emission Asphalt is produced by the Low Energy Process described in Section 2.2.2. This process relies on sequential mixing of the asphalt binder containing a chemical additive being added to the hot coarse aggregates, followed by the introduction of wet sand, which creates a foaming action. Production temps as low as 200°F. Plant modifications in the form of a microwave moisture unit and a shower on the wet sand feed belt, a contact probe to measure mix discharge temperature, and a pump and metering system to administer the chemical additive are required.

2.4.3 Rediset WMX

Rediset is a chemical additive in the pellet form and does not contain water. The material is added at 1.5 to 2.0 % by weight of asphalt binder. Production temperatures are reduced by 60°F. The material can be added to the binder at the terminal, in the plant supply tank or blown into the mixing drum, which means plant modifications are relatively minor.

2.5 Organic Additives

Organic additives are added to the binder to reduce its viscosity. These materials typically have melting points below normal HMA production temperatures. At temperatures above the melting point, these materials reduce the viscosity of the binder making it possible to produce asphalt concrete mixtures at lower temperatures. Below the melting point, they tend to increase the stiffness of the binder.

2.5.1 CECABASE RT

The organic additive used in this technology is unspecified and very few details were available to describe the technology.

2.5.2 Sasobit

Sasobit is a fine, crystalline, long-chain synthetic wax. The material is added at 3 to 4 % by weight of the total mix. The wax melts at 210°F and reduces viscosity of the binder at plant and compaction temperatures. A reduction of production temperatures between 18°F and 54°F are possible. At service temperatures, Sasobit forms a lattice structure in the asphalt binder that gives the mixture stability. This accounts for the reported resistance to rutting of Sasobit-modified mixes. Sasobit can negatively impact low-temperature mix properties (Hurley and Prowell, 2005b). Plant modifications in the form of a blending unit for stirring Sasobit into the hot binder prior to mixing with aggregate are required.

3 MIX DESIGN

NCHRP Project 9-43 research team has been tasked with developing a mix design methodology for WMA. Phase I of this study is complete and a draft report has been obtained and reviewed. Phase I was concerned with developing a draft standard of practice for mix design of WMA, which is further evaluated and updated with work being performed under Phase II. The information provided below is a summary of pertinent aspects of the NCHRP 9-43 Phase I report (Advanced Asphalt Technologies, 2008).

The Phase I study worked from the premise that existing mix design procedures for HMA should serve as the framework for WMA with several areas potentially needing modification. The general framework for mix design includes selection of binder grade, optimum binder content, aggregate gradation, specimen compaction, specimen curing time and mixture evaluation. The areas potentially requiring modification for WMA include:

- Binder selection: Lower temperatures used in WMA results in less aging during plant mixing and construction, meaning a stiffer high temperature binder grade may be needed.
- Recycled Asphalt Pavement (RAP): Lower production temperature may limit the types and quantity of recycled asphalt materials that can be used in WMA. Substantial mixing of the new and recycled binders is necessary, which may be difficult to achieve at lower temperatures.
- Additives: Lower temperatures may limit the effectiveness of anistripping additives.
- Additives: WMA additive dosage rates need to be confirmed by the user agency and a method is needed for this.
- Mixing: Procedures for fabricating specimens may change depending on the technology used.
- Mixing: Mixture coating, workability and compactability must be evaluated directly rather than by viscosity based evaluations.

These topics were studied to arrive at a proposed Standard Practice for Design of WMA. Provided below is a discussion of the major modifications made to accommodate WMA.

3.1 Binder Grading

NCHRP 9-43 reported on a study to evaluate the effect of plant mixing temperature on the high temperature properties of selected binders. Binders were subjected to short term aging through use of the Rolling Thin Film Oven Test (RTFOT) (AASHTO T240) at different temperatures representing the plant temperature. High temperature properties ($G^*/\sin\delta$) of the binders were then measured (AASHTO T315) at multiple temperatures to determine the grade of the binder after aging. The results showed a linear decrease in the RTFOT high temperature

grade with decreasing aging temperature, with the slope of the relationship being different for different binders. The study produced a relationship between the short term aging temperature, the aging index of the binder ($G^*/\sin\delta$ after RTFOT aging divided by $G^*/\sin\delta$ of the tank binder at the grading temperature), and the change in the RTFOT high temperature grade of the binder. Using this relationship and typical mix production temperatures for HMA, a table was developed to provide guidance on production temperatures below which the high temperature binder grade should be bumped (Table 2). If the proposed plant mixing temperatures are lower than those listed in Table 2, the performance grade of the binder should be increased one level above that normally used for the hot mix asphalt.

Table 2: Minimum WMA production temperatures not requiring a high temperature PG grade increase (after Advanced Asphalt Technologies, 2008)

PG High Temperature Grade	Aging Index											
	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6
Minimum WMA Mixing Temperature Not Requiring PG Grade Increase (°F)												
52	170	190	200	205	210	215	220	220	225	225	230	230
58	185	205	215	220	225	230	235	235	240	240	245	245
64	190	210	220	230	235	235	240	245	245	250	250	250
67	200	220	230	235	240	245	250	255	255	255	260	260
70	200	220	230	240	245	245	250	255	255	260	260	260
76	210	225	235	245	250	255	260	260	265	265	265	270
82	215	235	245	250	255	260	265	265	270	270	275	275

Table 2 was verified for several recovered binders from 3 projects (Colorado I-70, Yellowstone National Park and New York LEA). The first two used a PG 58 binder while the last used a PG 64 binder. For these materials, the results were found to be in agreement with the recommendations given in Table 2.

3.2 RAP

Work performed by NCHRP 9-43 research team showed that mixing of new and old binders when using RAP occurs at elevated temperatures and increases with time at elevated temperature. The study showed that short-term conditioning for 2 hours at WMA compaction temperatures was sufficient to provide adequate mixing. This study concluded that it is reasonable to expect mixing of RAP and new binders during storage, transport and placement of WMA provided the RAP binder has a viscosity less than 100 cP (100 Pa-s) at the compaction

temperature. The recommended standard of practice does not place a limit on the amount of RAP that may be added. Compatibility of binders did not appear to be a concern.

3.3 Workability

NCHRP 9-43 showed that it was possible to measure differences in workability and compactability of WMA as compared to HMA; however, the differences are significant only below temperatures that are typical of WMA discharge temperatures. This observation led to the conclusion that it was not necessary to make special provisions for assessing workability. Furthermore, it was concluded that an evaluation of coating at the proposed production temperature should ensure workability. It was recommended that the number of gyrations necessary to reach 8 % air voids in the gyratory compactor be evaluated at the production temperature and at a temperature 55°F below the production temperature to assess the impact of temperature on workability and compactability. This provision is included in the Design Binder Content section of the proposed procedure. Limits were set for these two measures, which will be further evaluated in Phase II of the project.

3.4 Design Aggregate Structure

Design of the aggregate structure for WMA mixes follows AASHTO M323. A new provision was added for short term aging of the mixture prior to gyratory compaction. Mixtures are to be short term aged by placing the mixture in a shallow pan in a forced draft oven at the proposed compaction temperature for 2 hours. Short term aging is also recommended for any mixture material compacted for performance tests, such as the Hamburg Wheel Tracking Device (HWTD) tests. The importance of cure time is demonstrated in Figure 1, which shows HWTD test results on WMA and HMA specimens that had and had not been short term aged. These results show that short term aging is more critical for WMA as compared to HMA.

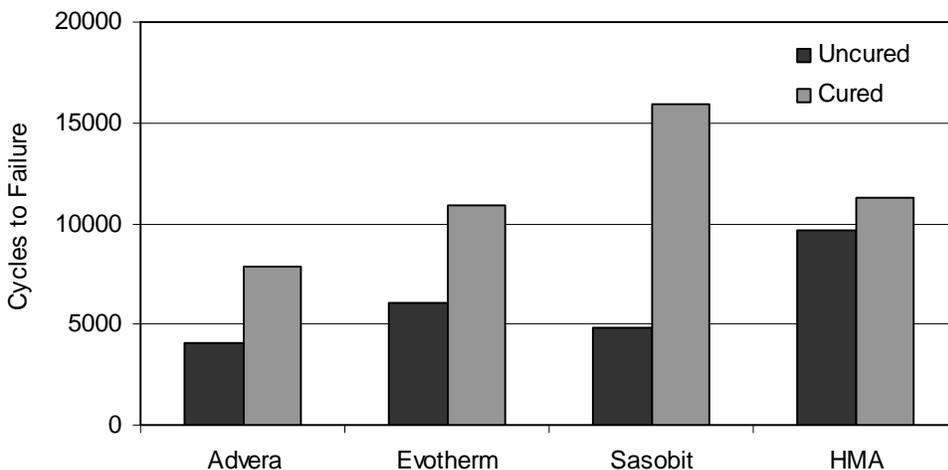


Figure 1: Influence of cure time on HWTD tests (after Lee 2008)

3.5 Process Considerations

The proposed Standard Practice for Design of WMA includes provisions for working with particular technologies when preparing materials for a mix design. Special sections have been added to treat the following grouped technologies:

- Zeolite additives
- Evotherm DAT
- Low Energy Asphalt (LEA)
- Sasobit
- WAM foam
- Foamed asphalt

The technologies of zeolite additives (Advera, Aspha-Min), Evotherm DAT and Sasobit require only the simple modification of adding the correct amount of additive directly to the binder before mixing or to the mix directly after the binder is added. In essence, no process modification is required. Low Energy Asphalt requires only the additional modification of preparing the cool wet fraction of aggregate and adding this after the hot aggregate, binder and additives are mixed.

WAM foam mixtures require a two step process of adding soft binder followed by hard foamed binder. Special asphalt binder foaming equipment is required for the hard foamed binder. The mixing process for the first step is conventional. The hard foamed binder is prepared as a batch using special equipment. Once foamed, it is added to the mixture from the first step and mixed. This same equipment is also used on all foamed asphalt technologies.

4 CONSTRUCTION AND SPECIFICATIONS

4.1 Construction

Construction activities for WMA asphalt does not differ significantly from HMA with the obvious exception of lower mat temperature. One study (Koenders et al. 2000) recommended keeping the breakdown roller directly behind the paver in order to considerably reduce compaction effort. WMA technologies do require, however, modifications to the plant, with the extent of the modifications dependent on the type of technology. Table 3 presents a brief description of modifications needed for the majority of the technologies discussed in Section 3. Prowell and Hurley (2007) provide additional details on plant modifications needed for various technologies.

Table 3: Plant modifications required for WMA technologies (after Anderson et al. 2008)

Technology	Plant Modifications
Double Barrel Green	Foaming manifold and feeder lines
Low Energy Asphalt	Added in-line (pump and metering system) for additive; additional cold feed bin for wet fine aggregate; moisture monitoring system
WAM Foam	Depends on plant type, but at least requires a second asphalt binder line (for the hard asphalt binder) and water line
Advera	Modified fiber feeder preferred (drum)
Aspha-Min	Vane feeder to blow additive into binder stream (drum); can also use addition at RAP collar (drum) or in bulk in pugmill (batch)
Evotherm DAT	Added in-line (pump and metering)
Evotherm 3G	Direct blended; added in-line (pump and metering); dry addition
Rediset	Direct blended; dry addition (near binder line in drum)
Sasobit	Direct blended into asphalt binder; added at RAP collar (drum); feeder (similar to fiber feeder) preferred (drum)

The reduced temperatures associated with WMA may lead to moisture problems (stripping) due to aggregate that is not fully dry. This may be particularly true for aggregates that are more adsorptive. Reduced production temperatures require a balance between drying the aggregate adequately and maintaining a baghouse temperature high enough to prevent condensation. The problem of moist aggregate may be addressed by placing stockpiles on a sloped paved surface or providing overhead coverage of stockpiles (Prowell and Hurley 2007). Finally, attention must be

paid to complete combustion of fuel at lower burner settings such that contamination of the WMA does not occur.

4.2 Specifications

The MDT office of Research Programs conducted a survey of state DOT specifications for WMA by sending an email request to each state Research Advisory Council member. Twelve states responded with specifications being used in their state. Another 12 states responded by saying they did not currently have a specification, were in the process of developing one or that the current specification for HMA was viewed as sufficient for WMA. The Warm Mix Asphalt Technical Working Group has prepared a generic specification that may be adopted by states and is contained in Appendix A. This specification is considered preliminary since additional information is needed from NCHRP 9-43 before the mixture design section can be finalized. Provided below is a summary of these specifications for the responding states. Copies of the specifications provided are given in Appendix A.

4.2.1 Alabama

The specification issued by Alabama DOT states that all procedures in the specification are applicable to both hot and warm mix asphalt. WMA is defined as mix temperatures between 215 and 280°F. For WMA, an approved list of processes is given. The specification requires an anti-stripping agent for all warm mix processes. Greater percentages of RAP (up to 35 %) are allowed with WMA.

4.2.2 California

The specification used by California DOT is based on a HMA specification. It allows three technologies for WMA; Advera, Evotherm and Sasobit. The specification contains language that provides for tests to ensure the correct dosage rate of these additives at the plant.

4.2.3 Florida

Florida has issued an interim specification for WMA. The specification allows for paving under cooler conditions than specified for HMA. The specification currently has an approved list of four technologies (Aspha-Min, Double Barrel Green, Evotherm and Aqua Foam system) and requires that the technology be a recognized process with successful projects demonstrated nationally or internationally.

4.2.4 Idaho

The Idaho specification recognizes that a lower air voids content may be obtained with field produced loose mixes and suggests that this material be allowed to cool and be reheated prior to laboratory compaction. The specification does not allow technologies that alter the performance grade of the binder.

4.2.5 Indiana

Indiana provided provisions for an HMA specification that allows for use of WMA by inclusion of the following passages:

QC/QA HMA may be produced as warm-mix asphalt, WMA, by using a water-injection foaming device for ESAL category 1, 2 and 3 mixtures. The DMF shall list the minimum plant discharge temperature for HMA and WMA as applicable to the mixture.

When RAP is used, the following provision was added for WMA:

A maximum of 25.0 % RAP or 5.0 % ARS by weight (mass) of the total mixture may be used in WMA for ESAL category 1, 2 and 3 mixtures except ESAL category 3 surface mixtures.

4.2.6 Iowa

Iowa DOT currently uses a contract modification to address WMA and is used on a project specific basis. The modification specifies the type of technology that will be used. The modification states that the manufacturer's recommendations shall be followed for incorporating the technology. Laboratory compaction and placement temperatures are specified.

4.2.7 Maine

Maine DOT uses a special provision to address the use of WMA (Special Provision Section 401.031). The specification acknowledges the possible use of WMA by including WMA additive as a possible material in the composition of mixtures. The specification states that WMA additive should be added in a manner and rate according to the manufacturer's recommendations. The specification describes four possible options for additives, consisting of organic, synthetic zeolite, chemical and other products/processes approved by the department. Foaming technologies would fall in the last option.

4.2.8 Ohio

Ohio DOT allows for the use of water-based foaming technologies by specifying a list of requirements for the equipment used at the plant to provide this technology (Supplemental Specification 800). The specification further requires that this equipment has been demonstrated to be stable and effective by use on non-Ohio DOT projects. The specification also allows increased RAP percentages by incorporating WMA technologies.

4.2.9 Pennsylvania

The Pennsylvania DOT has a special provision specification for both base and surface course WMA. The specification contains a list of approved technologies including Advera, Double Barrel Green, Evotherm, Green Machine, Low Energy Asphalt, Rediset WMX, Sasobit and Warm Mix Asphalt System. A Paving Operation QC Plan is required, which includes details on construction equipment and methods. A technical representative from the specified WMA manufacturer is required to be present during production and placement of WMA.

4.2.10 Texas

The specification developed by Texas is a traditional specification for dense-graded hot-mix asphalt that was amended by adding the following paragraph to allow WMA.

Warm Mix Asphalt (WMA) is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. WMA is allowed for use at the Contractor's option unless otherwise shown on the plans. The use of WMA is required when shown on plans. When WMA is required by the plans, produce an asphalt mixture within the temperature range of 215°F and 275°F. When WMA is not required as shown on plans, produce an asphalt mixture within the temperature range of 215°F and 350°F. Unless otherwise directed, use only WMA additives or processes listed on the Department's approved list maintained by the Construction Division.

4.2.11 Virginia

Virginia provides for the use of WMA as a special provision in Section 211 of their specifications. The department maintains an approved list of products that may be used. This list currently (as of August 2009) includes AQUABlack, Double Barrel Green, Evotherm ET, Sasobit and Ultrafoam GX. New products are added as they are evaluated. Evaluation includes development of independent test data to support the product, mix design submittals and a trial section.

For conformance testing, Superpave properties are determined on WMA that has been allowed to cool to 100°F or less and then reheated. The specification addresses the issue of stripping by requiring that the tensile strength ratio (TSR) be greater than or equal to 0.6 according to the AASHTO T283 test procedure. The specification limits the initial production to 500 tons per day in order to allow the engineer to examine the process control of the mixing plant, placement procedures, surface appearance of the mix, compaction patterns and correlation to nuclear density tests.

4.2.12 Washington

The state of Washington has amended their standard specification by including language that acknowledges WMA technologies. If the contractor proposes to use this technology, then they are required to submit for approval the process they will use.

5 CASE STUDIES

5.1 Yellowstone National Park & MDT Study

Two projects were constructed in Yellowstone National Park (YNP), one on the East Entrance Road west of Cody, WY and one south of Gardiner, MT. These projects used two technologies (Advera and Sasobit). MDT visited these projects during construction to gain observational experience.

For the East Entrance Road project, 28,000 metric tons (30,860 tons) of asphalt on 11.2 km (7 miles) of roadway was laid beginning August 21, 2007. Work was done in roughly 3 equal sections using traditional HMA, WMA with Advera and WMA with Sasobit. A temperature of 250°F was used for the WMA sections. The Contractor saved 20 % on fuel costs at the asphalt plant. Observations from construction showed that WMA handled similarly to HMA, WMA did not affect mix design and compaction required less effort to reach target density. The Gardiner project was constructed south of Mammoth Hot Springs and used an HMA section and a section with Advera.

Loose mix samples were obtained by MDT for the East Entrance Road project. The samples were reheated to a temperature specified by the technology used and slabs were created for the Hamburg Wheel Testing Device (HWTG) and allowed to cure. Slabs were compacted with a linear kneading compactor and produced similar air voids content in each slab. The Sasobit slab performed slightly worse than the HMA slab, yet both passed MDT specifications of 13 mm or less of rut in the specified number of passes, which is PG grade dependent. The Sasobit slab exhibited stripping as evidenced by an inflection point in the rutting curve. The Advera slab rutted much faster than the others and did not pass MDT specification.

Gyratory compaction pucks were obtained from the Gardiner project, which were tested in the HWTG. The HMA and WMA pucks both failed MDT specifications when tested in the HWTG; however, both performed approximately the same. The WMA cores showed a lower air voids content as compared to HMA pucks, indicating greater compaction occurred with the WMA mixture. It should be noted that both projects were federal projects and were not designed according to MDT mixture design specifications.

Based on their experience with the YNP projects, MDT decided to perform an in-house laboratory research project to evaluate 6 WMA technologies (Liva and McBroom, 2009), which included:

- Advera
- Aspha-Min
- Evotherm DAT
- Evotherm 3G

- Rediset WMX
- Sasobit

MDT performed a laboratory binder study using Evotherm DAT, Evotherm 3G, Rediset WMX and Sasobit. AASHTO M320 was followed to determine the PG grading of each binder with the appropriate additive. Table 4 lists results of the PG grading study for each binder where it is seen that only the Rediset WMX technology resulted in a shift of warm temperature grading, however all technologies resulted in a shift in grading based on the traffic designation.

Table 4: Binder grading results from MDT study (after Liva and McBroom, 2009)

	Technology				
	Base MRC 64-28	Evotherm DAT	Evotherm 3G	Rediset WMX	Sasobit
M 320 Performance Grading	64-34V	64-28H	64-34H	58-28S	64-28S

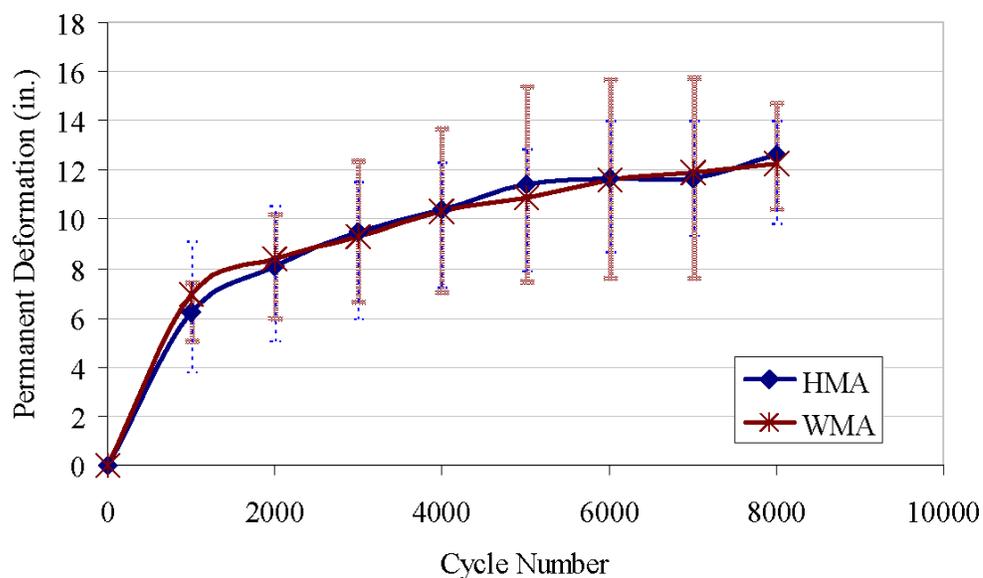
A mixture design study was conducted using a base mixture design from a local project. In this study, all six technologies listed earlier in this section were used. Since none of the technologies were foaming technologies, only minor changes in the mixture design process was necessary to accommodate the additives. Each technology used a mix temperature in accordance with the manufacturer's recommendations. A PG 64-28 binder was used. The mixture design study involved preparation of Superpave pucks using a gyratory compactor and the preparation of slabs for analysis with the HWTD. Table 5 lists the air voids content (VTM) for the compacted Superpave pucks and for the HWTD slabs. From this data it is seen that the Superpave puck air void content is roughly the same for all materials, with the exception of Advera and Aspha-Min, which are low, and Evotherm 3G, which is slightly high. The air voids in the HWTD slabs are all nearly the same. In terms of rutting in the HWTD, the base mix, Evotherm 3G and Sasobit performed well and all nearly the same. Evotherm DAT performed slightly worse. None of these technologies showed signs of stripping. Rediset WMX performed worse than these and showed signs of stripping. All of the above mentioned technologies passed MDT specifications in the HWTD. Advera and AsphaMin performed the worst in terms of rutting, showed signs of stripping and did not pass MDT specifications. These two technologies are the only two water-bearing additives, which were cured according to manufacturers' specifications but suggest that additional curing time to expel water contained in the mix may have been necessary.

Table 5: Mixture design results from MDT study (after Liva and McBroom, 2009)

Technology	VTM Superpave Puck (%)	VTM HWTD Slab (%)	Passes to 13 mm Rut or Rut at 20,000 Passes
Base MRC 64-28	4.3	7.2	5.1 mm
Advera	3.4	7.3	9900
AsphaMin	2.9	7.4	16,500
Evotherm DAT	4.6	7.5	7.6 mm
Evotherm 3G	5.3	7.0	5.6 mm
Rediset WMX	4.5	7.3	10.6 mm
Sasobit	4.7	7.2	4.5 mm

5.2 Michigan Study

Goh and You (2008) reported results from a study where materials from a field demonstration project on M-95 near Iron Mountain, Michigan were obtained and used in an Asphalt Pavement Analyzer to examine rutting. Sasobit was used for a WMA and was compared to HMA using the same mixture design. The WMA was produced and compacted at 260°F. Results of the study are shown in Figure 2 where it is seen that the WMA technology and HMA performed nearly identically in terms of rutting.

**Figure 2: APA rutting results for HMA and WMA (Goh and You, 2008)**

5.3 NCAT Studies

A series of three studies were performed by NCAT with support from National Asphalt Paving Association (NAPA) (Hurley and Prowell 2005a, 2005b, 2006). These studies evaluated the use of three technologies, namely Aspha-Min, Evotherm and Sasobit. Superpave gyratory compactor tests were performed using these technologies and two different aggregates. It was found that all WMA technologies resulted in a lower air voids content of compacted specimens as compared to HMA specimens. These results suggested that the optimum asphalt content should be reduced for WMA technologies, however, the report recommended that additional work was needed to justify this observation.

These studies showed generally good rutting results of WMA technologies in a HWTD. It was observed that the addition of lime to the WMA specimens improved cohesion and moisture resistance and improved rutting results. Reduced tensile strength and visual stripping were observed in samples produced at 250°F, indicating the potential for moisture damage due to incomplete drying of the aggregates.

5.4 Colorado I-70

Colorado has used WMA on a pavement overlay project on I-70 east of Eisenhower tunnel. The site, located at 8800 to 11,000 feet elevation, experiences 30,000 AADT and cold winter temperatures. Three WMA technologies (Advera, Evotherm, Sasobit) were used. Each technology was used for a 1 mile section with 1000 tons placed. Each section contained 3 lanes. WMA was placed in the center lane with HMA placed in the two outer lanes. A PG 58-28 binder was used. The mixture design was developed for the HMA and used on all three WMA. All WMA used a production temperature of 250°F, while the HMA used 280°F.

Binder grading tests showed that the base binder and the binder with Advera graded as the target grade of 58-28. Binder with Sasobit graded as a 64-22. Air voids were measured on the compacted materials. HMA and WMA was collected from the production mixes and reheated in the laboratory at the respective production temperatures and used to create HWTD slabs. Table 6 shows results of air voids and HWTD tests. Compacted air void contents were less for the WMA sections. In the HWTD, Sasobit performed better than HMA, while Advera and Evotherm performed worse. Similar results were observed in terms of the stripping inflection point. Performance of the sections from the first annual inspection showed all sections were performing well and similarly.

Table 6: CDOT WMA project results (CDOT, 2009)

	HMA Control	WMA Advera	HMA Control	WMA Evotherm	HMA Control	WMA Sasobit
Air Voids	3.1	1.8	3.6	2.2	6.4	6.3
HWTD Rut (mm)	9.0	9.5	10.0	13.5	16.0	11.0
HWTD Cycles	9700	5100	9650	7750	7650	9400
HWTD Inflection Cycles	7800	3300	8400	6200	5000	5700

5.5 Washington DOT I-90

Washington DOT performed an experimental project on the eastbound right-hand lane of I-90 for approximately 10 miles between the Columbia River and the town of George (Russell et al. 2009). Sections of HMA and WMA with Sasobit were placed, with the HMA being placed for the first half of the project. Binder PG76-28 was specified and graded as a PG83-28 with 2 % Sasobit.

Placement of HMA and WMA was accomplished with an equal measure of success, with the only problem noted being clumps within the WMA for one part of the section. This was attributed to RAP not being completely integrated into the mix. Density testing showed that there were less failing tests in the WMA section and was attributed to the greater ease of compaction with WMA. Hamburg wheel tracking tests showed equal rutting performance for HMA and WMA and both showed no indication of stripping. A temperature reduction between 30 to 50°F was realized for the WMA. Monitoring of long term performance of the test sections will occur over the next 5 years.

6 ON-GOING STUDIES

Currently, there are 2 national studies that are on-going and expected to impact the future direction of WMA use in the US. These studies are NCHRP Project 9-43 Phase II (*Mix Design Practices for Warm Mix Asphalt*) and NCHRP Project 9-47 (*Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies*). The sections below describe these studies with an emphasis on expected outcomes and impacts on WMA usage.

6.1 NCHRP Project 9-43

NCHRP Project 9-43 began in March 2007. Phase I of this project is completed. Phase II is expected to be completed by March 2010. The objective of this project is to develop a mix design method for WMA in the form of an AASHTO-style standard of practice. The standard of practice will be based on Superpave mixture design technology. A suite of performance tests will be included in the standard to assess whether a WMA mixture design will provide satisfactory field service. The standard is intended to apply to any WMA technology.

Phase I of the study has resulted in a preliminary mixture design and analysis procedure. This procedure was described in Section 3 of this report. Phase II will demonstrate the effectiveness and engineering reasonableness of the procedure developed under Phase I. Three laboratory studies have been recommended for the Phase II study, namely: 1) mix design study to compare mixes designed according to the Phase I recommendations and compared to similar HMA mixtures designed according to AASHTO R35; 2) Investigate fatigue properties of WMA relative to HMA; and 3) RAP mixing study to examine the effect of time at elevated temperatures on the degree of mixing between RAP and new binders in WMA.

6.2 NCHRP Project 9-47

NCHRP Project 9-47 began in March 2008 and is expected to be completed by September 2011. The objectives of this study are to 1) establish relationships among mechanical properties of WMA binders and mixes and mixture field performance; 2) compare different performance measures of WMA and conventional HMA; 3) compare production and laydown practices and cost between WMA and HMA; and 4) provide relative emission measurements of WMA and HMA technologies.

An interim report for the project dated October 2008 and constituting Phase I of the project has been obtained and reviewed. This report provides a summary of previous studies and presents an experimental plan for Phase II of the project.

6.3 MnROAD

MnROAD has constructed WMA test sections as part of MnROAD Phase II construction (Johnson et al. 2009). Phase II construction began in 2007 and continued into 2008. WMA was used for 7 cells along the test track mainline. The mix used a PG 58-34 binder with 20 % RAP. Evotherm 3G was used as the WMA additive. Production temperature was lowered by 50°F as compared to HMA sections. The construction report noted a reduction in emissions, reduced energy, and less compactive effort needed to achieve density requirements. It was noted that the WMA cells appeared more soft than the HMA cells the day following pavement placement, indicating that more time may be needed for curing. These test sections are being monitored and performance data is currently unavailable.

7 SUMMARY OF FINDINGS

The purpose of this section is to summarize significant findings discussed in this report as they pertain to current conditions in Montana. The findings presented in this section lead to the recommendations discussed in the next section concerning research and implementation activities for WMA in Montana.

This study identified 13 WMA technologies available in the US. These technologies fall into one of four categories: 1) water-based, 2) water-bearing, 3) chemical and 4) organic. Several of these technologies (Advera, Evotherm, Sasobit) appear to have been used most often on projects discussed in this report. The reported production temperature for each technology varies from 145°F to 260°F. Several technologies with low production temperatures have not received adequate consideration in most studies (CEBASERT, Low Energy Asphalt, Low Emission Asphalt, WAM Foam). Since the impetus for this technology lies in reduced emissions and reduced energy use, with greater reductions seen for lower production temperatures, technologies promising large production temperatures should be examined.

Water-based technologies generally require plant modifications to accommodate the foaming process. These technologies do not generally require additives. Water-bearing, chemical and organic technologies all require the use of additives. The cost tradeoff of plant modifications versus additives must be weighed when selecting a particular technology.

Much attention has been given to how mix design should be changed for WMA. NCHRP Project 9-43 has been tasked with developing a mix design methodology for WMA. Phase I of this study is complete and has resulted in a draft standard of practice. The major items contained in this standard of practice that differ from practice for HMA are listed below.

- A table (Table 2) was proposed to provide guidance for the minimum production temperature for which the high temperature PG grade would not be increased. This was expressed in terms of the original binder high temperature PG grade and the aging index of the binder. Beyond the temperatures listed in the table, the high temperature PG grade should be increased one level.
- When using RAP, WMA production temperatures are sufficient to ensure binder mixing. Short-term conditioning for 2 hours at WMA compaction temperatures is sufficient for mixing. No limits were placed on the amount of RAP that could be added.
- Workability is assessed in terms of an evaluation of coating, which in turn is evaluated through the gyratory compaction test by the number of gyrations necessary to reach 8 % air voids at the production temperature and compared to that at a temperature 55°F below the production temperature.
- Short term aging, consisting of placing the mixture at the production temperature for a period of 2 hours, should be performed before gyratory compaction and prior to compaction of specimens for performance tests, such as the HWTD.

- The standard does not address the possibility that the binder content should be reduced to account for the greater compaction and lower air voids that occurs with WMA. This implies that the asphalt content should be selected based on the optimum content from HMA samples using the same mixture.
- The standard includes instructions for how the mixture process should be changed to accommodate particular technologies.

Construction of WMA pavements is not significantly different from that with HMA. Changes to the plant, however, may be necessary. The greatest changes are necessary for water-based (foaming) technologies.

An informal survey of states indicates that 12 DOTs currently have some form of a specification for WMA. Copies of these specifications have been included in Appendix A of this report.

From the case studies examined in this project, the following observations pertinent to Montana conditions have been made:

- The two demonstration projects conducted in Yellowstone National Park were successfully constructed, however most HWTD tests did not pass MDT specification. The mixtures used in this study were not designed according to MDT specifications.
- A mixture design study by MDT using 6 technologies showed favorable results in terms of HWTD tests for 4 technologies. The two technologies that did not meet specification were water-bearing additive technologies that may require additional curing time to expel water contained in the mixture.
- An NCAT study showed that the addition of lime improved moisture resistance and improved rutting results.
- The other case studies reviewed showed favorable construction conditions, mixture design and performance testing results.

Currently, there are two on-going NCHRP studies that are expected to impact WMA practices. NCHRP 9-43 will be completed in March 2010. This study will result in a mixture design procedure for WMA. Currently, this study has proposed a design standard and is in the process of demonstrating the reasonableness of the proposal. NCHRP 9-47 will be completed in September 2011 and will provide greater insight into field practices and performance of WMA

8 ROADMAP FOR RESEARCH AND IMPLEMENTATION AT MDT

WMA has been shown to be a viable technology and appears to be appropriate for use on Montana's roadways. Significant work in this area has occurred internationally and nationally. This previous work has provided a foundation from which Montana can work from to develop specific practices pertinent to this state. Contained below is a bulleted list of research and implementation activities that Montana DOT is advised to undertake to allow WMA to become a common construction practice.

- A comprehensive mixture design study should be undertaken using the majority of WMA technologies and aggregate and binder materials common to Montana's regions. This study should include the following items.
 - Mixture design recommendations given in the NCHRP 9-43 Phase I report should be followed with respect to binder grade bumping, assessment of workability and short term aging.
 - Additional cure time should be examined for water-bearing or water-based technologies.
 - Aggregate water adsorption should be determined for all aggregates used to determine if drying precautions are necessary for aggregates with adsorption values greater than 2 %.
 - The addition of lime should be considered for those conditions where stripping appears to be a problem.
 - Chemical anti-stripping agents appropriate to the technology should be used.
 - Sufficient replicates should be available to make statistically valid conclusions.
 - Evaluate the use of a flow parameter for rutting.
- Establish practices for reheating bulk field specimens for laboratory evaluation.
- Develop an approval system for existing and future WMA technologies.
- Develop a specification for WMA.
- Construct field trials implementing the above findings.

9 REFERENCES

- Advanced Asphalt Technologies (2008). *Mix Design Practices for Warm Mix Asphalt*. Interim Report, Project NCHRP 9-43. National Cooperative Highway Research Program, Washington DC.
- Anderson, R.M., Baumgardner, G., May, R. and Reinke, G. (2008). *Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies*. Interim Report, Project NCHRP 9-47. National Cooperative Highway Research Program, Washington DC.
- Button, J.W., Estakhri, C. and Wimsatt, A. (2007). *A Synthesis of Warm-Mix Asphalt*. Texas Transportation Institute, Report No. SWUTC/07/0-5597-1, 94 p.
- Chowdhury, A. and Button, J.W. (2008). *A Review of Warm Mix Asphalt*. Texas Transportation Institute, Report No. SWUTC/08/473700-00080-1, 75 p.
- Colorado Department of Transportation, CDOT (2009). *Warm Mix for a Cold Climate: Update on Colorado DOT's 2007 WMA Project on I-70*. Presentation made at the 2009 Rocky Mountain Conference and Equipment Show.
- D'Angelo, J., Harm, E., Bartoszek, J., Baumgardner, G., Corrigan, M., Cowsert, J., Harman, T., Jamshidi, M., Jones, W., Newcomb, D., Prowell, B., Sines, R. and Yeaton, B. (2008). *Warm-Mix Asphalt: European Practice*. Federal Highway Administration, Report No. FHWA-PL-08-007, 68 p.
- Goh, S.W. and You, Z. (2008). "Warm Mix Asphalt Using Sasobit®: Field and Laboratory Experience". *Proceedings of the Mid-Continent Transportation Research Forum*, Madison, Wisconsin.
- Hurley, G.C. and Prowell, B.D. (2005a). *Evaluation of AsphaMin Zeolite for Use in Warm Mix Asphalt*, Report NCAT 05-04, National Center for Asphalt Technology, Auburn University, Auburn, Alabama.
- Hurley, G.C. and Prowell, B.D. (2005b). *Evaluation of Sasobit for Use in Warm Mix Asphalt*, Report NCAT 05-06, National Center for Asphalt Technology, Auburn University, Auburn, Alabama.
- Hurley, G.C. and Prowell, B.D. (2006). *Evaluation of Evotherm for Use in Warm Mix Asphalt*, Report NCAT 06-02, National Center for Asphalt Technology, Auburn University, Auburn, Alabama.
- Johnson, A., Clyne, T.R. and Worel, B.J. (2009). *2008 MnROAD Phase II Construction Report*. Minnesota Department of Transportation, 159 p.
- Koenders, B.G., Stoker, D.A., Bowen, C., de Groot, P., Larsen, O., Hardy, D. and Wilms, K.P. (2000). "Innovative Processes in Asphalt Production and Application to Obtain Lower Operating Temperatures", *2nd Eurasphalt and Eurobitume Congress*, Barcelona, Spain.
- Lee, R. (2008). "A Summary of Texas' Experience with Warm Mix Asphalt". Presentation at *Louisiana Warm-Mix Demonstration* – Shreveport, LA, June 2008.

- Liva, G.W. and McBroom, D.G. (2009). *Montana Department of Transportation Research Report Warm-Mix Asphalt*. Internal Montana Department of Transportation Report, 37 p.
- Prowell, B.D. and Hurley, G.C. (2007). *Warm-Mix Asphalt: Best Practices*, NAPA Quality Improvement Series 125, National Asphalt Paving Association, Lanham, MD, USA, 44p.
- Russell, M., Uhlmeyer, J., Weston, J., Roseburg, J., Moomaw, T. and DeVol, J. (2009). *Evaluation of Warm Mix Asphalt*. Report No. WA-RD 723.1, 65p.

10 APPENDIX A: STATE SPECIFICATIONS

Provided on the following pages are copies of WMA specifications received by the states of Alabama, California, Florida, Idaho, Indiana, Iowa, Maine, Ohio, Pennsylvania, Texas and Virginia.

**WARM MIX ASPHALT
TECHNICAL WORKING GROUP**

Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

Division 400 - Asphalt Pavements and Surface Treatments

SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENT

Warm mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of one of several WMA technologies.

Some modifications to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 4XX.03 Construction.

Production and paving temperatures may need to be increased for higher reclaimed asphalt pavement (RAP) contents, increased haul distances, decreased ambient temperatures, or other WMA project specific conditions.

All provisions for the production and placement of conventional HMA mixtures as stipulated in [applicable Agency specification] are in force except as noted below.

4XX.01 Description

Construct one or more courses of plant produced warm mix asphalt (WMA) pavement on a prepared foundation, using virgin aggregate or a combination of virgin and/or reclaimed aggregate material (RAM) and prescribed manufactured WMA additives and/or WMA plant process modifications. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture; and reclaimed asphalt shingles (RAS) are permitted at the current [Agency specified] percentages, provided that the mixture meets all the requirements of these specifications.

4XX.02 Material

WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185°F to 275°F. (Note: The upper temperature range is appropriate for modified asphalt binders and WMA mixtures which include higher percentages of reclaimed asphalt pavement.)

Provide materials as specified in:

Aggregate	Subsection XXX
Liquid Antistrips	Subsection XXX
Asphalt Binder	Subsection XXX
HMA Additives	Subsection XXX
Lime for Asphalt Mixtures	Subsection XXX
Mineral Filler	Subsection XXX
Reclaimed Asphalt Pavement	Subsection XXX
Reclaimed Aggregate Material	Subsection XXX
Reclaimed Asphalt Shingles	Subsection XXX

A. Mix Design. Develop and submit a job mix formula for each mixture according to AASHTO R 35 or [Agency specified procedure]. Each job mix formula must be capable of being produced, placed, and compacted as specified. Apply all mix design requirements for HMA to the development of the WMA mix design.

(Note to Contracting Agency: Recommended mix design practices specific to WMA have not been established. Job mix formulas for WMA mixtures are currently developed with conventional HMA mix design practices and the WMA technology process or additives are included afterward. The Contracting Agency and WMA producer must ensure the WMA technology does not adversely affect the asphalt binder performance grade and WMA mixture performance during the development and verification of the WMA job mix formula. All acceptance and performance testing must be conducted with the WMA technology added. A specific WMA mix design recommended practice is expected upon the completion of the National Cooperative Highway Research Program (NCHRP) Project 09-43 "Mix Design Practices for Warm Mix Asphalt" detailed at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=977.)

Submit a written job mix formula for review and approval at least [XX] calendar days before production, or when sources of asphalt binder, aggregates, WMA additives, or other components of the mix change.

Submit the following information:

1. All information required in the report section of AASHTO R 35 or [Agency specified procedure].
2. WMA technology and/or WMA additives information.
3. WMA technology manufacturer's established recommendations for usage.
4. WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
5. WMA technology material safety data sheets (MSDS).
6. Documentation of past WMA technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance; or documentation of WMA technology listing on [Agency specified] approved products list.
7. Temperature range for mixing.
8. Temperature range for compacting.
9. Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
10. WMA mixture performance test results [as required by the Contracting Agency].
11. Laboratory test data, samples and sources of all mixture components, and asphalt binder viscosity-temperature relationships.

(Note to Contracting Agency: Some WMA technologies may alter the asphalt binder grade and conventional performance grading may not be suitable to quantify the WMA technology effects.)

B. Additives. Use anti-stripping additives, silicone additives, WMA additives, and WMA technologies as specified. Comply with approved mix design quantities. Confirm the addition rate through field tests performed during production.

(Note to Contracting Agency: Silicon additives are historically used as both an antifoam and defoamer to inhibit foaming in asphalt binder applications. Ensure silicon additive compatibility when asphalt binder foaming processes are used to produce WMA.)

Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.

Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing WMA.

C. Sampling. Perform sampling according to the following standards:

1. **Aggregate.** AASHTO T 2 or [Agency specified procedure].
2. **Asphalt Binder.** AASHTO T 40 or [Agency specified procedure].
3. **Warm Mix Asphalt (WMA) Plant Mix.** AASHTO T 168 or [Agency specified procedure].

D. Weather Limitations.

1. Place WMA mixtures only on dry, unfrozen surfaces and only when weather conditions allow for proper production, placement, handling, and compacting.

2. Meet [agency specified] placement temperatures.

(Note to Contracting Agency: The minimum HMA delivery, placement, and compaction temperatures should be reviewed to accommodate the WMA reduced temperature and achieve workability and density requirements. Documentation that demonstrates a proven history of the WMA technology's ability to be placed and compacted at the reduced temperatures may be required. A test strip or initial production verification requirement can be used to demonstrate placement and compaction at the reduced temperature. Minimum ambient paving temperature requirements may be lowered 20°F from normal temperature requirements. Do not lower ambient paving temperatures to below freezing.)

E. Equipment. Use equipment and WMA technologies capable of producing an asphalt mixture that meet specification requirements and is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.

1. **Asphalt Mixing Plant.** Meet AASHTO M 156 or [as further modified by the Agency].

Modify the asphalt mixing plant as required by the manufacturer to introduce the WMA technology.

Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and/or WMA additive delivery systems, tuning the plant burner and adjusting the flights in order to operate at lower production temperatures and/or reduced tonnage.

(Note: Implementation of best management practices in the control of aggregate moisture content prior to introduction to the drying or mixing drum is highly recommended in order to achieve the maximum benefit of WMA technology.)

*(Note to Contracting Agency: It may be beneficial to produce an HMA mixture at conventional HMA temperatures immediately before WMA production at the lower temperatures in order to bring the plant up to temperature and ensure proper baghouse operating temperature. The following references published by the National Asphalt Pavement Association detail specifics related to plant modifications and operational changes in order to maximize the benefits of WMA production, especially regarding reduced fuel usage and reduced emissions:
Quality Improvement Series 125 (QIP 125), "Warm Mix Asphalt: Best Practices",*

All metering devices will meet the current [*Agency specified*] requirement for liquid or mineral additives. Document the integration of plant controls and interlocks when using WMA additive metering devices.

2. Hauling Equipment. Furnish equipment with tight, clean, smooth metal beds to haul WMA mixture. Keep beds free of petroleum oils, solvents, or other materials that would adversely affect the mixture. Apply a thin coat of approved release agent to beds as necessary to prevent mixture sticking. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mix.

Be prepared to cover and insulate hauling beds. Equip each truck with a waterproof and windproof cover of suitable material and sufficient size to protect the mix from the weather. Securely fasten covers when necessary to maintain temperature. Ensure that covers do not allow water to enter the bed, paver, or mix transfer device during mix unloading. Use insulated truck beds when necessary to maintain temperature.

3. Asphalt Pavers. Provide self-propelled asphalt pavers with activated, heated, adjustable, vibratory screed assemblies to spread and finish to the specified section widths and thicknesses. Provide full width screw augers and provide auger extensions to ensure the paver's distribution system places the mixture uniformly, maintaining a consistent head of material in front of the screed. Screed or strike-off the surface without segregating, tearing, shoving, or gouging the mixture.

Operate the paver at consistent speeds and in a manner that results in an even, continuous layer. Avoid and minimize stop and start operation or allowing the paver to remain stationary during operation.

Equip pavers with automatic screed controls with sensors capable of continuously sensing grade, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope. Control the screed to maintain the grade and transverse slope according to plan.

The Contractor may operate equipment manually in irregularly shaped, narrow, and minor areas.

If automatic controls fail, operate equipment manually only for the remainder of the work day and only if specified results are obtained.

Suspend paving if the specified surface tolerances are not met. Resume only after correcting the situation.

4. Rollers. Use rollers as required to achieve [*Agency specified*] pavement density and capable of reversing direction without shoving or tearing the mixture.

Operate rollers according to manufacturer's recommendations. Only use vibratory rollers equipped with separate energy and propulsion controls. Select equipment that will not crush the aggregate or displace the mixture.

F. Mixing and Holding. Heat the asphalt binder within the specified temperature range. Ensure a continuous supply of heated asphalt binder to the mixer.

Heat and dry aggregates to the required temperature. Avoid damaging or contaminating the aggregate.

Combine and mix the dried aggregates and asphalt binder to meet the job mix formula. Ensure a minimum of 95 percent uniform coating of aggregates according to AASHTO T 195 or [Agency specified procedure].

Correct procedures if storing or holding causes segregation, excessive heat loss, or a reduced quality mixture. Properly dispose of mixture which does not meet specifications.

G. Preparing Base or Existing Surface. Clear surface of debris and deleterious material. Apply and cure tack coat before placing the WMA. Apply a tack coat on all surfaces, curbs, gutters, manholes, or other structure surfaces, that will be in contact with the WMA.

Repair damaged areas of the base or existing surface. Restore the existing surface or base to a uniform grade and cross section before placing the mix.

H. Pre-paving Requirements. Prior to placing any WMA mix, produce a sufficient amount of WMA mix to properly calibrate the plant and procedures using the mix design approved for mainline construction. The Engineer will sample and test the WMA mix thus produced for the following:

1. voids in mineral aggregate (VMA);
2. asphalt binder content;
3. gradation;
4. air voids; and
5. tensile strength ratio (or Hamburg wheel tracking test for moisture damage)

Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

(Note: Field produced WMA loose mix samples which are immediately compacted and tested, without reheating, may produce lower voids in mineral aggregate and lower air voids test results when compared to reheated samples. This should be validated during the test strip or initial production lot. One possible remedy is to cool the WMA sample to room temperature and reheat to a temperature that is less than or equal to the WMA field production temperature before laboratory compaction. This will minimize the WMA technology's effects on the test results and ensures the sample is not excessively aged.)

Place no WMA mixture that fails to meet specification requirements. WMA mixture not meeting the requirements may be used in the construction of temporary facilities when approved by the Engineer.

Construct a control strip or initial production lot with production materials and equipment. Select compacting methods to meet the specified density. The Engineer will take random loose mix and core samples to verify compliance with job mix and specification requirements. Reconstruct the test strip or initial production lot if the job mix formula, the compacting method, or compacting equipment changes, or if results do not meet specifications.

I. Spreading and Finishing. Spread and finish the mixture with asphalt pavers to specified grade and thickness.

Hand place material in areas inaccessible to mechanical spreading and finishing equipment. Maintain a consistent supply of mixture to ensure uninterrupted paving.

Minimize inconvenience to traffic and protect existing and finished surfaces. Leave only short lane sections, normally less than [26 ft (8 m)], where the abutting lane is not placed the same day, or according to [Agency specified] traffic safety requirements.

J. Compacting. Compact immediately after spreading and before the WMA mixture falls below the minimum job mix design compaction temperature. Discontinue paving if unable to achieve the specified density before the mixture cools below the minimum recommended WMA job mix design compaction temperature.

Provide the number, weight, type, and sequence of rollers necessary to compact the mixture without displacing, cracking, or shoving. Roll the WMA mixture parallel to the centerline. Begin rolling superelevated curves at the low side and continue to the high side, overlapping longitudinal passes parallel to the centerline.

Maintain a uniform roller speed with the drive wheels nearest the paver. Operate vibratory rollers uniformly at the manufacturer's recommended speed and frequency.

Continue rolling to eliminate all roller marks and to achieve the minimum [Agency specified] percent of theoretical maximum density or the recommended [Agency specified] percent of laboratory density as determined according to [Agency-specified method].

(Note to Contracting Agency: Air void and density requirements are important to provide long term performance of asphalt pavements. Due to the potential for increased workability of WMA mixtures and therefore increased density, it is important to monitor rolling operations to ensure excessive compaction does not occur and minimum air void requirements and/or the upper limit on percent of maximum density are not exceeded.)

Maintain the line and grade of the edge during rolling.

Prevent the mixture from adhering to the rollers by using very small quantities of detergent or other approved release material.

Hand compact areas inaccessible to rollers.

The Engineer will take random tests of the compacted pavement to verify specification compliance. At no cost to the Agency, remove and replace mixture that does not meet specification requirements or that becomes contaminated with foreign materials. Remove defective materials for the full thickness of the course by saw cutting the sides perpendicular and parallel to the direction of traffic. Coat saw cut edges with bituminous materials and replace the defective material with specification materials.

K. Joints. Protect ends of a freshly laid mixture from damage by rollers. Form transverse joints to expose the full depth of the course. Apply a tack coat on transverse and longitudinal joint contact surfaces immediately before paving. Construct all longitudinal joints within 12 in. (300 mm) of the lane lines. Offset longitudinal and transverse joints on succeeding lifts 6 inches (150 mm) to 12 inches (300 mm) from the joint in the layer immediately below. Create the longitudinal joint in the top layer along the centerline of two-lane highways or at the lane lines of roadways with more than two lanes.

L. Surface Tests. The Engineer will test pavement surfaces to verify compliance with [Agency specified] smoothness and texture requirements.

Correct pavement surfaces that do not meet specification requirements by cold milling, diamond grinding, overlaying, or removing and replacing according to the following:

- a. *Diamond Grinding.* Diamond grind final pavement surfaces exposed to vehicle traffic to the required surface tolerance and cross section. Remove and dispose of all waste material.
- b. *Cold Milling.* Cold mill intermediate pavement surfaces to the required surface tolerance and cross section. Remove and dispose of all waste materials.
- c. *Overlaying.* Use specification materials for overlays. Overlay the full width of the underlying pavement surface. Place a minimum recommended overlay thickness of [1.6 in. (40 mm)]. Use only one overlay.
- d. *Removing and Replacing.* Replace rejected areas with WMA pavement materials that meet specification requirements. Test the corrected surface area. Complete all corrections before determining pavement thickness.

4XX.04 Measurement

The Engineer will measure work acceptably completed as specified in Subsection XXX and as follows:

- A. The Engineer will base quantities of asphalt binder on the theoretical mass incorporated into accepted product as verified by samples taken according to Subsection XXX.

4XX.05 Payment

Include costs of plant startup operations, considering both labor and materials, in the price bid for the mixture in place.

The Agency will pay for accepted quantities at the contract unit price as follows:

Pay Item Pay Unit

(A) Asphalt Binder ton (Mg), gal (L)

(B) WMA Plant Mix—Type _____ ton (Mg), yd² (m²)

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

ALABAMA

ALABAMA DEPARTMENT OF TRANSPORTATION

DATE: July 21, 2009

Special Provision No. 08-0378(5)

EFFECTIVE DATE: August 1, 2009

SUBJECT: Asphalt Pavement.

Alabama Standard Specifications, 2008 Edition, shall be amended by replacing Article 106.09 and Sections 410 and 424 with the following:

106.09 Quality Control and Quality Assurance (QC/QA) Requirements for Hot Mix Asphalt (HMA) Pavement.

(a) GENERAL.

The following modifications apply only to the materials and work performed under Sections 327, 410, 420, 423 and 424.

In all cases, the Department's testing will be separate from the Contractor's testing and both shall be conducted by certified technicians.

All Quality Control aspects of this provision shall be the responsibility of the Contractor. Quality Control is defined as the activities that are related to the production of Hot Mix Asphalt Pavement which meet all the requirements of the Specifications, including mix design, process control testing, sampling and acceptance testing (when so designated by the Department) for determination of Pay Factors, and necessary adjustments to the production process.

All Quality Assurance aspects of this provision shall be the responsibility of the Department and will be accomplished in the following ways:

1. By conducting assurance/verification testing, on a random basis, of independent samples obtained by the Department, at a frequency of one or more per day;
2. By periodically observing tests performed by the Contractor;
3. By monitoring required Contractor control charts exhibiting test results of control parameters.

Any Superpave Gyratory Compactor may have its angle of gyration verified by the Engineer following the procedure in ALDOT 404, "Evaluating the Superpave Gyratory Compactor's (SGC's) Angle of Gyration using the FHWA SGC Angle Validation Kit". This includes all design, quality control, and quality assurance SGC's. The average Peak-to-Peak 1/2 angle Average Summary should be validated to be 1.25 +/- 0.05 degrees (between 1.20 & 1.30 degrees). This should be done using standard mixes supplied by the State. If the SGC cannot meet this specification, adjustments to the SGC's angle of gyration may be required.

(b) QUALITY CONTROL.

The Contractor shall provide and maintain a quality control system that will provide reasonable assurance that all materials, products, and completed construction submitted for acceptance conform to contract requirements whether manufactured or processed by the Contractor or procured from subcontractors or vendors. Quality control managers, laboratory technicians and roadway technicians will be certified by the Department as outlined in ALDOT-374, "Certification Requirements for Hot Mix Asphalt Technicians". This quality control system shall conform to ALDOT-375, "Contractor Quality Control System for Hot Mix Asphalt".

The sampling and testing frequencies shall conform to the requirements given in Table 1 for a pay item when the accumulated amount of asphalt mix placed for that pay item exceeds 250 tons {250 metric tons}. The accumulated amount of asphalt mix shall be the current total amount of asphalt mix that has been placed beginning from the start of construction. The sampling and testing frequencies given in Table 1 may be waived by the Division Materials Engineer and the asphalt mix may be

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accepted by visual observation for a maximum accumulated asphalt mix placement quantity of 250 tons {250 metric tons} or less for any individual pay item. The Engineer will record the results of the acceptance of the asphalt mix on form BMT-16 if sampling and testing is not required.

TABLE I SECTION 327 and 420 MIXES SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS						
Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1. Asphalt Content *	ALDOT Sample = 55 lb (25 kg) Split into 2 equal samples	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 ***	1 per day per LOT	++ 1 per 700 tons
2. Mixture Gradation **	Contractor Sample = 55 lb (25 kg) Split into 2 equal samples	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	1 per day per LOT	++ 1 per 700 tons
3. Asphalt Draindown	12 lb (5 kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required
<p>* See ALDOT-353 Determining H.M.A. Laboratory Quality Control / Assurance Parameters.</p> <p>** If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.</p> <p>+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.</p> <p>++ One sample for each 500 tons (500 metric tons) for Section 420 mixes.</p> <p><u>Note:</u> The testing increment shall have a 150 ton buffer between each increment.</p> <p>+++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight (mass) and percent weight (mass) loss is computed and produced on hard-copy output.</p>						

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TABLE I (CONT'D.)		SECTION 423 MIXES			(STONE MATRIX ASPHALT)	
SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS						
Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1. Asphalt Content *	ALDOT Sample = 90 lb (40 kg) Split into 2 equal samples Contractor Sample = 90 lb (40 kg) Split into 2 equal samples	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 + + + +	1 per day per LOT	++ 1 per 700 tons
2. Maximum Specific Gravity *		AASHTO T 168 & ALDOT-210	+Loaded Truck	AASHTO T 209 (Flask determination with dry back)	1 per day per LOT	++ 1 per 700 tons
3. Air Void Content & VMA *		AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-353 & ALDOT-307	1 per day per LOT	++ 1 per 700 tons
4. Mixture Gradation *		AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	1 per day per LOT	++ 1 per 700 tons
5. Retained Tensile Strength Note: The TSR test is not required for any pay item less than a full lot.	25 lb (12 kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-361	1 set of 6 for the first full lot (2,800 tons (2,800 metric tons)) and 1 set of 6 for the next 10,000 tons (10,000 metric tons) and 1 set of 6 for each additional 20,000 tons (20,000 metric tons) or portion thereafter	1 set of 6 for the first full lot (2,800 tons (2,800 metric tons)) and 1 set of 6 for the next 10,000 tons (10,000 metric tons) and 1 set of 6 for each additional 20,000 tons (20,000 metric tons) or portion thereafter
6. Mat Density *		ALDOT-210	Roadway	ALDOT-222 & ALDOT-350		As per Contractor's QC plan (ALDOT-375)
				ALDOT-403 AASHTO T 166 AASHTO T 275 ASTM D 6752	°° 1/3000 lane feet/lift (1/900 lane m/lift)	
7. Clay Content	Adequate Quantity	AASHTO T 2	Aggregate Stockpiles	AASHTO T 176	As required	As required
8. Asphalt Draindown	12 lb (5 kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required
<p>* See ALDOT-353 Determining H.M.A. Laboratory Quality Control / Assurance Parameters.</p> <p>** If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.</p> <p>°° Cores shall be taken by the Contractor and the density will be determined by the Department.</p> <p>+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.</p> <p>++ The sample shall be one set of three Marshall samples+++.</p> <p><u>Note:</u> The testing increment shall have a 150 ton buffer between each increment.</p> <p>+++ When slag is used as an aggregate in the mixture, four Marshall samples shall be compacted. The test result the furthest away from the average of the four test results shall be discarded and the remaining three test results shall be averaged for use in the computation of air voids.</p> <p>++++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight (mass) and percent weight (mass) loss is computed and produced on hard-copy output.</p>						

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SECTION 424 MIXES (SUPERPAVE)						
TABLE I (CONT'D.) SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS						
Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
1. Asphalt Content *	ALDOT Sample = 135 lb (60 kg) Split into 2 equal samples	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-354 or AASHTO T 308 +****	1 per day per LOT	++ 1 per 700 tons
2. Maximum Specific Gravity *		AASHTO T 168 & ALDOT-210	+Loaded Truck	AASHTO T 209 (Flask determination with dry back)	1 per day per LOT	++ 1 per 700 tons
3. Air Void Content & VMA	Contractor Sample = 135 lb (60 kg) Split into 2 equal samples	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-384 ALDOT-388 ALDOT-353	1 per day per LOT	++ 1 per 700 tons
% Gmm @ Nd *		AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-371 AASHTO T 308	As needed	
4. Mixture *** Gradation & Dust to Asphalt Ratio *						
5. Retained Tensile Strength Note: The TSR test is not required for any pay item less than a full lot.	25 lb. (12 kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT-361	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter	1 set of 6 for the first full lot (2,800 tons {2,800 metric tons}) and 1 set of 6 randomly for the next 10,000 tons {10,000 metric tons} and 1 set of 6 for each additional 20,000 tons {20,000 metric tons} or portion thereafter
6. Mat Density *		ALDOT-210	Roadway	ALDOT-222 & ALDOT-350		As per the Contractor's QC plan (ALDOT-375)
				ALDOT-403 AASHTO T 166 AASHTO T 275 ASTM D 6752	° 1/3,000 lane feet/lift {1/900 lane m/lift}	
7. Fine Aggregate Angularity * FAA Note: The FAA test is not required for any pay item less than a full lot.	Adequate quantity to run AASHTO T 304, Method A or ASTM C 1252, Method A	AASHTO T 2	+Loaded Truck	AASHTO T 304, Method A Or ASTM C 1252, Method A	1 for the first full lot (2,800 tons {2,800 metric tons}) and 1 for the next 10,000 tons {10,000 metric tons} and 1 for each additional 20,000 tons {20,000 metric tons} or portion thereafter	1 for the first full lot (2,800 tons {2,800 metric tons}) and 1 randomly for the next 10,000 tons {10,000 metric tons} and 1 randomly for each additional 20,000 tons {20,000 metric tons} or portion thereafter
8. Clay Content	Adequate quantity	AASHTO T 2	Stockpile	AASHTO T 176	As required	As required
9. Asphalt Draindown	12 lb (5kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	AASHTO T 305	As Required	As Required
10. Split Tensile **	35 lb. (17 kg)	AASHTO T 168 & ALDOT-210	+Loaded Truck	ALDOT 361 (Report the Unconditioned Sample for Split Tensile)	N/A	1 for the first full lot and 1 randomly for each additional 10,000 tons thereafter
11. Quantitative Extraction & Recovery & Absolute Viscosity **				AASHTO T 319 & AASHTO T 202		
12. DSR **				AASHTO T 315		
13. RTFO **				AASHTO T 240		

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TABLE I (CONT'D.)	SECTION 424 MIXES	(SUPERPAVE)
SAMPLING AND TESTING REQUIREMENTS FOR QC/QA PROJECTS		
<p>* See ALDOT-353 Determining H.M.A. Laboratory Quality Control / Assurance Parameters.</p> <p>** In virgin mixes, the sample may be taken from the cold feed conveyor.</p> <p>*** If the test results are out of specification tolerance on two consecutive tests for the same size sieve, production shall cease until proper plant adjustments are made.</p> <p>°° Cores shall be taken by the Contractor and the density will be determined by the Department.</p> <p>+ Beginning each production day, no sample for acceptance purposes shall be taken prior to the production of 50 tons. If the random number selected falls within the first 50 tons, the sample shall be taken from the first loaded truck following the truck containing the fiftieth ton produced.</p> <p>++ The sample shall be one set of two gyratory samples+++.</p> <p><u>Note:</u> The testing increment shall have a 150 ton buffer between each increment.</p> <p>+++ When slag is used as an aggregate in the mixture, three gyratory samples shall be compacted. The test result the furthest away from the average of the three test results shall be discarded and the remaining two test results shall be averaged for use in the computation of air voids.</p> <p>++++ Under AASHTO T 308, mixture calibration shall be used. The ignition furnace shall be equipped with an internal weighing system with microprocessor control where sample weight {mass} and percent weight {mass} loss is computed and produced on hard-copy output.</p> <p>*x* Testing in accordance with the requirements given in Section 410 is only required for Job Mix Formulas that have greater than 25 % RAP. Mix shall be tested by an AASHTO accredited laboratory.</p>		

(c) QUALITY ASSURANCE.

1. ACCEPTANCE PROCEDURES.

All materials will be evaluated for acceptance and payment through the Department's Acceptance Procedures specified herein. The Department will be responsible for determining the acceptability and pay factor of the construction and materials incorporated therein.

The Department will utilize the Contractor's QC System test results for liquid asphalt binder content and laboratory compacted air void content for pay purposes except where:

- a. The Department's Quality Assurance testing, as described in Item 3 below and Subarticle 410.08, does not validate the quality of the material.
- b. QC sampling and testing was not performed in accordance with specified procedures.

The Department will determine the sample locations.

The sampling and testing frequencies shall conform to the requirements given in Table 1 for a pay item when the accumulated amount of asphalt mix placed for that pay item exceeds 250 tons {250 metric tons}. The accumulated amount of asphalt mix shall be the current total amount of asphalt mix that has been placed beginning from the start of construction. The sampling and testing frequencies given in Table 1 may be waived by the Division Materials Engineer and the asphalt mix may be accepted by visual observation for a maximum accumulated asphalt mix placement quantity of 250 tons {250 metric tons} or less for any individual pay item. The Engineer will record the results of the acceptance of the asphalt mix on form BMT-16 if sampling and testing is not required.

All conforming and nonconforming inspections and test results will be monitored in accordance with ALDOT-353 and ALDOT-370 and shall be recorded on approved forms and charts which shall be kept up to date and complete and shall be available at all times to the Department during the performance of the work. Only those tests designated by the Department in advance as acceptance tests will be utilized in the computation of pay factors. Test properties shall be charted on forms that are in accordance with the applicable requirements of the Department. A copy of each chart and form to be used by the Contractor will be furnished by the Department. The Contractor shall furnish his own supply of the charts and forms. The Contractor or Producer may design their own forms and charts; however, these must be approved by the Engineer prior to their use.

A LOT is normally defined as 2,800 tons {metric tons} for Section 327, 423 and 424 mixes, and 2,000 tons {metric tons} for Section 420 mixes, consisting of four QC test sets of laboratory tests (liquid asphalt binder content and laboratory air voids or gradation), unless specifically stated otherwise in this item or elsewhere in the specifications. A LOT will usually consist of at least four density tests; however, a LOT may have fewer than four density tests. The Engineer will round a testing increment or a LOT to the nearest truckload of material.

Mix produced after the completion of the last full LOT and small production projects will be evaluated and pay factors computed and may be accepted on the basis of less than four laboratory tests (liquid asphalt binder content and laboratory air voids or gradation) if four tests are not required by Table 1 to complete the LOT or for the total contract quantity.

UNDER REVISION

Each LOT will be accepted on the basis of the actual number of test sets run for that LOT. If the production process is considered out of control (any individual test result for asphalt content, gradation (single sieve), or air voids has a pay factor equal to 0.80 computed from the "1 Test" column in Table II, Table III, or Table VI, of Subarticle 410.08 whichever is appropriate), production shall be suspended and corrections made as outlined in Subarticle 410.08. Gradation pay factors are normally computed on each screen tested and then averaged, however, if any individual screen has a pay factor of 0.80 (before being averaged with the other screen(s)), the process is considered out of control.

The Contractor may voluntarily terminate a LOT when the pay factor will be less than 0.90 when calculated using the one test row of table II, III, and VI in Section 410. If the Contractor terminates a LOT, production shall be suspended and corrections made as outlined in Subarticle 410.08. The voluntary termination of a LOT may only be done once per pay item, per project.

All sampling, testing and computations for a LOT will be completed and pay factors provided the Contractor as soon as possible.

All sampling and testing of materials, including frequency of samples and tests for the Contractor's Quality Control and the Department's verification, shall be performed in strict conformance with the Department's Testing Manual as modified in Table I. This Manual (available on the ALDOT Internet Site) contains guidance for sampling and testing procedures from AASHTO, ASTM, and ALDOT procedures.

2. ACCEPTANCE OR REJECTION.

The decision of the Engineer will be final as to the acceptance, rejection, or acceptance at an adjusted payment of each LOT. Rejected LOTS shall be removed at no cost to the Department and replaced at the contract unit bid price.

3. SAMPLING OF LOTS AND SUBLOTS.

It is the intent of these specifications that each LOT (for mixture testing) and each SUBLLOT (for mat density testing) will meet specification requirements at the time of initial evaluation. No resampling or retesting (other than referee testing described below) will be allowed. The Department will, however, perform at least one liquid asphalt binder content, one maximum specific gravity, one mixture gradation, and one set of three laboratory compacted air void content tests per day, as specified in Table I, to verify the Contractor's test results. If the Contractor is not required to perform a test that day (the tonnage calculated by the random number is not reached), the Department will not run a verification test. The Department will perform a verification test for each LOT, even where there is more than one LOT per day.

The Contractor will be notified by the Engineer as to the point in production at which to procure mixture acceptance samples. The Contractor shall sample the mixture and split it into two samples: the Contractor's primary sample and a referee sample. The portions of mixture for the referee sample shall be bagged, labeled, and stored for testing, if required. All referee samples will be kept by the Department until they are tested (if required). The Contractor shall obtain a sample for each LOT for verification testing by the Department. These samples shall be taken independently from the Contractor's sample at locations directed by the Engineer. The verification sample will be split into two samples: the Department's sample and a Contractor verification sample. The Department will compare the verification sample to the closest (in tonnage) Contractor's primary sample. The sampling of Hot Mix Asphalt is outlined in ALDOT-380, Forms and Examples for Sampling and Computing Pay Factors for Hot Mix Asphalt.

4. TESTING AND LOT VERIFICATION.

Air voids shall be computed on the Contractor's sample by using the running average of the Contractor's last four maximum specific gravities. If slag is used as an aggregate in the mixture, the running average of the Contractor's four most recent determinations for the bulk specific gravity of the compacted mixture shall be used in the computation of the air voids for the Contractor's sample. Air voids shall be computed on the Department's sample by using the Department's individual maximum specific gravity and bulk specific gravity. The Department and the Contractor shall compare test results with each other for the above mentioned testing increments. If there are no differences or if the differences are within the tolerances listed in Tables V or VI, Section 410, for each parameter,

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no further testing and analysis will be necessary and the Contractor's test values will be used in the computation of the appropriate LOT pay factor.

If the results of the Department's verification test and the Contractor's test do not compare within the tolerances in Tables V or VI, Section 410, but yield the same pay factor for the LOT when the Department's result is substituted for the Contractor's result, no further testing will be required. Also, if the Contractor's air voids do not compare with the Department's test results, the Contractor shall re-compute test results using the individual maximum specific gravity for that particular testing increment and re-compare with the verification test result. If the results compare within the tolerances in Table V, Section 410, using the individual maximum specific gravities, no further testing will be required and the Contractor's running average of the last four maximum specific gravities will be used to compute air voids for pay factor determination.

When differences between test results of the verification samples are not within the tolerances listed in Tables V or VI, Section 410, and cannot be resolved by the above mentioned methods, referee testing will be required. All referee samples will be tested by the Bureau of Materials and Tests, Central Laboratory, 3704 Fairground Road, Montgomery, AL 36110. The Bureau of Materials and Tests Central Laboratory is an AASHTO accredited laboratory (see AASHTO R 18, Recommended Practice for Establishing and Implementing a Quality System for Construction Materials Testing Laboratories).

5. REFEREE TESTING

Laboratory:

All testing increments of the referee samples for the entire LOT shall be tested in the Bureau of Materials and Tests Hot Mix Laboratory for the pay factor parameter(s) (liquid asphalt binder content, laboratory compacted air voids, or gradation) in question. The Contractor's results (using the individual air voids and maximum specific gravities) will be compared to the Bureau of Materials and Tests results (using Materials and Tests individual bulk and maximum specific gravities) for each testing increment in the LOT. When the Contractor's results and the Bureau of Materials and Tests results are within the tolerances listed in Tables V or VI, Section 410, the Contractor's results will be used. When the Contractor's results are not within the tolerances listed in Tables V or VI, Section 410, the Bureau of Materials and Tests Central Laboratory results will be used for final pay factors. The Bureau of Materials and Tests Central Laboratory will record the Contractor's field results and the Central Laboratory's results of the parameter(s) in question on form BMT-135.

For each testing increment these results, either the Contractor's or the Bureau of Materials and Tests', will be used in the computation of the appropriate LOT pay factor.

Should differences between test results, that are not within the tolerances listed in Table V or VI, Section 410, for liquid asphalt binder content, air voids, or gradation continue for two consecutive days, operations shall be halted until testing discrepancies can be resolved. The Bureau of Materials and Tests will monitor testing procedures by Department and Contractor technicians until consistent test results are achieved.

Cores:

If the Contractor believes that the core density values determined by the State are in error, the Contractor shall notify the Division Materials Engineer in writing that referee testing is requested. Using the original cores, the Division will again determine the densities of the cores in question using a technician different from the technician who originally determined the core density. If these new densities result in a different pay factor, the new pay factor shall be applied to the tonnage in question (this may increase or decrease the Contractor's pay adjustment).

6. ADJUSTED PAYMENT FOR DEFICIENCIES.

The payment for each LOT will be adjusted on the basis of acceptance test results in accordance with the requirements given in this Section. Accurate records shall be kept of the quantity (tonnage) of plant mix in each LOT.

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Pay factors shall be determined for each LOT from the values given in Tables II, III, IV, and VI, Section 410, in accordance with the following:

Pay Factor For:	Mix 327	Mix 420	Mix 423	Mix 424
Air Voids	N/A	N/A	Table II	Table III
Asphalt Content	Table II	Table II	Table II	Table III
Mat Density	N/A	N/A	Table IV	Table IV
Gradation	N/A	Table VI	N/A	N/A

The lowest numerical pay factor will be applied to the total tonnage {metric tonnage} in each LOT resulting in an adjusted quantity for the LOT for payment purposes. The adjusted quantity will be used to compute payment by applying the appropriate contract unit bid price.

Pay factors above 1.00 will not be applied to mixes that are tested on fewer than three characteristics or when there are less than four laboratory tests (percent liquid asphalt binder and laboratory air voids or gradation) per characteristic; it is not necessary to obtain four roadway densities to obtain a pay factor above 1.00. When the pay factor is calculated to be greater than 1.00, a pay factor of 1.00 will be applied.

(d) ADJUSTMENT PERIOD.

During start-up operations, an adjustment period (test strip) as described below shall be required when producing a new job mix formula. The purpose of the adjustment period will be to permit the Contractor to adjust his production process and for Contractor QC personnel and ALDOT QA personnel to calibrate and coordinate their testing procedures. The Contractor has the option of running a test strip or waiving the test strip, if the proposed job mix formula has been produced satisfactorily on previous projects. The waiver of a test strip shall be in writing to the Project Engineer prior to any production and placement of the previously produced job mix design. The Contractor assumes the risk of milling and relaying unacceptable mix with no additional compensation if the test strip is not utilized.

A test strip of not more than 500 tons {500 metric tons} shall be constructed. If the placement of a test strip is not completed the same day it is begun, the Contractor shall construct a new test strip. Production shall stop until the Contractor has completed one liquid asphalt binder content, one air void content, and four mat density tests for mixes other than 327 and 420. For 327 and 420 mixes the Contractor shall complete one liquid asphalt binder content and one gradation. The pay factors for liquid asphalt binder content, air void content, and gradation will be calculated using the one test row of Table II, Table III and Table VI, and the pay factor for mat density will be calculated using the four test row of Table IV in Section 410. The production point at which the mix shall be sampled shall be determined by the Contractor. This sample does not have to be randomly selected, but should be representative of the mix produced. Contractor mat density tests shall be performed with non destructive density testing devices, meeting the requirements of Section 306, which have been calibrated for the layer being placed according to ALDOT-222, ALDOT-350, or Section 306. The Contractor shall cut cores at these locations and immediately turn the cores over to the Department for density measurements and determination of the pay factor. The Department will conduct the same tests for verification at the same time the Contractor is conducting his tests. If a pay factor of less than 1.00 is obtained using the one test row of Table II, Table III and Table VI, and using the four test row of Table IV in Section 410, a second test strip consisting of 200 tons {200 metric tons} shall be constructed. If a pay factor of less than 1.00 is obtained using the one test row of Table II, Table III and Table VI, and using the four test row of Table IV in Section 410 in the second test strip, additional 200 ton {200 metric ton} test strips shall be constructed until pay factors are equal to 1.00, at which time production can begin. A test strip is determined to be complete when the results of the tests are known.

The Engineer reserves the right to have any test strip removed at no cost to the Department and replaced if the pay factor (using the one test row) for any characteristic for the test strip is 0.80. For actual payment purposes, a pay factor of 1.00 will be used for all first and second test strips allowed to remain in place. Pay factors will be applied to the third and all subsequent 200 ton test strips at the average of the computed rate (using the one test row) and 1.00.

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SECTION 410 HOT MIX AND WARM MIX ASPHALT PAVEMENTS

410.01 Description.

The work under this Section covers the general requirements that are applicable to all types of hot and warm mix asphalt pavements of the plant mix type. Deviations from these general requirements will be indicated in the specific requirements for various types of mixes noted in the following sections of these Specifications.

This work shall consist of one or more courses of hot and warm mix asphalt plant mix constructed in accordance with these specifications and the specific requirements of the type of mixture required and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. The Contractor may use either hot mix or warm mix for Section 424, Superpave ESAL Ranges A/B and C/D only. Once the Contractor starts the production of a mix covered under a pay item, the mix type (hot or warm) for that pay item shall not be changed without the written approval of the ALDOT Construction Engineer. This work shall also include the preparation of the underlying surface on which the plant mix is to be placed, including patching and/or leveling as shown on the plans or directed.

In addition, this work shall also include the placing of widening at locations shown on the plans and/or directed by the Engineer. In general, widening shall consist of (1) narrow width build-ups, three feet or less {one meter or less}, required for widening existing pavement, (2) paving for turn-outs beyond three feet {one meter} from the edge of pavement, (3) pavement crossovers, and (4) turning lanes of less than 200 feet {60 m} for crossovers. Paving used on turn-outs for intersecting paved roads and shoulder paving will not be considered as widening unless shown on the plans.

All ALDOT procedures referenced are applicable to both hot and warm mix asphalt.

410.02 Materials.

(a) APPLICABLE SECTIONS OF SPECIFICATIONS.

Materials shall conform to requirements given in Sections 327, 420, 423 and 424.

(b) PRODUCTS AND PROCESSES FOR THE PRODUCTION OF WARM MIX ASPHALT.

Warm Mix Asphalt products and processes shall be selected from List II-27, of the Department's manual titled "Materials, Sources, and Devices with Special Acceptance Requirements". Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355.

(c) ANTI-STRIPPING AGENTS.

All warm mix asphalt mixtures shall include an anti-stripping agent. The warm mix additive supplier may certify that an anti-stripping agent is an integral part of the warm mix additive.

All hot mix asphalt mixtures except 327 and 420 shall be tested during design to determine if an anti-stripping agent is needed. During design and production, all other mixes shall have a tensile strength ratio (TSR) of at least 0.80 when tested in accordance with AASHTO T 283 as modified by ALDOT-361. If any TSR value falls below the minimum specified above, plant operations shall cease until corrective measures are taken. However, if any visual stripping occurs in the design or field production, an anti-stripping agent shall be required if deemed necessary by the Engineer. Should it become necessary for the Contractor to include an anti-strip agent in the mix due to the occurrence of visual stripping during field production of the mix after the design tests indicated that the same mix met the above listed TSR requirement, such work will be paid for as Extra Work as defined by Article 104.03. Additional payment for the anti-strip agent will not be made in cases where the same mix has been previously used in field production and visual stripping occurred.

The amount of anti-stripping agent, when required, shall be 0.25 to 1.0 % by weight {mass} of the liquid asphalt binder content for liquid agents and 0.5 to 2.0 % by weight {mass} of the total aggregate for powdered agents. Liquid anti-stripping agent shall be added to the liquid asphalt binder

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by approved on-line blending equipment either at the refinery or the Contractor's mixing plant within $\pm 10\%$ of the specified rate.

Silicone may be used in liquid asphalt binder, not to exceed 2 ounces per 5000 gallons {3 ml per 1000 L}. Other additives shall not be added to the liquid asphalt binder unless expressly authorized in writing by the Materials and Tests Engineer.

The use of any unauthorized additive will be cause for rejection of the mixture.

(d) COMPOSITION OF MIXTURES.

1. ADJUSTMENTS TO RATE OF PLACEMENT.

The project designated rate per square yard {square meter} of the plant mix layers are designed assuming a compacted mix unit weight {mass} of not greater than 158 pounds per cubic foot {2530 kg/m³} for dense graded mixes (light weight aggregates excepted.) Hence, a correction to the plan designated rate per square yard {square meter} will be made in accordance with the following:

- If the compacted mix density as determined in the job mix formula design exceeds 158 , or is below 130, pounds per cubic foot, {2530 kg/m³, or is below 2080 kg/m³}, the correction will be based on the formula:

$x = ab/158$ { $x = ab/2530$ }, where

x = corrected rate per square yard {square meter},

a = laboratory compacted mix unit weight in pounds per cubic foot {density in kilograms per cubic meter} as shown in the job-mix formula, and

b = project designated rate per square yard {square meter} of plant mix as shown on the job plans.

- If the laboratory compacted density is between 130 pounds per cubic foot and 158 pounds per cubic foot {2080 kg/m³ and 2530 kg/m³}, no correction will be made to the pounds per square yard {kilograms per square meter} designated by the plans or proposal.

- If the plans provide for the use of lightweight aggregate (expanded clay or shale), the pounds per square yard {kilograms per square meter} of the layer shown by the plans or proposal will not be adjusted.

- If the plans provide for the use of an "Open Graded" plant mix layer, the pounds per square yard {kilograms per square meter} of the layer shown by the plans or proposal will not be adjusted.

2. REQUIREMENT FOR APPROVED JOB MIX FORMULA.

Work shall not be started under this Section on a specific project until the Contractor has submitted and received approval of a job-mix formula from the Materials and Tests Engineer and the job mix formula has been checked by the Division Materials Engineer for use on the project.

A change in aggregate sources will require a new job-mix formula before the new material is used. A change in liquid asphalt binder source and anti-stripping agent will be allowed without a new job-mix formula provided the design criteria is met by a one-point check of the mixture. The one-point check shall include the Air Void, VMA, Stability, Flow, and TSR (Tensile Strength Ratio) and may be determined during the production of the mix. However, no change in the grade of liquid asphalt binder will be allowed without the approval of the Materials and Tests Engineer.

3. CONTRACTOR'S RESPONSIBILITY FOR JOB-MIX FORMULA.

Designs for all mixes shall be the responsibility of the Contractor and shall be submitted by the Contractor for approval. Refer to applicable Sections (420, 424, etc.) for design criteria. The submitted formula shall have been designed by a certified technician (Level III - Designer) in a laboratory that has been certified by the Department.

4. APPROVAL OF JOB MIX FORMULA BY MATERIALS AND TESTS ENGINEER.

The Contractor shall submit to the Materials and Tests Engineer, for approval, a Job Mix Formula (JMF) for each mixture to be supplied from a specific plant. The Contractor shall allow at least four weeks for the evaluation and approval of the job mix formula.

The submitted formula shall include any additive by type and trade name and be accompanied by samples from the material sources he proposes to use in producing the mix. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each

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required sieve size, a single percentage of liquid asphalt binder to be added to the aggregate, a single percentage of any additive, and a mixing temperature range suitable for the type, grade, etc. of liquid asphalt binder to be used in the mix. Each job-mix formula shall be accompanied by a test report from an approved laboratory certifying that all current Departmental design test parameters have been met (copies of the Departmental current design test parameters may be obtained from the office of the Materials and Tests Engineer). There will be no charge for the Department's checking of the Contractor's job-mix formula.

The approved job-mix formula for each mixture shall be in effect for a maximum of four years from the approval date on the JMF or until the Materials and Tests Engineer withdraws approval by written order.

5. APPROVAL OF JOB MIX FORMULA BY DIVISION MATERIALS ENGINEER.

At least two full working days prior to beginning the production of asphalt mix for a specific project, the Contractor shall submit a mix design (approved by the Materials and Tests Engineer) to the Division Materials Engineer. The project number shall be inserted on the approved job mix formula. The Division Materials Engineer will review the mix design to determine if the job mix formula is appropriate for the specific project. If the job mix formula is appropriate for the project, the Division Materials Engineer will sign the mix design as being approved, will note the date of approval, and will distribute copies for inspection of the asphalt production.

A copy of this approved job mix formula with the Materials and Tests Engineer's approval and the Division Materials Engineer's approval (with the date of approval) shall be available at the plant any time material is being delivered to the State.

6. ESTABLISHMENT OF DELIVERY TEMPERATURE.

After the job mix formula has been accepted for use on a specific project, the Contractor shall establish the delivery temperature of the mixture to the project site and inform the Engineer in writing of this temperature before beginning placement of the mix. The Engineer will check and record the temperature of the mixture upon delivery to the project site. The delivery temperature tolerance shall be a plus or minus 20 °F {11 °C} difference from the established delivery temperature. At the Engineer's discretion, isolated loads that are no more than 10 °F {5.5 °C} outside of the plus or minus 20 °F {11 °C} tolerance may be placed if, as determined by the Engineer, there is not a high variability in the delivery temperature, if the field densities are consistent, there is no segregation, no smoothness defects, and there are no factors that cause rapid cooling of the mix (ambient air temperature, wind speed, temperature of the underlying layer, and placement rate).

Loads shall not be delivered at a temperature greater than 350 °F {177 °C}.

7. CONFORMANCE TO APPROVED JOB MIX FORMULA.

All mixtures furnished for use on the project shall conform to the approved job-mix formulas and the established delivery temperature within the following ranges of tolerances:

All liquid asphalt binders used shall meet the requirements given in Section 804. See appropriate pay factor table for liquid asphalt binder content requirements.

The mixing temperature for hot mix shall not exceed 350 °F {177 °C} and the mixing temperature for warm mix shall fall within the range of 215 °F {102 °C} to 280 °F {138 °C}.

Tolerances for 327, 420 and 424 mixes:

- Plus or minus 7 % for the #4 {4.75 mm} and larger sieve requirements.
- Plus or minus 4 % for the #8 through #100 {2.36 mm through 150 μm} sieve requirements.
- Plus or minus 2.0 % for the #200 {75 μm} sieve requirement.

See Section 423 for gradation requirements for 423 mixes.

The initial setting of the controls for all materials shall be those amounts shown on the job-mix formula. The above tolerances are provided for slight variations inherent in job control applications. The Contractor shall make changes as necessary in order that the mixture will run as close as practical to the job-mix formula.

8. CONSISTANCY OF MIX DESIGN IN PLACEMENT OF WEARING LAYER.

More than one job mix formula may be submitted and approved for a layer of pavement. The placement of the entire wearing layer shall be from the same job mix unless otherwise approved in

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writing by the Engineer. For layers other than the wearing layer, the Contractor shall notify the Engineer in writing of the mix design change prior to changing production.

(e) RECYCLED ASPHALT PLANT MIX (RAP) AND RECLAIMED ASPHALT SHINGLES (RAS).

1. COMPLIANCE WITH ALDOT-372.

On all projects utilizing reclaimed material in the mixture, the Contractor's paving operation and RAP and RAS processing shall conform to the requirements given in ALDOT-372. The recycled hot and warm mix asphalt shall be a homogeneous mixture of reclaimed material, new aggregate (fine or coarse aggregate, or a mixture of fine and coarse aggregate) and new liquid asphalt binder material.

2. ALLOWABLE USAGE OF RAP AND RAS.

The Contractor shall have the option to use RAP and RAS in accordance with the requirements given in the following table unless shown otherwise on the plans:

ALLOWABLE USE OF RAP AND RAS Maximum Allowable Percent of RAP and RAS in Total Aggregate Content		
Type of Mix	Maximum RAP Content #	Maximum RAP and RAS Content ** #
327, Plant Mix Bituminous Base	25 %	25 %
327, Permeable Asphalt Treated Base	10 %	RAS Not Allowed
420, Open Graded Friction Course	10 % RAP shall not contain chert	RAS Not Allowed
423, Stone Matrix Asphalt 424, Superpave	Surface Layers: 20 % with no more than 15 % containing chert *; All Other Layers: 25 %	Surface Layers: 20 % *; All Other Layers: 25 %
* This limitation applies even if the surface layer is to be covered by an Open Graded Friction Course. If the aggregate is chert gravel with a bulk specific gravity that is less than 2.550, a maximum of 15 % of the RAP will be allowed. RAP containing chert gravel shall be crushed so that 100 % of the RAP passes the 1/2 inch {12.5 mm} sieve. Additional RAP that does not contain chert gravel may be added to the mixture through a separate feeder. ** RAS shall be limited to 3 % of the total aggregate content when the RAS is consumer waste (from roofing materials) and shall be limited to 5 % of the total aggregate content when the RAS is manufacturing waste. # The Engineer will consider allowing the RAP and RAS content to be greater than 25 % if requested by the Contractor with the submittal of the required testing of the proposed mix.		

3. PROCESSING AND RESTRICTIONS FOR AGGREGATE IN RAP.

RAP used in 3/8 inch {9.5 mm} Section 424 "Superpave" maximum size mix shall be processed so that 100 % of the RAP passes the 1/2 inch {12.5 mm} sieve. For all other mixes, the maximum size of the aggregate in the RAP shall meet the maximum size for the mix specified. The aggregate in the RAP shall meet the aggregate requirements of the mix it is used in and the requirements given in Sections 801 and 802 (no gravel in Section 327 PATB, Section 420 and Section 423 mixes). RAP used in Section 327 PATB and Section 420 mixes shall be processed so that 100 % of the RAP is retained on the No. 4 {4.75 mm} sieve.

4. RECLAIMED ASPHALT SHINGLES (RAS).

Reclaimed Asphalt Shingles (RAS) shall be handled, stored, and used in accordance with the requirements given for RAP and the following requirements.

The RAS shall be materials produced as a by-product of the manufacturing process for roofing shingles and/or scrap shingle (from roofing materials). The RAS shall be composed of approximately 20 % to 30 % asphalt, 30 % to 45 % mineral aggregate, and 18 % to 35 % fiber.

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The RAS shall be free from foreign materials such as paper, nails, wood, and metal flashing. The RAS shall be shredded or ground prior to being incorporated into the mixture so that all of the shredded pieces are less than 1/2 inch {12.5 mm} in any dimension.

5. CONTRACTOR PROPOSED DESIGN WITH INCREASED RAP AND RAS CONTENT.

a. Amount of Increased RAP and RAS Content Allowed for Consideration.

The Contractor may propose a mix using greater than 25 % RAP, or a RAP with RAS blend with a maximum limit of 35 %. This shall only be proposed for underlying layers of Section 424, Superpave ESAL Ranges A/B & C/D mixes. All approved JMF's approved with this increased amount of RAP, or RAP with RAS blend, shall be produced as warm mix asphalt (WMA) only.

b. Design Requirement for the Proposed Use of Increased RAP and RAS.

The Contractor shall have an AASHTO Accredited Laboratory perform a Quantitative Extraction and Recovery (AASHTO T 319, "Standard Method of Test for Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures") on the proposed blend of materials and then perform an Absolute Viscosity test at 140 °F {60 °C} (AASHTO T 202, "Standard Method of Test for Viscosity of Asphalts by Vacuum Capillary Viscometer") on the recovered liquid asphalt binder. The maximum allowable viscosity is 10,000 poises.

The Contractor shall also have the following tests performed by the AASHTO Accredited Laboratory:

- AASHTO T 240, "Standard Method of Test for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven)";
- AASHTO T 315, "Standard Method of Test for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)" after Rolling Thin-Film Oven test;

The Contractor shall also perform the tests given in ALDOT 361, "Resistance of Compacted Hot-Mix Asphalt to Moisture Induced Damage" for the mix blend and report the unconditioned samples for split tensile strength.

A copy of the passing viscosity report along with the rotational viscosity, DSR, and split tensile results shall be included as part of the design JMF submittal.

c. Testing Requirements During Production of Mix with Increased RAP and RAS.

During production, the first Lot and each additional 10,000 tons thereafter shall be sampled and an AASHTO Accredited Laboratory shall perform a Quantitative Extraction and Recovery (AASHTO T 319, "Standard Method of Test for Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures") on the mix and then perform an Absolute Viscosity at 140 °F {60 °C} (AASHTO T 202, "Standard Method of Test for Viscosity of Asphalts by Vacuum Capillary Viscometer") on the recovered liquid asphalt binder.

The Contractor shall also have the following tests performed by the AASHTO Accredited Laboratory:

- AASHTO T 240, "Standard Method of Test for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven)";
- AASHTO T 315, "Standard Method of Test for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)" After the Rolling Thin-Film Oven Test.

The Contractor shall also perform the tests given in ALDOT 361, "Resistance of Compacted Hot-Mix Asphalt to Moisture Induced Damage" for the mix blend and report the test data for the unconditioned samples for split tensile strength.

The contractor shall submit (preferably via email) a report of the results of these tests as soon as possible, but no later than 96 hours after sampling and testing the recovered liquid asphalt binder. A copy of this report shall be sent to the Project Engineer, the Division Materials Engineer, and the State Bituminous Engineer.

d. Additional Requirements for RAP Stockpiles Used in Mixes with Increased RAP Content.

In addition to the requirements set forth in ALDOT-372, RAP stockpiles utilized for JMF's with RAP content greater than 25 % shall also meet the following requirements.

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ADDITIONAL RAP STOCKPILE REQUIREMENTS FOR RAP USED IN A JOB MIX FORMULA WITH INCREASED RAP CONTENT	
Control Parameter	Standard Deviation*
Asphalt Content	0.5 %
% Passing #200 Sieve	1.0 %
Sieve with 50 % RAP Passing	5.0 %
*Based on a minimum of 10 tests	

Testing for RAP stockpile shall be included as part of the design JMF submittal.

(f) LIQUID ASPHALT BINDER DRAINDOWN.

1. FIBER STABILIZER.

A fiber stabilizer is required for some mix types (420, 423, etc). A fiber stabilizer may be used on other mix types where draindown is a problem. When fiber is used, the dosage rate shall be a minimum of 0.30 % for both cellulose and mineral fibers by weight of total mix and shall produce a maximum liquid asphalt binder draindown of 0.30 % or less when tested in accordance with AASHTO T305. When fiber is used, the sampling and testing frequency for all mixes for both Contractor and Department testing during production shall be one test for each 5000 tons {metric tons} or portion thereof. Either cellulose or mineral fibers may be used. The fiber shall be listed on List II-23, Fibers for use in Hot Mix Asphalt (from the Materials, Sources, and Devices with Special Acceptance Requirements (MSDSAR) manual). If pelletized fibers are used, the fiber within the pellet shall be listed on List II-23. All fibers listed on List II-23 shall meet the requirements of either Item 2 or 3 of this Subarticle.

2. CELLULOSE FIBERS.

The maximum length of the fiber shall be 0.25 inches {6.35 mm}. A representative 3 gram sample, when heated in a crucible between 1100 and 1200 °F {595 and 650 °C} for at least 2 hours, shall show between 13 % and 23 % non-volatiles. A representative 5 gram sample, when stirred into 100 ml of distilled water, shall have a pH between 6.5 and 8.5 after sitting for 30 minutes. A representative 5 gram sample, when saturated with mineral spirits for 5 minutes and then sieved for 10 minutes on a No. 40 {425 µm} sieve, shall absorb between 4 % and 6 % its own weight of mineral spirits. A representative 10 gram sample, when weighed and placed into a 250 °F {121 °C} oven for two hours, shall lose less than 5% by weight when weighed immediately upon removal from the oven.

Sieve analysis of the cellulose fiber shall be either of the following methods:

- Using an Alpine Air Jet Sieve (Type LS), a representative 5 gram sample of the fiber is sieved for 14 minutes at a controlled vacuum of 11 psi {75.8 kPa}. The fibers remaining on the screen are weighed. The results of this analysis shall indicate that 60 % to 80 % of the fiber passes the No. 100 {150 µm} sieve. Or:

- Using a Mesh Screen Analysis, a representative 10 gram sample of the fiber is sieved using a shaker with two nylon brushes on each screen. The results of this analysis shall indicate that the fiber has the following amounts passing the specified screens: 75 % to 95 % on the No. 20 {850 µm} sieve, 55 % to 75 % on the No. 40 {425 µm} sieve, and 20 % to 40 % on the No. 140 {100 µm} sieve.

3. MINERAL FIBERS.

When tested according to the Bauer-McNett fractionation, the fiber length shall have a maximum mean test value of 0.25 inches {6.35 mm}. By using a phase contrast microscope, and a representative test sample of at least 200 fibers, the fiber diameter shall have a maximum mean test value of 0.0002 inches {5.1 µm}. The shot content passing the No. 60 {285 µm} sieve shall be 85% to 95%. The shot content passing the No. 230 {65 µm} sieve shall be 60 % to 80 %. This is a measure of non-fibrous material determined on vibrating sieves (for further information see ASTM C 612).

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4. PLACING FIBER IN MIX.

a. Manual Method.

Provided it can be demonstrated to the satisfaction of the Engineer that the proper dosage of the fibers is uniformly distributed into the mix, manual introduction of fibers is acceptable when a batch plant is used to make the mix. When the fibers are available in prepackaged (weighed) containers, proper dosage may be pre-determined per batch. A device is required to interrupt mixture production and warn the plant operator if the operator manually feeding the fiber fails to introduce it properly. Dry mixing time shall be increased at least five seconds to insure adequate blending. Wet mixing time shall be increased at least five seconds for cellulose fibers and up to five seconds for mineral fibers. Manual introduction of fibers shall not be used in drum plants.

b. Automatic Method.

Methodology and equipment for metering bulk loose and pelletized fiber into asphalt plants has been developed by the fiber suppliers; whenever the fiber supplier's recommendations are more stringent than this specification, the fiber supplier's recommendations are controlling. This specification requires specialized equipment that can accurately proportion and meter, by weight {mass}, the proper amount per batch (for batch plants) or continuously, in a steady uniform manner (for drum plants). Fiber, pelletized or loose, shall not be fed through the cold feed bins or through the rap bin.

These proportioning devices shall be interlocked with the plant system and controlled to +/-10% of the weight of the fibers required so as to maintain the correct proportions for all production rates and batch sizes. During the test strip, an equipment calibration check shall be performed to the satisfaction of the Engineer which shows the fiber is being accurately metered and uniformly distributed into the mix. These metering devices shall provide in process highflow (+ 10% or more) and lowflow (-10% or less) plant operator notification and interrupt the mix production where the fiber rate is not properly controlled. The fiber metering system shall also provide a record of feed rate (weight or mass per time) and include a section of translucent pipe for visual confirmation of consistent flow rates. Care shall be taken to insure that the fibers are not entrained in the plant's exhaust system. If there is any evidence of fiber in the bag-house or wet-washer fines, the liquid asphalt binder line and/or the fiber line shall be relocated so that the fiber is captured by liquid asphalt binder spray and incorporated into the mix. If there is any evidence of clumps of fibers or pellets at the discharge chute, the contractor shall increase the mixing time and/or intensity. This may entail extending the liquid asphalt binder and fiber feeding lines further into the drum.

(g) SAMPLING AND INSPECTION.

Aggregates will be accepted in stockpiles in accordance with the Department's Testing Manual provided there is no segregation or contamination, but production of required gradation in the mix shall be the Contractor's responsibility.

Liquid asphalt binder will be accepted on the basis of ALDOT-243.

The right is reserved to take samples, including aggregates from stockpiles, plant mix from the hot elevator, plant mix from the spreader, liquid asphalt binder from storage tanks at the plant, etc., and to make further tests as needed as a basis for continued acceptance of the materials.

Samples of the mixture in use will be taken and tested in accordance with Subarticle 106.09(b).

When directed, the Contractor shall cut samples with mechanical equipment from the compacted pavement for testing. Samples not smaller than 4 inches {100 mm} square or 4 inches {100 mm} in diameter for the full depth of the course to be tested shall be taken at the locations directed by the Engineer. Furnishing of suitable approved cutting equipment, the cutting of the samples, and the immediate repair of the sample holes with similar type of material shall be performed by the Contractor without extra compensation.

A laboratory shall be furnished for the control of each hot and warm mix asphalt plant in accordance with the provisions of Section 601.

UNDER REVISION

410.03 Construction Requirements.**(a) EQUIPMENT.**

In general, choice of equipment will be left to the Contractor and it shall be his responsibility to provide proper sized and amounts of equipment that will produce, deliver to the roadbed, spread, and compact the plant mixed material in sufficient quantities for the continuous movement of the spreaders under normal operating conditions.

The mixing plant, hauling, spreading, and compaction equipment shall meet the requirements listed below; however, other equipment that will produce equally satisfactory results, such as electronically or automatically controlled devices of proven performance, will be considered for use in lieu thereof.

The Contractor shall secure approval of all equipment prior to beginning work and any equipment found unsatisfactory shall be promptly replaced or supplemented.

1. REQUIREMENTS FOR ALL PLANTS.

Mixing plants shall comply with the requirements of AASHTO M 156 as modified by ALDOT-324, Mixing Plant Requirements for Hot-Mixed, Hot-Laid Asphalt Paving Mixtures. In addition to the above, if a recycled/reclaimed mix is used, the mixing plant shall be modified as necessary to accommodate the use of the reclaimed material and necessary additives. Mixing plants shall be inspected at least annually to insure compliance with the requirements of AASHTO M 156 and ALDOT-324. The Contractor/Vendor will be charged a fee as specified by ALDOT-355, General Information Concerning Materials, Sources, and Devices with Special Acceptance Requirements. If the plant is relocated or substantially modified in any way within a year of the last inspection, an additional inspection and related fee will be required.

The plant shall be equipped with a dust collector constructed to waste or store and later return uniformly to the aggregate mixture all or any part of the material collected.

2. SCALES.

A digital recorder shall be installed as part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights {masses} of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process, and so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately determine the weight {mass} of the heaviest loaded truck or tractor trailers that are used for the delivery of the hot and warm mix asphalt from that plant.

In lieu of plant and truck scales, the Contractor may provide either (1) an approved automatic printer system which will print the weights {masses} of the material delivered (evidenced by a weight {mass} ticket for each load), provided the system is used in conjunction with an approved automatic batching and control system, or (2) an electronic load cell weight {mass} determination system with associated computer hardware and automated printing system.

The Contractor may provide a "weigh {mass} batcher" system utilizing a weigh {mass} hopper equipped with load cells that determine the net amount of mix delivered from the weight {mass} hopper. An automated weigh {mass} printing system shall be provided to accurately print the weight {mass} of material delivered, the time, and the date for each ticket.

All scales which determine the weight {mass} of the mix for pay purposes shall meet the requirements of Subarticle 109.01(h).

3. HAULING AND REMIXING EQUIPMENT.**a. Load Limitations.**

Reference is made to Article 105.12 concerning load limitations on hauling equipment.

Wherever a Material Remixing Device is used, the following restrictions shall apply:

- The device shall be empty while on a bridge.
- The device shall be moved across a bridge without any other vehicles or equipment being on the bridge.
- The device shall be moved on a bridge only within the limits of a lane and shall not be moved on the shoulder of a bridge.

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- The device shall move at a speed no greater than 5 miles {8 km} per hour without acceleration or deceleration.

b. Trucks.

Each truck shall have a hole in the side of the body, approximately 5/16 of an inch {8 mm} in diameter and suitably placed, to allow for temperature measurement of the asphalt mix.

Trucks used for hauling hot and warm mix asphalt mixtures shall have tight, clean, smooth metal beds that have been thinly coated with a minimum amount of approved asphalt release agent (List II-6, Hot Mix Asphalt Release Coating for Truck Beds, in the MSDSAR manual) to prevent the mixture from adhering to the beds. The use of gasoline, kerosene, diesel or other volatile material is prohibited.

Each truck shall be equipped with a tarpaulin that shall be used as needed to protect the mixture from adverse conditions. The tarpaulin shall be made of water repellent material, be of sufficient weight and strength to resist tearing and be in good condition with no holes or tears. The tarpaulin shall be large enough to cover the load.

Mixture shall not leave the plant unless the load is covered when the following conditions exist:

- when the air temperature is below 60 °F {15 °C};
- when hauling time exceeds 30 minutes;
- or when threatening weather exists.

c. Material Remixing Device.

When Pay Item 410-H is included in the contract, a material remixing device shall be used for the placement of all asphalt layers except the following:

- 327-E, Permeable Asphalt Treated Base (PATB);
- a layer placed directly on top of PATB if the placement must be accomplished by operating the remixing device on the PATB.

If a pay item is not shown on the Plans, the Contractor may use a material remixing device without compensation.

A material remixing device shall not be placed on a Permeable Asphalt Treated Base.

The material remixing device shall be capable of remixing plant mix between the trucks and the finished mat. Plant mix shall be remixed in the device prior to being laid by the paver or spreader. The plant mix delivered by the material remixing device shall be a homogeneous, non-segregated mixture.

Equipment known to accomplish this remixing operation and currently approved by the ALDOT are the ROADTEC Shuttlebuggy, Terex/Cedarapids CR 662 RM, BLAW-KNOX MC-330/TWIN PUG TUB, and the Weiler E1250.

A material transfer vehicle will not be required for temporary work of short duration, bridge replacements having less than 1000 feet {300 m} of pavement at each end of a bridge, acceleration and deceleration lanes less than 1000 feet {300 m} in length, tapered sections, widening, patching, spot leveling, shoulders, crossovers, ramps, side street returns and other areas designated by the Engineer. A material transfer vehicle will also not be required when placing a continuous leveling layer where the thickness of the layer is required to be transversely tapered (i.e. to correct cross slope) to a thickness less than twice the maximum aggregate size of the layer being placed.

4. HOT AND WARM MIX ASPHALT PAVERS OR SPREADERS.

Hot and warm mix asphalt pavers or spreaders shall be self-contained and of sufficient size, power, and stability to receive, distribute, and strike off the asphalt material at rates and widths consistent with the specified typical section requirements and details shown on the plans and noted in Item 410.03(f)2.

All asphalt pavers or spreaders used for mainline paving, including shoulders and interchange ramps, shall be operated with a full width vibratory, or other compactive type, screed. The augers used to move the material across the width of the screed shall extend within 1.5 feet {450 mm} of the edge of the screed. It will be permissible to use a hydraulically extendable strikeoff for paving turnouts and short sections of pavement including variable width sections and crossovers.

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When laying mixtures, the paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture, providing a finished surface of the required evenness and texture without tearing, gouging, or shoving of the mixture.

All hot and warm mix asphalt paving machines shall be operated with automatic grade and slope controls unless otherwise directed by the Engineer. Equipment operating together shall have the same type controls. The automatic controls may operate either from control grade wires or ski; however, when a ski is used, the spreader shall have a ski of not less than 30 feet {10 m} in length. Both grade and slope controls shall be in good working order at all times. In the event of a malfunction of the automatic control system, the spreading operation shall be discontinued after one hour until the equipment is repaired and restored to first class working order.

5. COMPACTION EQUIPMENT.

Compaction equipment shall be capable of compacting the mixture to the required density throughout the depth of the layer while it is still in a workable condition without damage to the material. The Contractor shall be responsible for the selection of the types and number of rollers to be used.

(b) DAYLIGHT, WET WEATHER AND TEMPERATURE LIMITATIONS.

1. OPERATIONS IN DAYLIGHT.

Placement and compaction operations shall be performed during daylight hours unless noted otherwise on the plans or directed otherwise by the Engineer. (The requirements for lighting for nighttime work are given in Article 104.04(a)).

2. WET WEATHER.

The mixture shall be laid only upon an approved underlying course, which is dry, and only when weather conditions are suitable. The Engineer may, however, permit work of this character to continue when overtaken by sudden rains, up to the amount which may be in transit from the plant at the time, provided the surface just ahead of the placing is swept clear of water and the mixture is within the allowable tolerances from the established delivery temperature. The layer placed under such conditions shall be at the Contractor's risk and shall be removed and replaced by him without extra compensation should it prove unsatisfactory.

3. COLD WEATHER RESTRICTIONS.

Hot mix asphalt (HMA) layers of 200 pounds per square yard {110 kg/m²} or less shall not be placed when the surface or air temperature is below 40 °F {4 °C}; air temperature shall be 40 °F {4 °C} before the spreading operation is started. Spreading operations shall be stopped when the air temperature is below 45 °F {7 °C} and falling. For HMA layers over 200 pounds per square yard {110 kg/m²}, the above temperature may be lowered 5 °F {2 °C}. Unless otherwise stated in the plans and specifications, polymer modified HMA layers of 200 pounds per square yard {110 kg/m²} or less shall not be placed when the surface or air temperature is below 60 °F {15 °C}; for layers over 200 pounds per square yard {110 kg/m²}, the above temperature may be lowered 10 °F {5 °C}.

Warm mix asphalt (WMA) layers of 200 pounds per square yard {110 kg/m²} or less shall not be placed when the surface or air temperature is below 32 °F {0 °C}; air temperature shall be 32 °F {0 °C} before the spreading operation is started. Spreading operations shall be stopped when the air temperature is below 35 °F {2 °C} and falling. For WMA layers over 200 pounds per square yard {110 kg/m²}, the above temperature may be lowered 5 °F {2 °C}. Unless otherwise stated in the plans and specifications, polymer modified WMA layers of 200 pounds per square yard {110 kg/m²} or less shall not be placed when the surface or air temperature is below 50 °F {10 °C}; for layers over 200 pounds per square yard {110 kg/m²}, the above temperature may be lowered 10 °F {5 °C}.

The Contractor, at his discretion, may place HMA and WMA layers at temperatures lower than these cold weather limits. The contractor is warned that other factors such as wind speed and percent humidity may increase the heat loss from the HMA and WMA layers. All other requirements for the installation and quality of the HMA and WMA layers shall be applicable to the work even when the restrictions against placement of the HMA and WMA during cold weather are not followed. The layers placed under such conditions shall be at the Contractor's risk and shall be removed and replaced by

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him without extra compensation should they prove unsatisfactory. There will be no direct payment for additional costs associated with the placement of HMA and WMA during cold weather.

(c) PREPARATION OF UNDERLYING SURFACE.

1. GENERAL.

The underlying surface must be approved before the placing of a plant mix application will be allowed. The underlying surface, whether an old surface or a new surface, shall be thoroughly cleaned of all foreign or loose material and maintained in such condition in advance of the surfacing work.

Failures in existing pavement or base shall be corrected, as noted in Item 410.03(c)2, in advance of the placement of an overlying layer.

A prime coat, when required, shall be placed in accordance with Section 401. A tack coat, when required, shall be placed in accordance with Section 405.

2. PATCHING.

When patching of an existing surface is provided by the plans, the Engineer will examine the pavement surface and designate the area to be patched. The designated areas shall be trimmed to neat vertical lines for the depth of the unstable material as directed. The loose faulty material shall be picked up and removed from the area. The newly exposed patch area shall be cleaned and treated with prime or tack material as directed before placement of patching material. The hot and warm mix asphalt patching material shall be placed and compacted by methods approved by the Engineer until the patch area is filled to the elevation of the surrounding surface. Compaction of the patching material shall be to the degree that further consolidation of the patching material is not anticipated and is acceptable to the Engineer.

3. LEVELING.

When leveling of an existing pavement or base is provided by the plans, the surface shall be brought to proper grade and cross section with plant mix material. The surface to be treated shall be prepared as noted herein and approved before placing the new material. The plant mix material shall be spread in accordance with the provisions of Item 410.03(f)2 and shall be compacted to the satisfaction of the Engineer.

Leveling shall include superelevating when so directed.

4. WIDENING.

When widening is provided by the plans, the widening shall be placed at the locations designated by the plans and/or directed by the Engineer. The requirements for placing of the widening shall be the same, as far as practical, as for the placing of the normal roadway. Compaction of the widening material shall be to the degree that further consolidation of the widening material is not anticipated and is acceptable to the Engineer.

(d) PREPARATION OF MIXTURES.

1. LIQUID ASPHALT BINDER.

The liquid asphalt binder material shall be heated in a manner that insures the even heating of the entire mass under efficient and positive control at all times. Any liquid asphalt binder material which, in the opinion of the Engineer, has been damaged shall be rejected.

2. AGGREGATE.

a. Aggregate Used for Batch Mixing and Continuous Mixing Operations.

All aggregates shall be dried so that the moisture content of the hot and warm mix asphalt at the point of sampling is less than 0.20 % by weight {mass} in accordance with ALDOT-130. The temperature of the aggregate at the dryer shall not exceed 600 °F {315 °C}.

When more than two ingredients enter into the composition of the mineral aggregate, they shall be combined as directed.

The aggregate, immediately after being heated, shall be screened into three or more sizes and conveyed into separate bins, ready for batching and mixing with liquid asphalt binder material. However, for mixes using aggregate of 1/2 inch {12.5 mm} maximum size, the number of bins may be reduced to two.

b. Aggregates for Dryer Drum Mixing Operations.

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Maintenance of a uniform aggregate gradation is essential for a dryer drum operation; hence, caution and care shall be exercised in stockpiling of materials to avoid segregation.

3. MIXING.

a. Mixing Temperature.

The mixing temperature of HMA and WMA shall be in accordance with the refineries' recommendations, based upon the temperature-viscosity curve, and shall be adequate to produce a mixture in accordance with the specification requirements. The mixing temperature for hot mix shall not exceed 350 °F {177 °C} and the mixing temperature for warm mix shall fall within the range of 215 °F {102 °C} to 280 °F {132 °C}.

The mixing temperature for HMA and WMA shall be continuously recorded and delivered to the Engineer on the next working day.

b. Batch Mixing.

The dried mineral aggregate, and measured mineral filler when used, prepared as prescribed above, shall be combined in uniform batches by determining the weight {mass} of and conveying into the mixer the proportionate amounts of each aggregate required to meet the job-mix formula. The largest size aggregate shall be introduced first, then smaller sizes progressively, with mineral filler last, or all mineral components may be added simultaneously. The mineral components shall be thoroughly mixed. The required quantity of liquid asphalt binder material for each batch shall be measured by weight {mass} using scales or a liquid asphalt binder material metering device attached to the liquid asphalt binder material bucket.

After the mineral components have been mixed, the liquid asphalt binder material shall be added and the mixing continued for a period of at least 45 seconds, or longer if necessary to produce a homogeneous mixture. However, if a check by ASTM D 2489 (Ross Method) shows that 95% plus coating is obtained, a shorter mixing time will suffice. The Engineer may then give written permission for a change. Each batch must be kept separate throughout the weight {mass} determining and mixing operations.

The mixture shall be uniform in composition, free from lumps or balls of material containing an excess quantity of asphalt, or from pockets deficient in asphalt.

c. Continuous Mixing.

Components shall be introduced and proportioned volumetrically by continuous methods utilizing equipment specified herein for continuous plants. Amounts of aggregate and liquid asphalt binder material entering the mixer, and the rate of travel through the mixer, shall be so coordinated that a uniform mixture of specified gradation and liquid asphalt binder content will be produced.

d. Dryer-Drum Mixing.

Components shall be proportioned by weight {mass} as noted herein in Item 410.03(a)1 for this method of mixing. Amounts of aggregate and liquid asphalt binder material entering the mixer, and the rate of travel through the mixer, shall be so coordinated that a uniform mixture of specified gradation and liquid asphalt binder content will be produced. An anti-stripping agent may be required to insure adequate coating of the aggregates, if so directed by the Engineer.

4. RECYCLED MIXTURES.

a. New Aggregate Temperature.

The temperature of the new aggregate shall be super-heated to the point where, when combined with the reclaimed material, the specified discharge or delivery temperature is produced; however, in no case shall the temperature of the new aggregate exceed 600 °F {315 °C}.

b. Mixing.

The plant shall be designed and operated so that heat transfer will take place in the mixing unit without damage to, or vaporization of, the liquid asphalt binder material. For batch type plants, a minimum dry mixing cycle of 15 seconds shall be required for the new aggregate and reclaimed material before introduction of the new liquid asphalt binder material. All environmental regulations shall be met as required by Article 107.22.

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(e) TRANSPORTING MIXTURE.

The mixture shall be transported in approved equipment in accordance with Item 410.03(a)3. The equipment shall be in sufficient numbers to deliver the material to the roadbed without delay in the quantity required. Loads shall not be delivered too late in the day to be spread, compacted, and finished during daylight hours, unless nighttime work is allowed as shown on the plans or directed by the Engineer. Loads shall not be delivered at a temperature greater than 350 °F {177 °C} without written permission of the State Materials and Tests Engineer.

(f) PLACING THE MIXTURE.

1. RATE OF PLACEMENT.

The rate of plant mix to be placed will be specified by the plans; however, this rate may require correction to adjust for the compacted mix unit weight {density} as determined in the job-mix formula design as outlined in Subarticle 410.02(b). The Engineer may direct in writing that the designated weight {mass} be increased or decreased in certain areas. It shall be the Contractor's responsibility to place and spread the material uniformly to such thickness as will produce the specified average rate, separately for each layer of base, binder, and surface, and to maintain a continuing check on tonnage {mass} and yardage {area} throughout the day's operation to insure uniform specified rate.

The unit for checking the average rate shall be approximately 5000 square yards {5000 m²} to the nearest even truck load. If the last check performed in any day or any section of roadway is between 2000 and 5000 square yards {2000 and 5000 m²}, this section shall be classified as a unit; if less than 2000 square yards {2000 m²}, this section shall be added to the previous unit and the revised unit rechecked. When the initial day's operation is less than 2000 square yards {2000 m²}, this initial section will be carried over to subsequent days' operations to make a unit of approximately 5000 square yards {5000 m²}.

In any unit checked, the average rate shall not vary from the specified rate by more than 10 pounds per square yard {5 kg/m²} for layers of 200 pounds per square yard {110 kg/m²} or less, and 15 pounds per square yard {8 kg/m²} for layers greater than 200 pounds per square yard {110 kg/m²}. On the first applied layer of resurfacing where there is no required milling or leveling, this tolerance is increased to 15 pounds per square yard {8 kg/m²} for layers of 200 pounds per square yard {110 kg/m²} or less, and 25 pounds per square yard {13 kg/m²} for layers greater than 200 pounds per square yard {110 kg/m²}. This tolerance is for providing leeway in equipment adjustment only. A consistent and uncorrected variation from the specified rate, even within this tolerance, will not be allowed without the Engineer's written approval. This tolerance does not apply to patching, leveling, and widening.

If the average rate of any unit is found deficient by more than the above referenced tolerance, the Engineer will determine (1) whether the Contractor shall remove and replace the deficient unit without payment for the removal or the material removed, or (2) whether the Contractor may leave the deficient unit in place and cover it with a layer of the same mix of adjusted maximum size aggregate of not less than 80 pounds per square yard {45 kg/m²} average. In case (2), the surface layer shall not be feather-edged at the end of the overlay layer, but a sufficient amount of the surface beyond the ends of the deficient unit shall be removed, to a neat line across the pavement, to allow placing the full 80 pounds per square yard {45 kg/m²} and make a joint that will meet the surface requirements. There will be no payment for any portion of the overlay needed to bring the total up to the designated average rate for that unit.

If the average rate of any unit is found to exceed the above referenced tolerance, the tonnage {metric tonnage} in the unit that is in excess of the specified rate will be paid for as specified in Subarticle 410.09(a).

Unless otherwise provided in the following sections of these specifications, or shown on the plans, the average rate placed and compacted in one layer shall not exceed 350 pounds per square yard {200 kg/m²} for base or binder layers, and 200 pounds per square yard {110 kg/m²} for surface layers. Where the amount to be placed exceeds these limits, it shall be placed and compacted in two or more approximately equal layers or as shown on the plans.

2. SPREADING.

a. General.

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Spreading of the hot and warm mix asphalt mixture shall be performed by equipment meeting the requirements of Item 410.03(a)4, except as noted in this Item. Approved specialized equipment may be employed to spread the hot and warm mix asphalt material where standard full scale equipment is impractical due to size and irregularity of the area to be paved.

For hot and warm mix asphalt pavement wearing layers, spreading operations shall be so correlated with plant and hauling equipment that the spreading operation, once begun, shall proceed at a speed as uniform and continuous as practical. The continual forward movement of the spreader requires the use of hauling vehicles capable of supplying the spreader with hot and warm mix asphalt material while the spreader is in motion. Repetitive interruptions or stopping of the spreader shall be cause for the Engineer to stop the work until the Contractor evaluates the cause of the stoppage and has provided a definite action plan for correction of the interruptions. Any interruption will require the thorough check of the area immediately under the spreader and any variances shall be corrected immediately or the material removed and replaced, as directed, without additional compensation.

Material placed in the spreader shall be immediately spread and screeded to such uniform depth that the average rate of the mixture required is secured. Alignment of the outside edges of the pavement shall be controlled by preset control lines, and shall be finished in conformity with these controls.

Any spreading operation, which cannot produce acceptable joints within the surface tolerances and density requirements, shall be cause for requiring the Contractor to modify his operations to include additional spreading equipment.

b. Spreading by Motor Grader.

For areas of a hot and warm mix asphalt plant mix surface inaccessible to the mechanical spreader, patching of pot holes and correcting failures in existing pavement, the plant mix may be dumped in low areas in the amounts directed, windrowed, spread, and compacted to bring the elevation and section to the desired level.

If shown on the plans, the Contractor shall use a motor grader or a motor grader equipped with a dragbox to perform the spreading for the leveling operation. The motor grader shall be equipped with smooth faced tires. The dragbox, when required, shall be of sufficient size and weight {mass} to effectively shape and level the plant mix and shall be approved by the Engineer prior to use.

c. Spreading by Hand.

For areas inaccessible to mechanical spreading equipment, and when patching potholes and minor pavement failures, hand spreading of the hot and warm mix asphalt mixture may be permitted. The mixture shall be distributed immediately into place by means of suitable tools and spread in a uniformly loose layer.

(g) COMPACTING.

As soon as the mixture has been spread and has set sufficiently to prevent undue cracking or shoving, rolling shall begin. A delay in the initial rolling will not be tolerated and the initial or breakdown rolling should in general be performed by rolling longitudinally, beginning at the sides and proceeding toward the center of the surface.

The Contractor as part of his QC plan shall establish a rolling pattern when initially constructing any leveling layers using the nondestructive testing devices approved in Section 306 of the Specifications. The device shall either be calibrated to roadway cores or gage counts and shall be used to determine the rolling pattern producing maximum density. Contractor QC personnel shall be on site throughout each day to perform periodic checks and verify that the rolling pattern continually produces the maximum density that is achievable.

When paving abuts a previously placed lane, the longitudinal joint shall be rolled in the first pass. On superelevated curves rolling shall begin at the low side and progress toward the high side.

If any displacement occurs during rolling, it shall be corrected at once. To prevent adhesion of surface mixture to the rollers, the wheels shall be kept adequately moistened with water and a non-foaming detergent, but an excess of water will not be permitted.

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Adequate precaution shall be taken to prevent dropping of gasoline or oil on the pavement. In places inaccessible to a roller, compaction shall be obtained with hand or mechanical tampers that produce adequate pressure to obtain required density.

Throughout the process of compacting, tests for surface smoothness as required by Article 410.05 and density as required by Section 306 shall be made continuously.

(h) JOINTS.

1. GENERAL.

Placing of hot and warm mix asphalt paving layers shall be as continuous as possible. All joints shall be made in a careful manner in such a way as to provide a smooth, well-bonded, and sealed joint meeting the density and surface requirements of Articles 410.04 and 410.05. Failure to meet requirements noted above shall be cause for ordering the removing and reconstruction of the joint without extra compensation.

The contact surface of concrete structures shall be treated with a thin coat of liquid asphalt binder material, tack material, or the liquid asphalt binder material used in the mix, prior to construction of the joint. When directed by the Engineer, the same treatment noted above shall be used on cold asphalt joints.

2. LONGITUDINAL.

Longitudinal joints in the wearing surface shall conform with the edges of proposed traffic lanes, insofar as practical. Any necessary longitudinal joints in underlying layers shall be offset so as to be at least 6 inches {150 mm} from the joint in the next overlying layer.

3. TRANSVERSE.

Transverse joints shall be carefully constructed. Rollers shall not pass over the unprotected edge of the freshly laid mixture unless laying operations are to be discontinued. To facilitate the expeditious removal of the plant mix joint when laying operations are resumed, the Contractor shall place a heavy wrapping paper on the underlying surface across the joint and place plant mix on top of the paper.

Upon resumption of the work, a neat vertical joint shall be formed into the previously laid material to expose the full depth of the layer. The fresh mixture shall be raked and tamped to provide a well-bonded and sealed joint meeting surface and density requirements.

410.04 Density Requirements.

Density requirements shall be as specified in Table IV, Subarticle 410.08(c).

410.05 Surface and Edge Requirements.

(a) SURFACE SMOOTHNESS REQUIREMENTS.

1. GENERAL.

Surface smoothness and roadway section will be checked by the use of string, Engineer's level, and straight edge.

The Contractor shall furnish string, straightedges, and the necessary personnel to handle them under the supervision of the Engineer.

Surface smoothness tests shall be made continuously during and immediately after rolling so that irregularities may be eliminated to the extent possible by rolling while the material is still workable; otherwise, deficiencies shall be corrected as provided in Article 410.06.

2. PERPENDICULAR TO CENTERLINE OF ROADWAY.

The finished surface of all base, binder, and wearing surface layers shall not vary more than 1/4 of an inch {6 mm} from a 10 foot {3.0 m} straightedge placed perpendicular (at a right angle) to the centerline of the roadway anywhere on the surface.

Unless shown otherwise in the contract, the slope shall not vary by more than 0.20 % from the required slope in any 10 foot {3.0 m} distance over which the slope is measured without the Engineer's written approval. (If, for example, a 2.0 % slope is required, the measured slope shall not be greater than 2.2 % or less than 1.8 %.)

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3. PARALLEL TO CENTERLINE OF ROADWAY.

The surface shall not vary more than 1/4 of an inch {6 mm} from a 16 foot {4.8 m} straightedge placed parallel to the centerline anywhere on the surface. A 16 foot {4.8 m} rolling straightedge, equipped with marking capability, may be used in lieu of the fixed straightedge if approved by the Engineer.

The finished surface shall not vary more than 3/8 of an inch {9 mm} in any 25 foot {8 m} section from a taut string applied parallel to the surface at the following locations: 1 foot {300 mm} inside of the edges of pavement, at the centerline, and at other points designated by the Engineer. The variance from the designated grade shall not increase or decrease by more than 1/2 of an inch {12 mm} in 100 feet {30 m}.

(b) EDGE REQUIREMENTS.

Surface, binder, and leveling pavement edges not confined by curbing or other structures may be lightly tamped, generally with a lute and immediately behind the placement operation, to form an approximately 1:1 slope as a preventative measure against cracking and bulging during the rolling process. This procedure shall also be required on the initial edge of a longitudinal cold joint. These edges shall be neatly shaped to line behind the breakdown roller and shall be trimmed as necessary after final rolling, to an accurately lined string or wire providing a maximum tolerance of 2 inches {50 mm} outside the theoretical edge of pavement, with a maximum variation from a true line of 1/2 of an inch {12 mm} in 10 feet {3 m} and a slope not flatter than 1:1. Edges that are distorted by rolling shall be corrected promptly.

(c) RIDEABILITY REQUIREMENTS.

The rideability requirements covered in this Subarticle shall apply only when either Item 410-A, 410-B, or 410-C is included on the plans or in the proposal.

1. TESTING DEVICE.

a. Description.

The testing device shall be a longitudinal profilograph including all accessories and chart paper herein described. The chart paper containing the log of the smoothness index shall become the property of the Department at the time the measurements are taken. The following categories cover the furnishing and disposition of the profilograph:

Pay Item 410-A - The furnishing, by the Contractor, of a new profilograph, including chart paper, and its reconditioning, if deemed necessary by the Engineer, and title transfer to the Department upon completion of its use on the project.

Pay Item 410-B - The furnishing, by the Department, of a profilograph for use on the project. The Contractor shall furnish the chart paper.

Pay Item 410-C - The furnishing, by the Contractor, of a new or acceptable used profilograph, including chart paper, for use on the project with the Contractor retaining ownership of the profilograph.

b. Equipment Requirements.

The profilograph shall be a California type profilograph, completely equipped with all necessary accessories. The profilograph shall be hand-propelled and shall have multiple averaging wheels.

When the profilograph is required to be furnished by the Contractor, the Contractor shall calibrate the profilograph prior to delivery to the project and shall maintain the profilograph during the time its use is required on the project. When the profilograph is furnished by the State, the Department will calibrate and maintain the profilograph.

Chart paper for the profilograph shall be furnished in sufficient quantities for all calibration, test runs, and actual tests deemed necessary by the Engineer.

c. Equipment Delivery.

The profilograph shall be delivered to the project a minimum of two weeks before the beginning of the paving operation of the pavement layer to be tested to allow time for checking the profilograph.

2. TESTING PROCEDURE.

a. Description.

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Unless shown otherwise by the plans, the following surfaces will be subject to the requirements of this Subarticle if one of the pay items listed in Subitem 410.05(c)1.a. is included in the proposal:

- Actual wearing surfaces including Polymer Modified Open Graded Friction Course (Section 420);
- The surface of the layer directly beneath the Polymer Modified Open Graded Friction Course.

The actual testing procedure shall be as outlined in ALDOT-335, a copy of which may be obtained from the Department’s webpage. The Engineer reserves the right to make minor modifications to this procedure if he deems such will produce better results.

The profilograph test shall be performed as soon as practical after the pavement has been rolled and compacted sufficiently to prevent damage to the surface but no later than the next work day after placement of the pavement, unless otherwise authorized by the Engineer. The Contractor shall furnish the necessary personnel to operate the profilograph under the direction of the Engineer.

The profilograph test is considered a part of the paving operation and will be performed immediately in the proper sequence, in a satisfactory manner, even to the exclusion of other work.

b. Rideability Requirements.

The results of the profilograph tests shall be evaluated by Department personnel as outlined in ALDOT-335.

If a Profile Index of 50.0 inches per mile {800.0 mm/km} is exceeded in any test section of any daily paving operation, the paving operation will be suspended as soon as possible after results of the unacceptable test section are obtained. The paving will not be allowed to resume until corrective action is taken by the Contractor.

When the Profile Index is more than 20.0 inches per mile {320.0 mm/km}, per section, a unit price reduction will be assessed. When the Profile Index is less than 10.0 inches per mile {160.0 mm/km} per section, a unit price increase will be added. The price adjustments are given in the following Table 1.

TABLE I	
Profile Index Inches/Mile/Section {Millimeters/Kilometer/Section}	Contract Price Adjustment Percent of Pavement Unit Bid Price
Under 10.0 {Under 160.0}	105 - (Profile Index/2.0) {105 - (Profile Index/32.0)}
10.0 to less than 20.0 {160.0 to less than 320.0}	100
20.0 thru 50.0 {320.0 thru 800.0}	100 - (Profile Index - 20.0)/1.5 {100 - (Profile Index - 320.0)/24.0}
Over 50.0 {Over 800.0}	Unacceptable

Any price adjustment for rideability considerations will be applied to the theoretical tonnage {metric tonnage}, calculated using the plan specified rate of placement, placed in those sections testing under 10.0, or more than 20.0, inches/mile {160.0, or more than 320.0, mm/km} per section.

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c. Stringline and Straightedge Requirements.

On test sections where the Profile Index is 20.0 inches per mile {320.0 mm/km}, or less, the longitudinal stringline and straightedge requirements of Item 410.05(a)3 may be waived by the Engineer except at transverse construction joints and tie-ins. Within 50 feet {15 m} of all transverse construction joints and tie-ins, and on all test sections where the Profile Index is greater than 20.0 inches per mile or greater {320.0 mm/km}, all requirements of Item 410.05(a)3 will apply.

410.06 Correction of Deficiencies and Defects.

Deficiencies in surface smoothness shall be remedied to the extent practicable by rolling while the material is still workable. Otherwise the layer shall be removed and replaced as necessary to obtain required smoothness. "Skin patching" of a surface layer to correct low areas or heating and scraping to correct high areas will not be permitted. Overlays of not less than 80 pounds per square yard {45 kg/m²} may be authorized by the Engineer for surface smoothness deficiencies provided all material in the overlay is without additional cost to the Department.

Deficiencies in thickness shall be remedied as specified in Item 410.03(f)1.

All areas containing excessive or deficient amounts of liquid asphalt binder, all areas showing unacceptable segregation of materials, and all areas unbonded after rolling shall be removed and replaced at no cost to the Department. Unacceptable segregation of a hot and warm mix asphalt mat is defined as any area in which two six inch {150 mm} cores are taken and the average percent liquid asphalt binder content of the cores have an absolute difference greater than 0.50 percentage points of the design liquid asphalt binder content, or the combined gradation analysis of the two cores on selected sieves has an absolute difference greater than 10 percentage points from the job-mix formula. All testing shall be in accordance with ALDOT-389, "Evaluation of Segregated Areas in Hot Mix Asphalt Pavement." The location of all cores taken for segregation evaluation will be determined by the Department. All coring and traffic control required by ALDOT-389 shall be conducted/supplied by the Contractor at no cost to the Department; however, the Contractor will be reimbursed \$500.00 per core when core results are within tolerances and the coring operations require additional traffic control.

At any time that segregation is determined to be unacceptable, work shall be automatically suspended if positive corrective action is not taken by the Contractor to prevent further segregation in the mat. Upon suspension, the Contractor shall place a test section not to exceed 500 tons {500 metric tons} of the affected mixture for evaluation by the Engineer. However, if after a few loads it is apparent that the corrective actions were not adequate, work shall again be suspended and the segregated areas evaluated in accordance with ALDOT-389. Likewise, if after 500 tons {500 metric tons} it is apparent that the problem has been solved, work will be allowed to continue.

When correcting subsurface mixtures (base and binder layers), the removal and replacement may be limited to the actual defective areas or the full mat width within the limits of individual defective areas as directed by the Engineer. Removal and replacement of hot and warm mix asphalt wearing surface layers shall be a minimum of the full mat width and 10 feet {3 m} in length. All surface tolerance requirements shall apply to the corrected areas for both subsurface and surface mixes.

Areas found deficient in density shall be removed and replaced or immediately re-rolled until density is acceptable.

All work specified in this Article shall be performed without additional compensation.

410.07 Maintenance and Protection.

Sections of newly finished work shall be protected from all traffic until they become properly hardened. Maintenance shall include immediate repairs of any defects that may occur on the work; such repairs shall be repeated as often as necessary to maintain the work in a continuously satisfactory condition. The Contractor shall be responsible for the protection of the work and protection of any traffic using the work. No extra compensation will be paid for maintenance and protection.

410.08 Method of Measurement.

(a) GENERAL.

The accepted quantity of hot and warm mix asphalt plant mix used as directed will be measured in tons of 2000 pounds {metric tons} in accordance with the following:

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When the laboratory compacted density as determined in the job-mix formula design exceeds 158 pounds per cubic foot {2530 kg/m³}, the actual total tonnage {metric tonnage} of mix placed will be adjusted for pay purposes in accordance with the following formula (this shall not apply to Section 327 PATB and Section 420 OGFC):

$$y = 158 c / a \quad \{ y = 2530 c / a \}, \text{ where}$$

y = total tonnage {metric tonnage} of plant mix for pay purposes;

c = actual tonnage {metric tonnage} of plant mix measured and placed, except items subject to pay factor adjustment under the QC/QA provisions. On items subject to pay factor adjustment, the adjusted tonnage {metric tonnage} (after pay factor adjustment) will be used;

a = laboratory compacted mix unit weight in pounds per cubic foot {density in kilograms per cubic meter} as shown in the job-mix formula.

No adjustments to the actual total tonnage {metric tonnage} placed will be made where the laboratory compacted mix density is below 158 pounds per cubic foot {2530 kg/m³}.

No adjustments to the actual tonnage {metric tonnage} placed will be made when the use of lightweight aggregate (expanded clay or shale) is designated.

For determining weight {mass}, each load of hot and warm mix asphalt mixture shall have its weight {mass} determined on approved certified scales, as specified in Article 109.01, furnished by the Contractor without direct compensation.

The weight {mass} measurement shall include all components of the mixture. No deductions will be made for any of the components, including the liquid asphalt binder material, contained in the mixture.

The laboratory compacted density requirements for OGFC are given in Section 420. Section 327 PATB does not have a laboratory compacted density requirement because a layer thickness (typically 4 inches {100 mm}) is required instead of a rate of placement.

(b) ACCEPTANCE OF THE MIXTURE.

The hot and warm mix asphalt mixture will be evaluated at the plant on a LOT to LOT basis. The material will be tested for acceptance in accordance with the provisions of Section 106 and the following requirements. However, any load or loads of mixture, which, in the opinion of the Engineer, are obviously unacceptable, will be rejected for use in the work.

The Contractor shall control all operations in the handling, preparation, and mixing of the hot and warm mix asphalt plant mix so that the percent liquid asphalt binder and voids in laboratory compacted samples or gradation will meet the approved job-mix formula within the tolerances shown in Tables II, III, and VI for the 1.00 pay factor. In recognition of the fact that the drying and screening operations may generate additional dust over that shown in the approved mix design, the Contractor's attention is drawn to the realization that the dust must be controlled in order to control VMA and voids in the total mix.

Acceptance of the mixture will be in accordance with Subarticle 106.09(c).

LOT pay factors for asphalt content and air voids will be determined from Table II for Section 423 mixes and from Table III for a Section 424 mix after the requirements of Item 106.09(c)3 are satisfied. LOT pay factors for asphalt content will be determined from the top half of Table II for Section 327 and 420 mixes after the requirements of Item 106.09(c)3 are satisfied. Air voids are not a pay factor for Section 327 and 420 mixes. Gradation is shown as a pay factor for Section 420 mixes in Table VI. The pay factor values determined for the each sieve noted in Table VI will be averaged. This average will then be compared to the asphalt content pay factor. The lowest of these two pay factors will be applied to the mix.

Calculations for the acceptance test results for asphalt content and voids in total mix shall be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01). Calculations for averages shall be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01) in accordance with AASHTO R 11 rules of rounding. LOT pay factors will be calculated to the nearest hundredth (0.01).

Payment for Section 327 and 423 mixes will be on the basis of Table II Acceptance Schedule for Payment. Payment for a Section 424 mix will be on the basis of Table III Acceptance Schedule for Payment. Payment for Section 420 mixes will be on the basis of Table II and Table VI.

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(c) SUSPENSION AND VOLUNTARY TERMINATION OF LOTS.

The production process will be considered out of control when any individual test result (asphalt content, gradation, or air voids) from a LOT has a pay factor equal to 0.80 computed from the "1 Test" row in Table II, Table III, or Table VI, whichever is appropriate. When gradation is a pay factor, a 0.80 result for an individual screen (before averaging) is considered out of control. If any single gradation for the 327 mixes falls outside of the gradation band shown in Section 327 the process is considered out of control. When this happens, production shall be suspended. If mix from the suspended LOT is contained in storage/surge bins, that mix will be considered part of the suspended LOT, and shall not be placed on any State project.

When production is suspended as described above, or when the contractor voluntarily terminates a lot, production shall not be re-started until after all of the following has been accomplished:

- (1) the Contractor shall notify the Project Engineer immediately that the process is out of control, or that the LOT has been terminated voluntarily, and that production has been suspended;
- (2) the Contractor shall determine what adjustments to make in order to bring the process under control and inform the Project Engineer in writing of these adjustments;
- (3) after adjustments, the Contractor shall produce sufficient mix (approximately 25 to 35 tons {25 to 35 metric tons}) as a trial batch and test for control parameters (asphalt content, gradation, and air voids);
- (4) adjustments, trial batches, and tests shall be repeated as many times as necessary until pay factors for asphalt content, gradation, and air voids equal 1.00, minimum, at which time production may be re-started. Mix utilized as a trial batch shall not be used on the project.

(d) ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS.

TABLE II						
SECTION 327 MIXES**						
SECTION 420 MIXES (OPEN GRADED FRICTION COURSE)**						
SECTION 423 MIXES (STONE MATRIX ASPHALT)						
ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS						
Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values						
Asphalt Content						
LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-0.48	0.49-0.51	0.52-0.57	0.58-0.66	Over 0.66
2 Tests	-	0.00-0.34	0.35-0.36	0.37-0.40	0.41-0.47	Over 0.47
3 Tests	-	0.00-0.28	0.29-0.29	0.30-0.33	0.34-0.38	Over 0.38
4 Tests	0.00-0.14	0.15-0.24	0.25-0.26	0.27-0.28	0.29-0.33	Over 0.33
Voids in Total Mix (Lab. Compacted Samples)						
LOT Pay Factor ->	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-1.50	1.51-1.62	1.63-1.80	1.81-2.10	Over 2.10
2 Tests	-	0.00-1.06	1.07-1.15	1.16-1.27	1.28-1.48	Over 1.48
3 Tests	-	0.00-0.87	0.88-0.94	0.95-1.04	1.05-1.21	Over 1.21
4 Tests	0.00-0.45	0.46-0.75	0.76-0.81	0.82-0.90	0.91-1.05	Over 1.05
* If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.						
** The Acceptance Schedule of Payment for "Voids in Total Mix" will not apply to the 327 and 420 mixes						

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TABLE III						
SECTION 424 MIXES (SUPERPAVE)						
ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS						
Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values						
Asphalt Content						
LOT Pay Factor - >	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-0.62	0.63-0.68	0.69-0.75	0.76-0.88	Over 0.88
2 Tests	-	0.00-0.44	0.45-0.48	0.49-0.53	0.54-0.62	Over 0.62
3 Tests	-	0.00-0.36	0.37-0.39	0.40-0.43	0.44-0.51	Over 0.51
4 Tests	0.00-0.19	0.20-0.31	0.32-0.34	0.35-0.38	0.39-0.44	Over 0.44
Voids in Total Mix (Lab. Compacted Samples)						
LOT Pay Factor - >	1.02	1.00	0.98	0.95	0.90	0.80*
1 Test	-	0.00-2.50	2.51-2.70	2.71-3.00	3.01-3.50	Over 3.50
2 Tests	-	0.00-1.77	1.78-1.91	1.92-2.12	2.13-2.47	Over 2.47
3 Tests	-	0.00-1.44	1.45-1.56	1.57-1.73	1.74-2.02	Over 2.02
4 Tests	0.00-0.75	0.76-1.25	1.26-1.35	1.36-1.50	1.51-1.75	Over 1.75
* If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.						

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TABLE VI				
SECTION 420 MIXES (OPEN GRADED FRICTION COURSE)				
ACCEPTANCE SCHEDULE OF PAYMENT FOR ASPHALT PLANT MIX CHARACTERISTICS				
Arithmetic Average of the Absolute Values of Deviations of the LOT Acceptance Tests From Job Mix Formula Values				
Gradation 3/8" {9.5 mm} Sieve				
LOT Pay Factor	1 Test	2 Tests	3 Tests	4 Tests
1.02	-	-	-	0.00 - 3.60
1.00	0.00 - 12.00	0.00 - 8.48	0.00 - 6.93	3.61 - 6.00
0.98	12.01 - 12.96	8.49 - 9.16	6.94 - 7.48	6.01 - 6.48
0.95	12.97 - 14.40	9.17 - 10.18	7.49 - 8.31	6.49 - 7.20
0.90	14.41 - 16.80	10.19 - 11.88	8.32 - 9.70	7.21 - 8.40
0.80*	Over 16.80	Over 11.88	Over 9.70	Over 8.40
Gradation No. 8 {2.36 mm} Sieve				
LOT Pay Factor	1 Test	2 Tests	3 Tests	4 Tests
1.02	-	-	-	0.00 - 2.40
1.00	0.00 - 8.00	0.00 - 5.66	0.00 - 4.62	2.41 - 4.00
0.98	8.01 - 8.64	5.67 - 6.11	4.63 - 4.99	4.01 - 4.32
0.95	8.65 - 9.60	6.12 - 6.79	5.00 - 5.54	4.33 - 4.80
0.90	9.61 - 11.20	6.80 - 7.92	5.55 - 6.47	4.81 - 5.60
0.80*	Over 11.20	Over 7.92	Over 6.47	Over 5.60
The comparison value for ALDOT and Contractor testing for the 3/8" {9.5 mm} and No. 8 {2.36 mm} sieves is +/- 2.0%.				
* If approved by the Department, the Contractor may accept the indicated LOT partial pay. The Department may require removal and replacement. If the LOT pay factor is greater than 0.80, the Contractor has the option to remove at no cost to the Department and to replace at contract unit bid price rather than accepting the reduced LOT payment.				

(e) ACCEPTANCE OF THE ROADWAY DENSITY.

For other than mainline paving (patching, widening, crossovers, and leveling), in-place density pay factors will not be applied. For mainline paving (including shoulders, ramps, and acceleration/deceleration lanes), in-place density pay factors will be applied as specified herein unless otherwise noted on the plans or in the specifications.

After the hot and warm mix asphalt mixture has been placed and compacted, it shall be evaluated for density. A core for mat density determination shall be taken by the Contractor on each 3000 foot {900 m} segment of roadway lane of asphalt mixture placed. The location of each test will be designated by the Department. The core shall meet a minimum thickness for use in determining the roadway density. If the core's average thickness in inches {millimeters} is not at least 0.008 times the rate in pounds per square yard {0.375 times the rate in kilograms per square meter}, another core shall be taken where the Engineer believes the pavement is thick enough for roadway density determination (as close a practical to the original location). The core's average thickness shall be determined by measuring the core's thickness at six equidistant locations around the circumference of the core. The Department will take immediate possession of the core and will make a density determination of the core in accordance with AASHTO T 166. The density values of the cores will be used to compute the pay factor for that subplot. Testing locations will be selected with the random number method outlined in ALDOT-210. Contractors are allowed, but not required, to take cores anywhere, anytime for quality control. This includes taking cores from the wearing layer. The contractor must have the permission of the Engineer to take cores from a PATB (327) or OGFC (420) mix. All core holes shall be promptly repaired at the contractor's expense. For purposes of evaluation, a LOT will be as defined in Item 106.09(c)1. A SUBLOT for evaluation of density will be equal to 12,000 feet {3600 m} (4 test results) or fraction of a 12,000 foot {3600 m} length as applicable. For instance, a 27,000 foot {8100 m} LOT would be divided into two 12,000 foot {3600 m} SUBLOTS and one 3000 foot {900 m} SUBLOT.

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The in-place density will be expressed as a percentage of the theoretical maximum mix density with the following relationship:

$$\% \text{ TMD} = \frac{\text{In-place Density}}{\text{Maximum Mix Density}} \times 100$$

Maximum mix density is equated to maximum mix specific gravity as measured with AASHTO T 209, Flask determination with dry back. The maximum mix specific gravity used will be the average of the values from the four most recent determinations using Contractor data.

The appropriate pay factor for each SUBLOT will be determined from Table IV for the appropriate number of test results. The pay factor for the LOT will be determined by computing the weighted average of the SUBLOTS:

$$\text{LOT Pay Factor (PF)} = \frac{\text{PF SUBLOT 1 (Length SUBLOT 1)} + \text{PF SUBLOT 2 (Length SUBLOT 2)} + \dots}{\text{Length SUBLOT 1} + \text{Length SUBLOT 2} + \dots}$$

Calculations for the acceptance test results for in-place density will be carried to the hundredths (0.01) and rounded to the nearest tenth (0.1). LOT and SUBLOT pay factor calculations will be carried to the thousandths (0.001) and rounded to the nearest hundredth (0.01) in accordance with AASHTO R 11 rules of rounding.

The low rates of placement at which minimum density does not apply are given in Section 306. Density pay factors will not be applied to pavement layers placed at these rates.

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TABLE IV ACCEPTANCE SCHEDULE OF PAYMENT FOR IN-PLACE DENSITY					
SECTION 423 MIXES (STONE MATRIX ASPHALT)					
Characteristic	SUBLOT PAY FACTOR	Arithmetic Average of the Absolute Values of Deviations of SUBLOT Acceptance Tests From Target**			
		1 Test	2 Tests	3 Tests	4 Tests
In-Place Density	1.02	0.00 - 2.00	0.00 - 1.41	0.00 - 1.15	0.00 - 1.00
	1.00	2.01 - 3.33	1.42 - 2.36	1.16 - 1.92	1.01 - 1.67
	0.98	3.34 - 3.60	2.37 - 2.55	1.93 - 2.08	1.68 - 1.80
	0.95	3.61 - 4.00	2.56 - 2.83	2.09 - 2.31	1.81 - 2.00
	0.90	4.01 - 4.67	2.84 - 3.30	2.32 - 2.69	2.01 - 2.33
	0.80*	Over 4.67	Over 3.30	Over 2.69	Over 2.33
SECTION 424 MIXES (SUPERPAVE)					
Characteristic	SUBLOT PAY FACTOR	Arithmetic Average of the Absolute Values of Deviations of SUBLOT Acceptance Tests From Target**			
		1 Test	2 Tests	3 Tests	4 Tests
In-Place Density	1.02	0.0-2.25	0.0-1.59	0.0-1.30	0.0-1.12
	1.00	2.26-3.75	1.60-2.65	1.31-2.17	1.13-1.88
	0.98	3.76-4.05	2.66-2.86	2.18-2.34	1.89-2.02
	0.95	4.06-4.50	2.87-3.18	2.35-2.60	2.03-2.25
	0.90	4.51-5.25	3.19-3.71	2.61-3.03	2.26-2.62
	0.80*	Over 5.25	over 3.71	over 3.03	Over 2.62
<p>* If approved by the Department, the Contractor may accept the indicated partial SUBLOT pay. The Department may require removal and replacement. The Contractor has the option to remove at no cost to the Department and replace at contract unit bid price rather than accepting the reduced SUBLOT payment.</p> <p>** Target density shall be 94.0 % of the theoretical maximum density for all mixes except for: - the range of placement rates given in Item 306.03(g)3 (140 pounds per square yard or greater {76 kg per square meter or greater} and less than 200 pounds per square yard {109 kg per square meter} over surface treatments) the target density shall be 92.0 % and; - ESAL Range A and B mixes where the Contractor demonstrates and explains in writing why 94 % of the theoretical maximum density cannot be achieved and the Engineer informs the Contractor by written notification that the target density can be reduced to 93 % or 92 %.</p>					

TABLE V COMPARISON OF ALDOT AND CONTRACTOR TESTING	
TEST	ACCEPTABLE
ASPHALT CONTENT	± 0.30 %
AIR VOIDS	± 0.50 %
MAT DENSITY, GAGE vs. CORES	± 1.50 %
GRADATION *	See Table VI
* Gradations given in Articles 327.02 and 420.02.	

(f) TACK COAT.

Tack coat liquid asphalt material used as directed will be measured and paid for as specified in Section 405.

(g) WASTED AND EXCESS MATERIALS APPLIED.

Deductions in measurement will be made for all material wasted or lost due to negligence of the Contractor or applied beyond the limits of the work.

(h) PROFILOGRAPH.

The number of profilographs measured for payment will be the actual number of units ordered and accepted.

(i) MATERIAL REMIXING DEVICE.

The number of material remixing devices measured for payment will be the number of units approved by the Engineer for use. These devices will be measured per each device.

410.09 Basis of Payment.

(a) UNIT PRICE COVERAGE.

Compensation for plant mix material, measured as provided above, will be made on a tonnage {metric tonnage} basis and the contract unit price per ton {metric ton} for each individual item shall be full compensation for construction of the hot and warm mix asphalt plant mix layer complete in place on the roadbed as indicated or directed, including all materials, procurement, handling, hauling, and processing cost, and includes all equipment, tools, labor, and incidentals required to complete the work.

Unless otherwise covered by a separate pay item, the cost of excavation for patching and widening, compacting the subgrade, backfilling, spreading, or disposing of excess excavated material, removal and disposal of old pavement, removal and resetting of roadway signs and mailboxes, and removal and disposal of pavement markers shall be subsidiary obligations of the associated plant mix pay item, and no additional payment will be made for performing the work.

No payment will be made for unacceptable material; for material needed to overlay layers deficient in thickness; for material used in replacing defective or condemned construction; for material wasted in handling, hauling, or otherwise; or for maintaining the work.

When the average rate of placement is found to exceed the tolerance given in Item 410.03(f)1., the tonnage {metric tonnage} placed above the specified rate in that unit will be paid for at 50 percent of the contract unit price. This reduction will not be applied to patching, leveling, and widening.

The ordered and accepted profilographs, measured as noted above, will be paid for at the contract unit price bid which shall be full compensation for furnishing the unit and includes all equipment, tools, labor, calibration, maintenance, services, supplies, chart paper, and incidentals necessary to complete these items of work.

The number of approved remixing devices, measured as noted above, will be paid for at the contract unit bid price. This price shall be full compensation for furnishing the vehicles and shall include all equipment, tools, labor, calibration, maintenance, services, operator, and all other items necessary to furnish and operate the vehicles.

(b) PAYMENT WILL BE MADE UNDER ITEM NO.:

See Appropriate Section for Type of Plant Mix Involved.

410-A Profilograph - per Each

410-B State Furnished Profilograph - per Each

410-C Contractor Retained Profilograph - per Each

410-H Material Remixing Device - per Each

**SECTION 424
SUPERPAVE BITUMINOUS CONCRETE BASE, BINDER, AND
WEARING SURFACE LAYERS**

424.01 Description.

The work covered by this Section shall consist of a hot or warm bituminous plant mixed pavement layer placed on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, typical cross section, and the approximate placement rate shown on the plans or as directed.

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The Contractor may use either hot mix or warm mix for Section 424, Superpave ESAL Ranges A/B and C/D only. Once the Contractor starts the production of a mix covered under a pay item, the mix type (hot or warm) for that pay item shall not be changed without the written approval of the ALDOT Construction Engineer.

General requirements for all bituminous concrete pavements as specified in Section 410 are applicable to this Section, subject to any exceptions contained herein. Quality Control/Quality Assurance (QC/QA) requirements as specified in Section 106 are applicable to this section, subject to any exceptions contained herein.

The work will be accepted on a LOT by LOT basis in accordance with the applicable requirements.

424.02 Materials.

The materials furnished for use shall conform to the requirements of Section 410 and the following:

(a) AGGREGATES.

1. PROCEDURE FOR ACCEPTANCE OF COARSE AND FINE AGGREGATES.

All fine and coarse aggregate furnished shall come from an approved producer who is participating in and meeting the requirements of ALDOT-249, *Procedure for Acceptance of Coarse and Fine Aggregates*. The producer's name shall be listed in the Department's *Materials, Sources, and Devices with Special Acceptance Requirements Manual*, List I-1. The Department has established a list of qualified producers of fine and coarse aggregates. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list.

2. TYPES OF ACCEPTABLE COARSE AGGREGATES FOR SUPERPAVE.

Coarse aggregate shall be aggregate retained on the No. 4 {4.75 mm} sieve.

Coarse aggregate shall consist of crushed (or uncrushed) gravel with a bulk specific gravity greater than 2.550 (AASHTO T 85), crushed stone, or crushed slag, or a combination thereof having hard, strong, durable pieces, free from adherent coatings, and meeting all requirements of these specifications.

3. FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATES FOR SUPERPAVE.

The maximum amount of flat and elongated particles in coarse aggregate for Superpave is given in the following table.

PERCENT OF FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE FOR SUPERPAVE		
Test Method		Maximum
Flat & Elongated % by Count 5:1 (max to min)	ASTM D 4791 Section 8.4	10 % *
* Shall not apply to the 3/8 inch {9.5 mm} mix or to ESAL Range A/B		

4. COARSE AGGREGATE SOUNDNESS FOR SUPERPAVE.

The percent degradation of the source aggregate by the sodium sulfate soundness test (AASHTO T 104, Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate) after five cycles of testing shall not exceed 10 %.

5. DELETERIOUS MATERIALS AND ABSORPTION IN COARSE AGGREGATE FOR SUPERPAVE.

The amount of deleterious substances and absorption in the coarse aggregate shall not exceed the following limits:

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RESTRICTION OF DELETERIOUS MATERIALS AND ABSORPTION IN COARSE AGGREGATE FOR SUPERPAVE	
Coal and Lignite (Visual)	0.25 %
Clay Lumps and Friable Particles (AASHTO T 112)	0.25 %
Other local deleterious substances (Shale, Mica, Marcasite, etc.) (Visual)	2.0 %
Absorption (Absorption on the material passing the 3/4 inch {19.0 mm} sieve and retained on the No. 4 {4.75 mm sieve}) (AASHTO T 85 *). Applies to gravel aggregates only.	2.0 %
* Section 8.1 of AASHTO T 85 modified to require a 15 minute vacuum saturation period as per Section 6.3 of AASHTO T 209 prior to the required 15-19 hour soaking period.	

6. LOS ANGELES ABRASION CRITERIA FOR COARSE AGGREGATE FOR SUPERPAVE.

The percent loss of the coarse aggregate by the LA Abrasion test (AASHTO T 96, Resistance to Abrasion of Small Size Aggregate by use of the Los Angeles Machine) shall not exceed 48 % except that, for Sandstone and Blast Furnace Slag, the LA Abrasion shall not exceed 55 %.

7. FINE AGGREGATE FOR SUPERPAVE.

Fine aggregate shall be aggregate passing the No. 4 {4.75 mm} sieve. Gravel used to manufacture fine aggregate shall have a bulk specific gravity greater than 2.550 (AASHTO T 85).

The fine aggregate shall be non-plastic when tested in accordance with AASHTO T 89, as modified by ALDOT-232, and AASHTO T 90 and shall have a maximum of 1.0 % clay lumps and friable particles as determined by AASHTO T 112. It shall consist of hard, tough grain, free of injurious amounts of clay, loam, or other deleterious substances.

8. CLAY CONTENT FOR SUPERPAVE.

The amount of clay material, as indicated by the sand equivalent, measured on the aggregate passing the No. 4 {4.75 mm} sieve as determined by AASHTO T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test, shall be no less than the values defined in the following table according to the total design traffic in equivalent single axle loads (ESALs).

CLAY CONTENT CRITERIA FOR SUPERPAVE		
ESAL Range	Traffic (ESALs)	Sand Equivalent
A/B	ESALs < 1.0x10 ⁶	≥ 40.0
C/D	1.0x10 ⁶ ≤ ESALs < 1.0x10 ⁷	≥ 45.0
E	1.0x10 ⁷ ≤ ESALs < 3.0x10 ⁷	≥ 45.0

9. MINERAL FILLER FOR SUPERPAVE.

Mineral filler shall consist of finely divided mineral matter such as rock dust, slag dust, hydrated lime, hydraulic cement, or fly ash meeting the requirements of Section 805.

The introduction of mineral filler shall be in accordance with AASHTO M 156, Section 3.3, as specified in ALDOT-324, with the additional requirement that accurate proportioning shall be accomplished by means of pneumatic or mechanical metering.

(b) RECYCLED ASPHALT PAVEMENT (RAP) & RECLAIMED ASPHALT SHINGLES (RAS).

The requirements for allowing the use of RAP and RAS are given in Article 410.02.

(c) BLEND OF AGGREGATES.

1. GRADATIONS FOR BLEND OF AGGREGATES.

The coarse and fine aggregates, mineral filler, and recycled material shall be combined in a total blend that will produce an acceptable job mix within the gradation limits determined by the maximum and minimum control points and a restricted zone as shown in the following tables. Restricted zones are a function of the maximum particle sizes in the blended gradations. Maximum particle size is defined as the sieve size that is two sizes larger than the first sieve to retain more than 10 % of the material. The sequence of sieve sizes to be used in determining maximum particle size is given in the following tables. Gradation charts illustrating gradation requirements are given in Article 424.03.

The required mix will be shown on the plans. Unless otherwise shown on the plans, binder and base layer mixtures may be designed on either the fine or coarse side, or through of the restricted zone. All wearing layers shall be designed either through the restricted zone or on the fine side of the restricted zone. Also, all ESAL range "E" mixes shall exhibit 4.50 mm or less rutting when

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tested according to ALDOT-401, Rutting Susceptibility Determination of Asphalt Paving Mixtures Using the Asphalt Pavement Analyzer.

AGGREGATE GRADATION CONTROL POINTS AND BOUNDARIES OF RESTRICTED ZONE FOR SUPERPAVE 1 1/2 inch {37.5 mm} Maximum Size Mix		
Sieve Size	Control Point (Percent Passing)	
	Minimum	Maximum
No. 200 {75 μ m}	1	7
No. 8 {2.36 mm}	19	45
3/4" {19 mm}	-	90
1" {25 mm}	90	100
1.5" {37.5 mm} Maximum	100	-
Restricted Zone		
No. 4 {4.75 mm}	39.5	39.5
No. 8 {2.36 mm}	26.8	30.8
No. 16 {1.18 mm}	18.1	24.1
No. 30 {600 μ m}	13.6	17.6
No. 50 {300 μ m}	11.4	11.4

AGGREGATE GRADATION CONTROL POINTS AND BOUNDARIES OF RESTRICTED ZONE FOR SUPERPAVE 1 inch {25.0 mm} Maximum Size Mix		
Sieve Size	Control Point (Percent Passing)	
	Minimum	Maximum
No. 200 {75 μ m}	2	8
No. 8 {2.36 mm}	23	49
1/2" {12.5 mm}	-	90
3/4" {19 mm}	90	100
1" {25 mm} Maximum	100	-
Restricted Zone		
No. 4 {4.75 mm}	-	-
No. 8 {2.36 mm}	34.6	34.6
No. 16 {1.18 mm}	22.3	28.3
No. 30 {600 μ m}	16.7	20.7
No. 50 {300 μ m}	13.7	13.7

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AGGREGATE GRADATION CONTROL POINTS AND BOUNDARIES OF RESTRICTED ZONE FOR SUPERPAVE 3/4 inch {19.0 mm} Maximum Size Mix		
Sieve Size	Control Point (Percent Passing)	
	Minimum	Maximum
No. 200 {75 μ m}	2	10
No. 8 {2.36 mm}	28	58
3/8" {9.5 mm}	-	90
1/2" {12.5 mm}	90	100
3/4" {19.0 mm} Maximum	100	-
Restricted Zone		
No. 4 {4.75 mm}	-	-
No. 8 {2.36 mm}	39.1	39.1
No. 16 {1.18 mm}	25.6	31.6
No. 30 {600 μ m}	19.1	23.1
No. 50 {300 μ m}	15.5	15.5

AGGREGATE GRADATION CONTROL POINTS AND BOUNDARIES OF RESTRICTED ZONE FOR SUPERPAVE 1/2 inch {12.5 mm} Maximum Size Mix		
Sieve Size	Control Point (Percent Passing)	
	Minimum	Maximum
No. 200 {75 μ m}	2	10
No. 8 {2.36 mm}	32	67
No. 4 {4.75 mm}	-	90
3/8" {9.5 mm}	90	100
1/2" {12.5 mm} Maximum	100	-
Restricted Zone		
No. 4 {4.75 mm}	-	-
No. 8 {2.36 mm}	47.2	47.2
No. 16 {1.18 mm}	31.6	37.6
No. 30 {600 μ m}	23.5	27.5
No. 50 {300 μ m}	18.7	18.7

AGGREGATE GRADATION CONTROL POINTS FOR SUPERPAVE 3/8 inch {9.5 mm} Maximum Size Mix		
Sieve Size	Control Point (Percent Passing)	
	Minimum	Maximum
No. 200 {75 μ m}	6	12
No. 16 {1.18 mm}	30	60
No. 4 {4.75 mm}	75	100
3/8" {9.5 mm} Maximum	95	100
Note: This mix has no Restricted Zone and up to 5% may be retained on the maximum size sieve (3/8 inch {9.5 mm}).		

2. COARSE AGGREGATE ANGULARITY FOR BLEND OF AGGREGATES.

The coarse aggregate angularity shall be measured on the total blended aggregate retained on the No. 4 {4.75 mm} sieve in accordance with ASTM D 5821.

A fractured face is defined as an angular, rough, or broken surface of an aggregate particle created by crushing, by other artificial means, or by nature. A face is considered fractured

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only if it has a projected area at least as large as one-quarter of the maximum projected area (maximum cross-sectional area) of the particle and has sharp, well-defined edges.

The percent by weight {mass} of the coarse particles of the blended aggregate retained on the No. 4 {4.75 mm} sieve with one fractured face and with two or more fractured faces shall be no less than the values in the following table.

COARSE AGGREGATE ANGULARITY REQUIREMENTS FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Wearing Surface & Binder Layers	Base Layers
A/B	ESALs < 1.0x10 ⁶	75 / -	50 / -
C/D	1.0x10 ⁶ ≤ ESALs < 1.0x10 ⁷	85 / 80	60 / -
E	1.0x10 ⁷ ≤ ESALs < 3.0x10 ⁷	95 / 90	80 / 75

Note: "85 / 80" denotes that 85 % of the coarse aggregate has at least one fractured face and 80 % has two or more fractured faces.

3. FINE AGGREGATE ANGULARITY FOR BLEND OF AGGREGATES.

The percent air voids in loosely compacted fine aggregate, measured according to AASHTO T 304, Method "A", or ASTM C 1252, Method "A", *Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)* shall be no less than the values in the following table.

FINE AGGREGATE ANGULARITY REQUIREMENTS FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Minimum % Air Void	
		Base	Binder & Surface
A/B	ESALs < 1.0x10 ⁶	43	43
C/D	1.0x10 ⁶ ≤ ESALs < 1.0x10 ⁷	43	45
E	1.0x10 ⁷ ≤ ESALs < 3.0x10 ⁷	43	45

4. RESTRICTIONS IN THE USE OF CARBONATE STONE FOR BLEND OF AGGREGATES.

The restrictions for the use of carbonate stone are given in the following table. These restrictions do not apply to widening as defined in Article 410. 01, shoulder paving, underlying layers, and layers that are to be covered by Polymer Modified Open Graded Friction Course (Section 420) mix in this contract.

CRITERIA FOR THE USE OF CARBONATE STONE IN SUPERPAVE	
BPN 9 Value Of Aggregate Source *	Maximum Allowable Percentage Of Carbonate Stone
≤ 25	30
26 through 28	35
29 through 31	40
32 through 34	45
≥ 35	50

* This value, BPN 9, is made using the British Pendulum Tester on aggregate source specimen polished for 9 hours on an accelerated polishing machine known as the British Wheel as per ASTM D 3319, ASTM E 303 and ALDOT-382.

In no case shall the total amount of virgin carbonate stone in the combined mixture used as actual wearing surface layers that are exposed to traffic exceed the percentage shown in Table 5. When parts of the carbonate stone used in the mix are from differing strata of material or coming from multiple sources that are represented by different BPN 9 values, the lowest BPN 9 value will be used.

(d) LIQUID ASPHALT BINDER.

Liquid asphalt binders shall come from an approved producer who is participating in and meeting the requirements of ALDOT-243, *Acceptance Program For Asphalt Materials*. The producer's name shall be listed in the Department's *Materials, Sources, and Devices With Special Acceptance Requirements Manual*, List I-4. The Department has established a list of qualified producers of asphalt materials. Refer to Subarticle 106.01(f) and ALDOT-355 concerning this list. Unless shown otherwise on

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the plans or in the proposal, liquid asphalt binder for use in all mixes shall meet the requirements of AASHTO M 320, *Standard Specification For Performance Graded Asphalt Binder*, as modified by the requirements given in the following table and Section 804.

ALLOWABLE ASPHALT BINDER GRADES FOR SUPERPAVE			
ESAL Range	Traffic (ESALs)	Base & Lower Binder Layers	Upper Binder & Wearing Surface Layers
A/B	ESALs < 1.0x10 ⁶	PG 67-22	PG 67-22
C/D	1.0x10 ⁶ ≤ ESALs < 1.0x10 ⁷	PG 67-22	PG 67-22
E	1.0x10 ⁷ ≤ ESALs < 3.0x10 ⁷	PG 67-22	PG 76-22*

* The asphalt binder shall be 76-22 for leveling when the top of the leveling is within 4 inches {100 mm} of the final pavement surface. The asphalt binder may be PG 67-22 for leveling that is not within 4 inches {100 mm} of the final pavement surface and for all patching and widening. If Open Graded Friction Course (Section 420) layers are required, the final pavement surface shall be the surface of the layer below these layers.

Asphalt Binders shall meet the requirements of Section 804.

Polymer modifiers shall be blended at an approved refinery and meet the requirements of Section 811.

(e) MIX PROPERTIES.

1. AIR VOIDS (Va).

The design air voids for all levels of traffic is 4.0 %.

2. VOIDS IN MINERAL AGGREGATE (VMA).

The job mix shall be designed at a minimum VMA given in the following table.

VOIDS IN MINERAL AGGREGATE DESIGN VMA FOR SUPERPAVE ***		
Maximum Aggregate Size *	Minimum VMA (%) for Mixes Designed on the Fine Side of the Restricted Zone	Minimum VMA (%) for Mixes Designed Thru or on the Coarse Side of the Restricted Zone
3/8" {9.5 mm}	16.5 **	16.5 **
1/2" {12.5 mm}	16.5	15.5
3/4" {19.0 mm}	15.5	14.5
1" {25.0 mm}	14.5	13.5
1.5" {37.5 mm}	13.5	12.5

* As defined in Subarticle 424.02(c)
 ** All 3/8" (9.5 mm) mixes where the ESAL range is greater than A/B shall have a maximum VMA of 18.0.
 *** Production VMA may be 0.5 lower than design VMA.

3. LIQUID ASPHALT BINDER CONTENT (Pb).

The job mix shall be designed at a minimum Liquid Asphalt Binder Content (Pb) given in the following table. Production tolerances shall be governed by the pay factors in Table III, Section 410.08.

LIQUID ASPHALT BINDER CONTENT (Pb) CRITERIA FOR SUPERPAVE	
Maximum Aggregate Size*	Minimum Liquid Asphalt Binder Content (Pb) by Percent of Total Mix
	Nd = 60
3/8" {9.5 mm}	5.90
1/2" {12.5 mm}	5.50
3/4" {19.0 mm}	5.10
1" {25.0 mm}	4.40
1.5" {37.5 mm}	4.20

* As defined in Subarticle 424.02(d)

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4. DUST PROPORTION (D/Pbe).

The ratio of the percent by weight {mass} of aggregate passing the 75 μ m sieve to the effective asphalt content expressed as percent by weight {mass} of the total mix shall be between 0.60 and 1.20 for mixes designed either through or on the fine side of the restricted zone and between 0.60 and 1.60 for mixes designed on the coarse side of the restricted zone. All 3/8 inch {9.5 mm} mixes shall have a dust to effective asphalt ratio range of 0.90 to 2.00. These ratio limits apply to both the design and production phases. Effective asphalt content is that liquid asphalt binder not absorbed into the aggregate pore structure and is determined according to Section 4.09 of the Asphalt Institute's, MS-2, *Mix Design Methods for Asphalt Concrete*.

5. LIQUID ASPHALT BINDER DRAINDOWN.

A fiber stabilizer meeting the requirements given in Section 410 may be incorporated into the mix to reduce draindown. The fiber shall be blended into the mix in accordance with the requirements given in Section 410.

6. RESISTANCE TO MOISTURE-INDUCED DAMAGE.

All mixes shall be designed and produced to have a tensile strength ratio (TSR) of at least 0.80 when compacted according to ALDOT-384 at 7.0 % air voids and tested in accordance with AASHTO T 283 as modified by ALDOT-361, except the specimen shall be 6.00" {150 mm} in diameter and 3.75" {95 mm} in height.

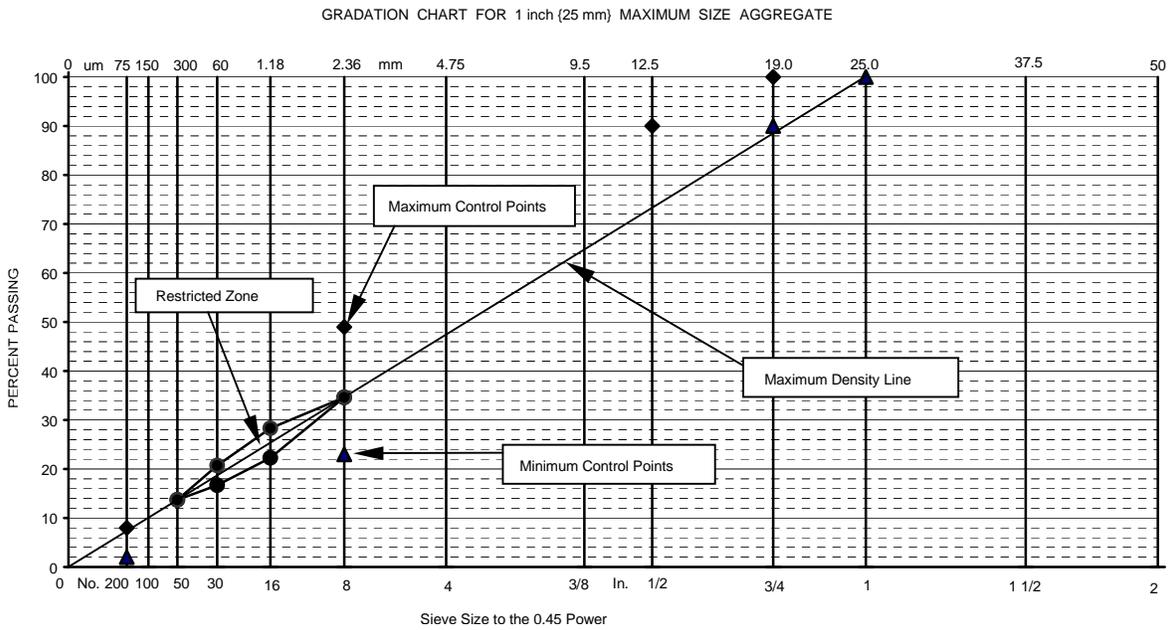
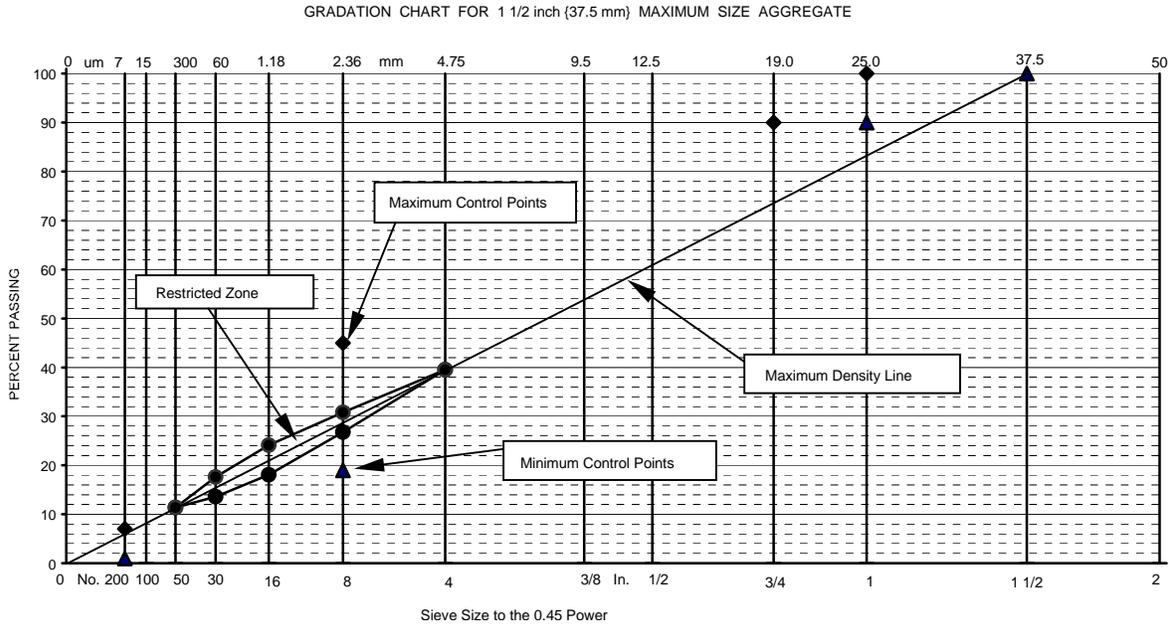
(f) DESIGN PROCEDURE.

All Superpave mixes with 100 % virgin aggregate shall be designed in accordance with ALDOT-384, *Mix Design Procedure for Superpave Level I*. All other Superpave mixes containing RAP shall be designed in accordance with ALDOT-388, *Superpave Volumetric Mix Design Procedure Using Recycled Asphalt Pavement*. Any Superpave Gyrotory Compactor may have its angle of gyration verified by the Engineer following the procedure given in ALDOT 404, "Evaluating the Superpave Gyrotory Compactor's (SGC's) Angle of Gyration using the FHWA SGC Angle Validation Kit". This includes all design, quality control, and quality assurance SGC's. The average Peak-to-Peak 1/2 angle Average Summary should be validated to be 1.25 +/- 0.05 degrees (between 1.20 & 1.30 degrees). This should be done using standard mixes supplied by the State. If the SGC can not meet this specification, adjustments to the SGC's angle of gyration may be required. The aggregate structure and liquid asphalt binder content shall be selected to produce a densification curve which passes through 96.0 % of theoretical maximum specific gravity (4.0 % air voids) at 60 gyrations.

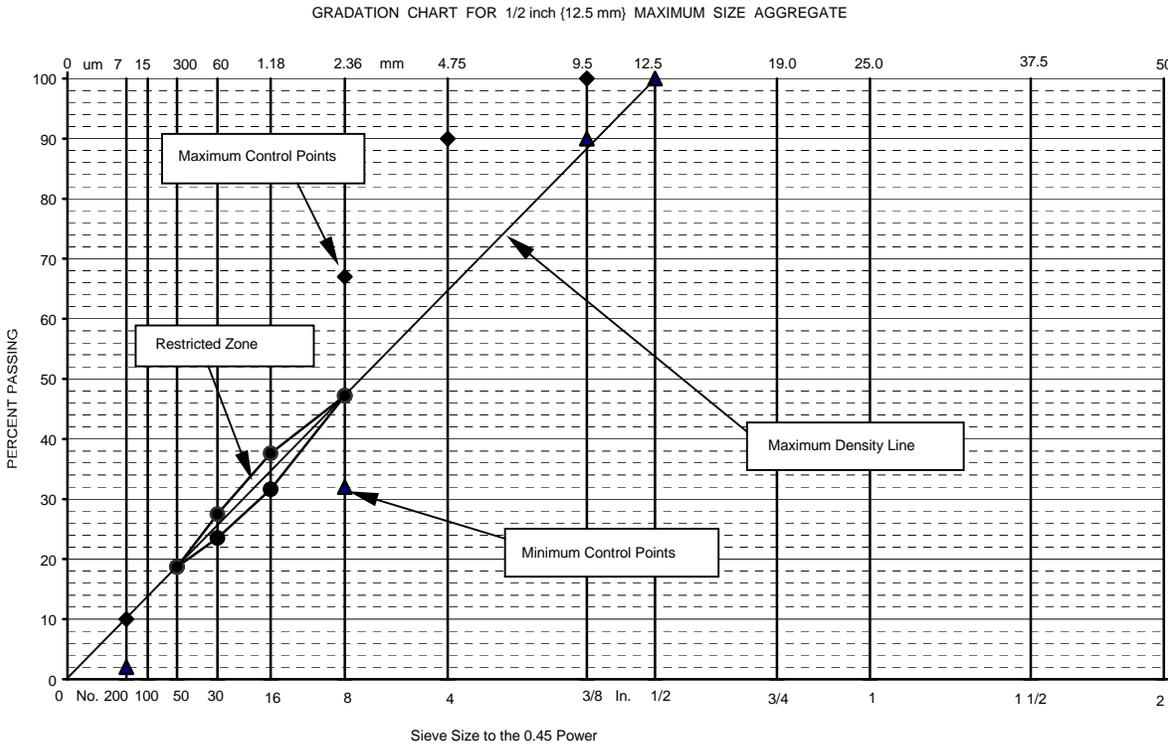
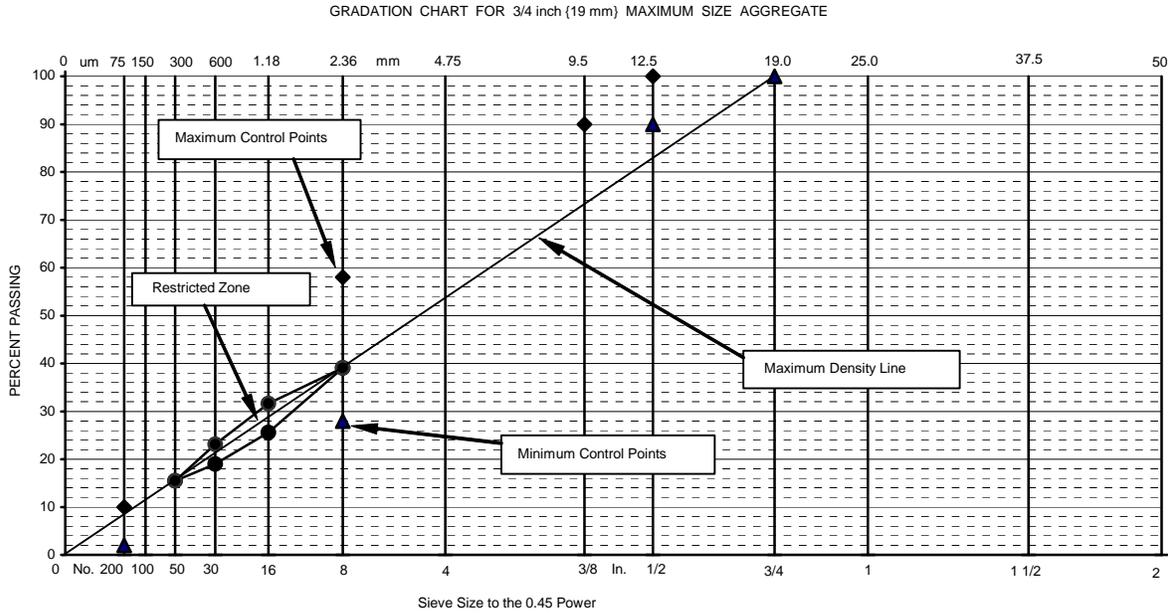
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424.03 Gradation Requirements.

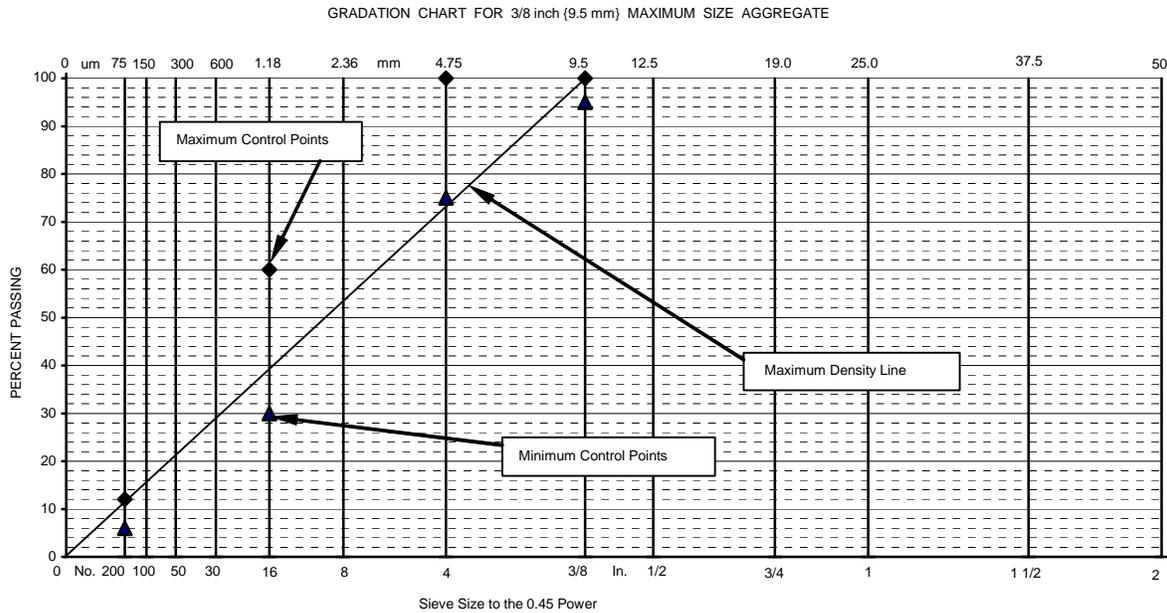


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424.04 Construction Requirements.

(a) GENERAL.

The mixing temperature for hot mix shall not exceed 350 °F {177 °C} and the mixing temperature for warm mix shall fall within the range of 215 °F {102 °C} to 280 °F {132 °C}.

(b) BINDER LAYER AND WEARING SURFACE LAYER.

Construction requirements shall be as specified in Articles 410.03 through 410.07.

(c) BASE LAYER.

The construction requirements for base layers shall be as specified in Articles 410.03 through 410.07, except as follows:

The edges shall be trimmed immediately after final rolling, using an accurately aligned string or wire, to a tolerance of 2 inches {50 mm} outside the theoretical edge of the layer and to a slope not flatter than 1:1.

Any edge distorted by rolling shall be promptly corrected.

(d) PREPARATION OF MIXTURES - MOISTURE CONTENT.

Each time an asphalt content measurement is made (ALDOT-354 or AASHTO T 308), the amount of moisture in the mixture shall be determined, regardless of aggregate type, as specified in ALDOT-130 and reported on Form BMT-20. The moisture determination shall be used in computing the corrected asphalt content. Moisture samples shall be taken with the asphalt content samples from the loaded truck. Moisture in the mixture shall not exceed 0.20% by weight {mass}.

(e) PRODUCTION TOLERANCES.

All mixtures furnished for use shall conform to the approved job mix formula (JMF) within the tolerances set in Article 410.02. Mixture gradations may be produced within the restricted zone provided the gradations are within the tolerances.

424.05 Method of Measurement.

The accepted quantities of Superpave Bituminous Concrete Wearing Surface Layer, Superpave Bituminous Concrete Binder Layer, and Superpave Bituminous Concrete Base Layer will be measured as provided in Article 410.08, subject to any exceptions contained herein.

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424.06 Basis of Payment.

(a) UNIT PRICE COVERAGE.

Superpave Bituminous Concrete Wearing Surface Layer, Superpave Bituminous Concrete Binder Layer, and Superpave Bituminous Concrete Base Layer will be paid for at the contract unit price bid in accordance with Article 410.09, subject to any exceptions contained herein.

(b) PAYMENT WILL BE MADE UNDER ITEM NO.:

- 424-A Superpave Bituminous Concrete Wearing Surface Layer, ** ,
 *** Maximum Aggregate Size Mix, ESAL Range **** - per ton {metric ton}
- 424-B Superpave Bituminous Concrete * Binder Layer, ** ,
 *** Maximum Aggregate Size Mix, ESAL Range **** - per ton {metric ton}
- 424-C Superpave Bituminous Concrete Base Layer, ** ,
 *** Maximum Aggregate Size Mix, ESAL Range **** - per ton {metric ton}

- * Specify either "Upper" or "Lower".
- ** Specify "Patching", "Leveling", "Widening", etc. only when required.
- *** Specify Maximum Aggregate Size: 3/8", 1/2", 3/4", 1", or 1.5" {9.5 mm, 12.5 mm, 19.0 mm, 25.0 mm, or 37.5 mm}.
- **** Specify "A/B", "C/D", or "E".

UNDER REVISION

CALIFORNIA

DRAFT

10-1. __ HOT MIX ASPHALT USING WARM MIX TECHNOLOGIES

GENERAL

Summary

This work includes producing and placing hot mix asphalt using warm mix asphalt technologies (HMA-W) Type ____ using the _____ process. Warm Mix Asphalt is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed.

Comply with Section 39, "Hot Mix Asphalt," of the Standard Specifications.

Use the following warm mix asphalt additives:

Product name:	Evotherm
Producer name:	MeadWest Vaco Corporation
Contact:	Scott Dmytrow or Wade Miller
Phone number:	(916) 825 – 9415 or (949) 495 – 4822

Product name:	Advera
Producer name:	PQ Corporation
Contact:	Annette Smith
Phone number:	(610) 651 – 4469

Product name:	Sasobit
Producer name:	Sasol Wax Americas, Inc.
Contact:	Larry Michael
Phone number:	(301) 745 – 3334

Submittals

Submit information from each producer about each warm mix asphalt additive. Submit the method and location for addition of each additive.

Submit a list of names participating in the prepaving conference. Identify each participant's name, employer, title, and role in construction of HMA-W-W with warm mix asphalt additives.

Submit the log of production data on electronic and printed media at the end of each production shift, or when requested by the Engineer. Each set of production data on electronic media must be in line feed carriage return, on one line, on a separate record, and with sufficient fields to satisfy the amount of data specified. The daily log must include:

1. Date of production
2. Time of day the data is captured
3. Data titles at least once per report
4. Aggregate size being treated
5. Flow rate of wet aggregate collected directly from the aggregate weigh belt
6. Aggregate moisture content at the time of treatment expressed as a percent of the dry aggregate
7. Calculated difference between the agreed warm mix asphalt additive ratio and the actual warm mix asphalt additive ratio

3. Use Paras 3 through 10 for QC / QA projects.

Quality Control and Assurance

General

During production, make loose HMA-W available at the plant for sampling. The Engineer determines the quantity and time for sampling.

Prepaving conference

Discuss HMA-W at the prepaving conference. Discuss the methods for production and placement including contingency planning and standards or workmanship.

Provide the facility for the prepaving conference. Attendees must include:

1. Project Manager
2. Superintendent
3. Technical representatives from each warm mix additive company
4. Paving subcontractors
5. Asphalt rubber binder supplier
6. Plant manager
7. Plant operator

Technical Representatives

A technical representative from each warm mix asphalt additive supplier must be present during production and placement of HMA-W. The technical representative must advise you, the Engineer, and the asphalt rubber binder producer. The technical representative must direct the mix operation as it relates to the warm mix asphalt additive.

The technical representative must advise the producer regarding plant and controller modifications necessary for product delivery and proper mixing. Plant modifications must comply with California Test 109.

California Test 109

Review the plant to assure compliance with weights and measures under California Test 109 within 30 days before production of HMA-W.

Data Collection

The device controlling warm mix asphalt additive proportioning must produce a log of production data. The log must be a series of data captured at 1-minute intervals during production. Each 1-minute data set must register the production activity for that minute and not be a summation of the preceeding minute. Each 1-minute data set represents an amount of material produced 5 minutes before and 5 minutes after the capture time. Store collected data with the plant control device while the contract is in progress.

Open House – (When an open house is required.)

During construction, present the HMA-W with warm mix asphalt additives activities at an open house. You and the Engineer must agree on the date of the open house. The Engineer coordinates the location and plans the open house. Make the plant accessible for a tour by open house participants. Allow the open house participants to view the paving activities on the scheduled date of the the open house. You and the Engineer must agree on a safe location for the open house participants to view the paving activities without obstructing the paving.

MATERIALS

Asphalt Binder

The grade of asphalt binder mixed with aggregate for HMA-W Type ____ must be ____.

Aggregate

The aggregate for HMA-W Type ____ must comply with the _____ grading.

Antistrip Treatment

Treat aggregate with lime slurry under "Lime Treatment of Hot Mix Asphalt Aggregates (Slurry Method)." For the mix design, use Lab Procedure LP-7.

Treat asphalt binder with liquid antistrip under "Liquid Antistrip Treatment of Asphalt Binder." For the mix design, use Lab Procedure LP-5.

CONSTRUCTION

Proportioning Warm Mix Asphalt Additives

General

Proportion warm mix asphalt additives by weight. Use either a continuous or batch type plant.

Continuous Mixing

If continuous proportioning for HMA-W with warm mix asphalt additive is used, determine the exact ratio of warm mix asphalt additive to the total HMA-W at the production rates to be used. Rate-of-flow indicators and totalizers for like materials must be accurate within 0.5 percent from each other. Comply with the following:

1. Weigh dry warm mix asphalt additives with a belt scale or loss in weight feeder. If operating from 30 to 100 percent of production capacity, the average difference between the indicated weight of material delivered and the actual weight delivered must not exceed 2.0 percent of the actual weight for 3 individual runs. For any of the 3 individual runs, the indicated weight of material delivered must not vary from the actual weight delivered by more than 3.0 percent of the actual weight. The platform scale's maximum capacity must not exceed 2.5 tons with a maximum graduation size of 0.10 pound. Each test run must be at least 100 pounds of warm mix asphalt additive.

The addition device must rest on either concrete pads or steel plates (*SMOOTH LEVEL SUFACE??*). The steel plates must be 1.5 inch thick and be no smaller than 20 inches width and height

2. Measure emulsified warm mix asphalt additive with a meter. If operating from 50 to 100 percent of production capacity, the difference between the indicated weight of emulsion delivered and the actual weight delivered must not exceed 1.0 percent of the actual weight for 3 individual runs. Weigh tests on a platform scale located at the proportioning plant. The platform scale's maximum capacity must not exceed 2.5 tons with a maximum

graduation size of 0.10 pound. Run tests for at least 300 gallons of emulsified warm mix asphalt additive.

Batch Mixing

If batch proportioning for HMA-W with warm mix asphalt additive is used, comply with the following:

1. Proportion dry warm mix asphalt additives by weight. Weigh the additive at the warm mix asphalt production site with a scale appropriate for the amount of additive weighed. If batches use dry warm mix additive weighing less than 1 ton, use an automatic batch controller. Run tests for at least 100 pounds of dry warm mix asphalt additives.
2. Measure emulsified warm mix asphalt additive with a meter. If operating from 50 to 100 percent of production capacity, the difference between the indicated weight of emulsion delivered and the actual weight delivered must not exceed 1.0 percent of the actual weight for 3 individual runs. Weigh tests on a platform scale located at the proportioning plant. The platform scale's maximum capacity must not exceed 2.5 tons with a maximum graduation size of 0.10 pound. Run tests for at least 300 gallons of emulsified warm mix asphalt additive.

HMA-W Production and Placement

Produce an asphalt mixture within the temperature range of 215°F and 325 °F.

Transporting, Spreading and Compacting (*For METHOD Spec*)

Spread HMA-W Type A and Type B only if atmospheric and surface temperatures are:

Minimum Atmospheric and Surface Temperatures

Compacted Layer Thickness, feet	Minimum Atmospheric and Surface Temperatures			
	Atmospheric, ° F		Surface, ° F	
	Unmodified Asphalt Binder	Modified Asphalt Binder ^a	Unmodified Asphalt Binder	Modified Asphalt Binder ^a
< 0.15	50	50	50	50
0.15 – 0.25	45	45	45	45

Note:

^a Except asphalt rubber binder.

If the asphalt binder for HMA-W Type A and Type B is:

1. Unmodified asphalt binder, complete:
 - 1.1. First coverage of breakdown compaction before the surface temperature drops below 200 °F
 - 1.2. Breakdown and intermediate compaction before the surface temperature drops below 180 °F
 - 1.3. Finish compaction before the surface temperature drops below 140 °F
2. Modified asphalt binder, complete:

- 2.1. First coverage of breakdown compaction before the surface temperature drops below 200 °F
- 2.2. Breakdown and intermediate compaction before the surface temperature drops below 180 °F
- 2.3. Finish compaction before the surface temperature drops below 140 °F

Rumble Strips

Construct shoulder rumble strips in the top layer of new HMA-W surfacing.

Vertical Joints

If you perform half-width paving, at the end of each day's work the distance between the ends of adjacent surfaced lanes must not be greater than can be completed in the following day of normal paving.

Before opening the lane to public traffic, pave shoulders and median borders adjacent to a lane being paved.

Do not leave a vertical joint more than 0.15 foot high between adjacent lanes open to public traffic.

Place HMA-W on adjacent traveled way lanes so that at the end of each work shift, the distance between the ends of HMA-W layers on adjacent lanes is between 5 feet and 10 feet. Place additional HMA-W along the transverse edge at each lane's end and along the exposed longitudinal edges between adjacent lanes. Hand rake and compact the additional HMA-W to form temporary conforms. You may place Kraft paper or another approved bond breaker under the conform tapers to facilitate the taper removal when paving operations resume.

Widening

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge for the project's entire length before placing HMA-W over the existing pavement.

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge at each location before placing HMA-W over the existing pavement.

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge in increments of at least _____ feet before placing HMA-W over the existing pavement.

Conform Tapers

Place shoulder conform tapers concurrently with the adjacent lane's paving.

Place additional HMA-W along the pavement's edge to conform to road connections and private drives. Hand rake, if necessary, and compact the additional HMA-W to form a smooth conform taper.

Payment

The contract prices paid per ton for hot mix asphalt using warm mix asphalt technologies as designated in the Engineer's Estimate include full compensation for furnishing all labor, materials, tools, equipment, warm mix additives and technical representation and incidentals for doing all the work involved in constructing hot mix asphalt with warm mix asphalt additives,

complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

FLORIDA



Florida Department of Transportation

CHARLIE CRIST
GOVERNOR

5007 Northeast 39th Avenue
Gainesville, Florida 32609

STEPHANIE KOPELOUSOS
SECRETARY

March 26, 2009

MATERIALS BULLETIN NO. 03-09

DCE MEMORANDUM NO. 03-09

(FHWA Approved: 3/25/09)

**TO: DISTRICT MATERIALS RESEARCH ENGINEERS
DISTRICT CONSTRUCTION ENGINEERS**

FROM: Thomas O. Malerk, P.E., Director, Office of Materials
David A. Sadler, P.E., Director, Office of Construction

COPIES: Bob Burluson, Jim Warren, Jim Musselman, Chris Richter (FHWA)

SUBJECT: WARM MIX ASPHALT

The use of warm mix asphalt will be addressed in a future revision of the Standard Specifications. In the interim, this memorandum is issued to provide specification language for warm mix asphalt for projects where the Contractor has proposed to use warm mix asphalt and the Engineer has agreed to its use.

Replace subarticle 330-3.2.2 with the following:

330-3.2.2 Temperature: Spread the mixture only when the air temperature in the shade and away from artificial heat is at least 40°F for layers greater than 1 inch (100 lb/yd²) in thickness and at least 45°F for layers 1 inch (100 lb/yd²) or less in thickness (this includes leveling courses). The minimum temperature requirement for leveling courses with a spread rate of 50 lb/yd² or less is 50°F. The minimum ambient temperature requirement may be reduced by 5°F when using warm mix technology, if mutually agreed to by both the Engineer and the Contractor.

Replace subarticle 334-3.2.1 with the following:

334-3.2.1 General: Design the asphalt mixture in accordance with AASHTO R35 04, except as noted herein. Prior to the production of any asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all mix design criteria to the Engineer. For Traffic Level B through E mix designs, include representative samples of all component materials, including asphalt binder. Allow the State Materials Engineer a maximum of four weeks to either conditionally verify or reject the mix as designed.

For Traffic Level C through E mix designs, final verification of the mix design will occur when the requirements of 334-5.1.2.1 have been met. Do not use more than three mix designs per nominal maximum aggregate size per traffic level per binder grade per contract year. Exceeding this limitation will result in a maximum Composite Pay Factor of 1.00 as defined in 334-8.2 for all designs used beyond this limit.

Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is:

<http://www.dot.state.fl.us/statematerialsoffice/quality/programs/warmmixasphalt/index.shtm>

The Engineer will consider any marked variations from original test data for a mix design or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of the mix design.

Replace subarticle 334-3.2.7 with the following:

334-3.2.7 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The design traffic level and the design number of gyrations (N_{design}).
2. The source and description of the materials to be used.
3. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source.
4. The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation caused by handling and processing as necessary.
5. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly material passing the No. 200 sieve) should be accounted for and identified.
6. The bulk specific gravity (G_{sb}) value for each individual aggregate and RAP component, as identified in the Department's aggregate control program.
7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1 percent.
8. A target temperature for the mixture at the plant (mixing temperature) and a target temperature for the mixture at the roadway (compaction temperature) in accordance with 330-6.3. Do not exceed a target temperature of 330°F for modified asphalts (PG 76-22, ARB-5, and ARB-12) and 315°F for unmodified asphalts.
9. Provide the physical properties achieved at four different asphalt binder contents. One of which shall be at the optimum asphalt content, and must conform to all specified physical requirements.
10. The name of the CTQP Qualified Mix Designer.
11. The ignition oven calibration factor.
12. The warm mix technology, if used.

Replace subarticle 337-2.1 with the following:

337-2.1 General Requirements: Meet the requirements specified in Division III as modified herein. The Engineer will base continuing approval of material sources on field performance. Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information, if available, is: <http://www.dot.state.fl.us/statematerialsoffice/quality/programs/warmmixasphalt/index.shtm>

Replace subarticle 337-7.3 with the following:

337-7.3 Temperature Requirements for FC-5:

337-7.3.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 65°F. As an exception, place the mixture at temperatures no lower than 60°F, only when approved by the Engineer based on the Contractor's demonstrated ability to achieve a satisfactory surface texture and appearance of the finished surface. The minimum ambient temperature may be further reduced to 55°F when using warm mix technology, if agreed to by both the Engineer and the Contractor.

337-7.3.2 Temperature of the Mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 330-6.3. Meet all requirements of 330-9.1.2 at the roadway. The target mixing temperature shall be established at 320°F. The target mixing temperature may be reduced when using warm mix technology, if agreed to by the Engineer and the Contractor.

Replace subarticle 337-7.5.1 with the following:

337-7.5.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 45°F. The minimum ambient temperature may be reduced by 5°F when using warm mix technology, if agreed to by both the Engineer and the Contractor.

This memorandum serves as a blanket approval to process a no-cost specification change for on-going projects and should be attached to the Work Order or Supplemental Agreement accomplishing this task.

For any questions concerning this matter, please contact Greg Sholar, (352) 955-2920, or Pat Upshaw, (352) 955-2906, at the State Materials Office.

TM/DS/smw

Warm Mix Asphalt Information

Requirements

Requirements to be included on the approved products/process list:

1. Be a recognized process with successful project(s) constructed nationally or internationally.
2. Partner with a contractor and FDOT District Office and construct a demonstration section on a FDOT project.
3. Meet all FDOT construction specifications during construction of the demonstration section.

For additional warm mix asphalt information, see the following website:

<http://www.warmmixasphalt.com/>

Approved Additives/Processes

1. Aspha-min (Aspha-min)
<http://www.aspha-min.com/>
2. Astec Industries (Double Barrel Green System)
<http://www.astecindustries.com/www/announcements/0.239/astec-double-barrel-warm-mix-don-brock-asphalt.html>
3. MeadWestvaco Asphalt Innovations (Evotherm DAT)
<http://www.evotherm.com>
4. Meeker Equipment (Aqua Foam System)
http://www.meekerequipment.com/new_warmmix.html

IDAHO

SP - Warm Mix Asphalt (WMA) Technology for Superpave

Notes to the Contractor

Warm Mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of one of several WMA technologies.

Some modifications to HMA plants may be necessary to accommodate the WMA technologies.

Production and paving temperatures may need to be increased for higher reclaimed asphalt pavement (RAP) contents, increased haul distances, decreased ambient temperatures, or other WMA project specific conditions.

Use equipment and WMA technologies capable of producing an asphalt mixture that meet specification requirements and is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.

Implementation of best management practices in the control of aggregate moisture content prior to introduction to the drying or mixing drum is highly recommended in order to achieve the maximum benefit of WMA technology.

It may be beneficial to produce an HMA mixture at conventional HMA temperatures immediately before WMA production at the lower temperatures in order to bring the plant up to temperature and ensure proper baghouse operating temperature. The following references published by the National Asphalt Pavement Association detail specifics related to plant modifications and operational changes in order to maximize the benefits of WMA production, especially regarding reduced fuel usage and reduced emissions:

Quality Improvement Series 125 (QIP 125), "Warm Mix Asphalt: Best Practices",

Quality Improvement Series 126 (QIP 126), "Energy Conservation in Hot Mix Asphalt Production," and

Environmental Council 101 (EC-101), "Best Management Practices to Minimize Emissions During HMA Construction").

Field produced WMA loose mix samples which are immediately compacted and tested, without reheating, may produce lower voids in mineral aggregate and lower air voids test results when compared to reheated samples. This should be validated during the test strip. The specified remedy is to cool the WMA sample to room temperature and reheat to a temperature that is less than or equal to the WMA field production temperature before laboratory compaction. This will minimize the WMA technology's effects on the test results and ensures the sample is not excessively aged.)

All provisions for the production and placement of HMA mixtures as stipulated in the Superpave Special Provision are in force unless otherwise specified in the Warm Mix Asphalt Special Provision.

Notes to the Resident Engineer

Recommended mix design practices specific to WMA have not been established. Job mix formulas for WMA mixtures are currently developed with conventional HMA mix design practices and the WMA technology process or additives are included afterward. The Contractor and WMA producer shall ensure the WMA technology does not adversely affect the asphalt binder performance grade and WMA mixture performance during the development and verification of the WMA job mix formula. All acceptance and performance testing must be conducted with the WMA technology added. A specific WMA mix design recommended practice is expected upon the completion of the

National Cooperative Highway Research Program (NCHRP) Project 09-43 "Mix Design Practices for Warm Mix Asphalt" detailed at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=977.)

Some WMA technologies may alter the asphalt binder grade and conventional performance grading may not be suitable to qualify the WMA technology effects.

Silicon additives are historically used as both an antifoam and defoamer to inhibit foaming in asphalt binder applications. Ensure silicon additive compatibility when asphalt binder foaming processes are used to produce WMA.

The minimum HMA delivery, placement, and compaction temperatures should be reviewed to accommodate the WMA reduced temperature and achieve workability and density requirements. Documentation that demonstrates a proven history of the WMA technology's ability to be placed and compacted at the reduced temperature will be required. The test strip will be used to demonstrate placement and compaction at the reduced temperature. Minimum ambient paving temperature requirements may be lowered 20 ° F from normal temperature requirements. Do not lower ambient paving temperatures to below freezing.

Air void and density requirements are important to provide long term performance of asphalt pavements. Due to the potential for increased workability of WMA mixtures and therefore increased density, it is important to monitor rolling operations to ensure excessive compaction does not occur and minimum air void requirements and/or the upper limit on percent of maximum density are not exceeded.

SP - Warm Mix Asphalt (WMA) Technology for Superpave

4XX.01 Description

This work shall consist of providing the technology to construct one or more courses of plant produced warm mix asphalt (WMA) pavement on a prepared foundation, using prescribed manufactured WMA additives and/or WMA plant process modifications. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture; are permitted, provided that the mixture meets all the requirements of these specifications including plant startup operations.

4XX.02 Material

WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185° F to 275° F. The upper temperature range is appropriate for modified asphalt binders and WMA mixtures which include higher percentages of reclaimed asphalt pavement.

4XX.03 Construction

A. *Mix Design.* For Warm Mix Asphalt, the JMF documentation shall include the following information:

1. All information required for Superpave HMA.
2. WMA technology and/or WMA additives information.
3. WMA technology manufacturer's established recommendations for usage.
4. WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
5. WMA technology material safety data sheets (MSDS).
6. Documentation of at least 3 past WMA technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance.

7. Temperature range for mixing.
8. Temperature range for compacting.
9. Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
10. WMA mixture performance test results specific to the Contractor's proposed WMA technology listed under *Acceptance Test Strip* below.
11. Laboratory test data, samples and sources of all mixture components, and asphalt binder viscosity-temperature relationships.

Use anti-stripping additives, silicone additives, WMA additives, and WMA technologies as specified. Comply with approved mix design quantities. Confirm the addition rate through field tests performed during production.

Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.

Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference with producing WMA.

B. *Weather Limitations.*

1. Place WMA mixtures only on dry, unfrozen surfaces and only when weather conditions allow for proper production, placement, handling, and compacting.
2. Placement temperatures shall be as specified for Superpave HMA unless otherwise approved for the specific Warm Mix Asphalt technology.

C. *Asphalt Mixing Plant.* For WMA, modify the asphalt mixing plant as required by the manufacturer to introduce the WMA technology.

Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and/or WMA additive delivery systems, tuning the plant burner and adjusting the flights in order to operate at lower production temperatures and/or reduced tonnage.

WMA metering devices will meet the WMA producer's current recommendations for liquid or mineral additives. Document the integration of plant controls and interlocks when using WMA additive devices.

D. *Acceptance Test Strip.* Prior to placing any WMA mix, produce a sufficient amount of WMA mix to properly calibrate the plant and procedures using the Contractor's proposed mix design. The engineer will sample and test the WMA mix thus produced for the following:

1. voids in mineral aggregate (VMA);
2. asphalt binder content;
3. gradation;
4. air voids; and
5. immersion compression

Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

Include production WMA materials and equipment with the test strip. Select compacting methods to meet the specified density. The Engineer will take random mix loose mix and core samples to verify compliance with job mix

and specification requirements. Reconstruct the test strip if the job mix formula, the compacting method, or compacting equipment changes, or if results do not meet specification requirements.

E. *Compacting.* Compact immediately after spreading and before the WMA mixture falls below the minimum job mix design compaction temperature. Discontinue paving if unable to achieve the specified density before the mixture cools below the minimum recommended WMA job mix design compaction temperature.

4XX.04 Measurement

Warm Mix Asphalt Technology will be measured by ton of mix in place.

4XX.05 Basis of Payment

Payment for accepted work will be made as follows:

Pay Item	Pay Unit
WMA Technology for Superpave	ton

Superpave HMA will be paid under its respective item.

INDIANA

400-R-553 HMA PROVISIONS

(Revised 04-16-09)

The Standard Specifications are revised as follows:

SECTION 401, BEGIN LINE 46, INSERT AS FOLLOWS:

ESAL CATEGORY	ESAL
1	< 300,000
2	300,000 to < 3,000,000
3	3,000,000 to < 10,000,000
4	10,000,000 to < 30,000,000
5	≥ 30,000,000

QC/QA HMA may be produced as warm-mix asphalt, WMA, by using a water-injection foaming device for ESAL category 1, 2 and 3 mixtures. The DMF shall list the minimum plant discharge temperature for HMA and WMA as applicable to the mixture.

SECTION 401, BEGIN LINE 135, INSERT AS FOLLOWS:

A maximum of 15.0% RAP or 3.0% ARS by weight (mass) of the total mixture may be used in ESAL category 3, 4, or 5 surface mixtures and open graded mixtures. The RAP recycled material for the ESAL category 3, 4, or 5 surface mixtures shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

A maximum of 25.0% RAP or 5.0% ARS by weight (mass) of the total mixture may be used in WMA for ESAL category 1, 2 and 3 mixtures except ESAL category 3 surface mixtures.

SECTION 401, BEGIN LINE 158, INSERT AS FOLLOWS

401.08 Job Mix Formula

A job mix formula, JMF, shall be developed by a certified HMA producer. A JMF used in the current or previous calendar year that was developed to N_{des} will be allowed. The mixture compaction temperature shall be $300 \pm 9^{\circ}\text{F}$ ($150 \pm 5^{\circ}\text{C}$) for dense graded mixtures and $260 \pm 9^{\circ}\text{F}$ ($125 \pm 5^{\circ}\text{C}$) for open graded mixtures. The JMF shall list the minimum plant discharge temperature for HMA and WMA as applicable to the mixture. The JMF for each mixture shall be submitted to the Engineer and shall use the same MAF as the DMF.

SECTION 401, BEGIN LINE 493, INSERT AS FOLLOWS:

If the Lot PWL for any one of the properties is less than 50 or a subplot has an air void content less than 1.0% or greater than 7.0%, the lot will be referred to the Office of Materials Management for adjudication as a failed material in accordance with normal Department practice as listed in 105.03.

SECTION 401, BEGIN LINE 622, INSERT AS FOLLOWS:

401.20 Appeals

If the QC test results do not agree with the acceptance test results, a request, along with the QC test results, may be made in writing for additional testing. The appeal sample will be analyzed in a lab different than the lab that analyzed the original sample when requested by the Contractor. Additional testing may be requested for one or more of the

IOWA

Contract Modification
NHSX-218-9(129)—3H-34

Definition

Warm Mix Asphalt uses additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed.

Short Description

This mutual benefit work order requires a test section containing no more than 1 day's production (2,000 – 3,500 tons) of Warm Mix Asphalt (WMA) be used in the surface mix of this project. The WMA technology to be used shall be **Revix**. Unless otherwise stated, all specifications in the contract documents shall remain in effect.

QA/QC

The WMA test section shall be considered as a separate lot whereby quality assurance and quality control measures will remain unchanged from GS-2303 with the following exceptions:

1. The maximum 8% field voids shall be waived
2. The production tolerance for lab voids shall be waived
3. The QI for field density shall receive 100% payment

Materials

The contractor shall comply with manufacturer's recommendations regarding receiving, storage, and delivery of the WMA additive. The contractor shall also adhere to the manufacturer's recommendations for incorporating the additive into the mix or liquid binder. These recommendations of the WMA technology supplier shall be made available to the Contracting Authority and kept on file at the asphalt mixing plant during production.

The virgin asphalt binder shall meet the grade requirements stated in the contract documents.

Mix proportions included in the hot mix asphalt control section shall remain unchanged for the WMA test section.

Construction

Laboratory compaction temperature shall be 240°F.

Placement temperatures shall remain between 220°F and 275°F immediately behind the screed.

Cost

The Contracting Authority will pay \$3/ton for a WMA additive. If a foaming process is used as the WMA technology in lieu of an additive, this contract modification shall remain cost neutral.

MAINE



JOHN ELIAS BALDACCI
GOVERNOR

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0016

DAVID A. COLE
COMMISSIONER

June 20, 2008
Subject: **Madrid**
State Project No. 010019.00
Amendment No. 3

Dear Sir/Ms:

Make the following change to the Bid Documents:

In the Bid Book; **REMOVE** the "SCHEDULE OF ITEMS", pages 3 through 9 (6 pages dated 080515) and **REPLACE** with the attached, new "SCHEDULE OF ITEMS", 8 pages dated 080616.

In the Bid Book, after page 41, **ADD** the attached SPECIAL PROVISION, SECTION 203, EXCAVATION AND EMBANKMENT (5 pages dated June 10, 2008).

In the Bid Book, **REMOVE** "SPECIAL PROVISION, SECTION 308, FULL DEPTH RECYCLED PAVEMENT, (With Bituminous Stabilizer)" pages 43 through 46 (4 pages dated January 5, 2006).

In the Bid Book, **REMOVE** "SPECIAL PROVISION, SECTION 308, (Recycled Pavement with Bit. stabilizer)" page 47 (1 page dated April 30, 2008).

In the Bid Book, after SPECIAL PROVISION, DIVISION 400, PAVEMENTS (page 68), **ADD** the attached "SPECIAL PROVISION, SECTION 401, HOT MIX ASPHALT PAVEMENTS, (Hot Bituminous Stabilized Base), 2 pages dated June 16, 2008.

In the Bid Book, after "SPECIAL PROVISION, DIVISION 400, PAVEMENTS" (page 68 and after the previous addition), **ADD** the attached "SPECIAL PROVISION, SECTION 401, HOT MIX ASPHALT PAVEMENTS", (Hot Bituminous Stabilized Base w/additive), 3 pages dated June 16, 2008.

In the Bid Book, **REMOVE** "SPECIAL PROVISION, SECTION 403, HOT MIX ASPHALT" (page 69 and 70, 2 pages dated May 19, 2008) and **REPLACE** with the attached, new "SPECIAL PROVISION, SECTION 403, HOT MIX ASPHALT" (2 pages dated June 16, 2008).

In the Plans, TYPICAL SECTIONS, **REMOVE SHEET 1 OF 3** and **REPLACE** with the attached (and mailed or FEDEXED) new TYPICAL SECTIONS, SHEET 1 OF 3. (Plan changes will be FEDEXED to street address and mailed to PO Boxes.)



PRINTED ON RECYCLED PAPER

In the Plans, GENERAL NOTES, SHEET 1 OF 1, CONSTRUCTION NOTES, **ADD** Note 40 to read as follows; "Item 603.209 changed from 59m to 49m due to pipe at station 1+350 reduced from 19.2m to 9.6 m (walking path only)."

In the Plans, ESTIMATED QUANTITIES & EARTHWORK SUMMARY, ESTIMATED QUANTITIES, **CHANGE** the ESTIMATED QUANTITIES to reflect the attached, new "SCHEDULE OF ITEMS". Make this change in pen and ink.

The following questions have been received:

Question: It is impossible to confirm the exact quantity for item #308.35 with the information that we have been given. It is also difficult, with the information given, to insure there is enough product coming from the project to complete the task given. How do we quantify both items?

Response: Item 308.35 has been eliminated in this amendment.

Question: How does one place this material (item#308.35) without either wasting recycled material on the shoulders if place first, or installing a gravel berm (shoulder) prior to placing the rap when the thickness exceeds 18 inches in place?

Response: Item 308.35 has been eliminated in this amendment.

Question: The cross sections have a cut slope similar to your presplit detail but there is no pay item for presplit. Do you want these items presplit? If so, will you add a pay item?

Response: Refer to SPECIAL PROVISION 203 added this amendment.

Question: Reference the GENERAL CONSTRUCTION NOTES in the Plans. Note #35 calls for existing guardrail to be removed. How much footage needs to be removed? There is no bid item 606.265, should there be?

Response: Note #35 is in reference to the abandoned section of roadway near the beginning of the project. There are some signs and some old cable guardrail that needs to be removed. The payment for removal of these items shall be incidental to common excavation.

Consider these changes and information prior to submitting your bid on **June 25, 2008**.

Sincerely,

Handwritten signature in black ink, appearing to read "S. Bickford" followed by "FOR" in a separate, slightly larger font.

Scott Bickford
Contracts & Specifications Engineer

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
SECTION 0001 PROJECT ITEMS						
0010	201.11 CLEARING	8.000 HA				
0020	201.12 SELECTIVE CLEARING AND THINNING	1.000 HA				
0030	202.15 REMOVING MANHOLE OR CATCH BASIN	1.000 EA				
0040	203.20 COMMON EXCAVATION	98000.000 M3				
0050	203.21 ROCK EXCAVATION	15500.000 M3				
0060	203.212 SPECIAL PERIMETER CONTROL BLASTING	9000.000 M				
0070	203.242 DIRTY BORROW	4300.000 M3				
0080	203.25 GRANULAR BORROW	670.000 M3				
0090	206.061 STRUCTURAL EARTH EXCAVATION - DRAINAGE AND MINOR STRUCTURES, BELOW GRADE	100.000 M3				

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0100	206.07 STRUCTURAL ROCK EXCAVATION - DRAINAGE AND MINOR STRUCTURES	120.000 M3				
0110	304.10 AGGREGATE SUBBASE COURSE - GRAVEL	30800.000 M3				
0120	403.207 HOT MIX ASPHALT 19.0 MM NOMINAL MAX SIZE	2600.000 MG				
0130	403.208 HOT MIX ASPHALT 12.5 MM, SURFACE	5650.000 MG				
0140	403.209 HOT MIX ASPHALT 9.5 MM (SIDEWALKS, DRIVES, INCIDENTALS)	55.000 MG				
0150	403.211 HOT MIX ASPHALT (SHIM)	180.000 MG				
0160	403.213 HOT MIX ASPHALT 12.5 MM, BASE	6900.000 MG				
0170	409.15 BITUMINOUS TACK COAT APPLIED	11700.000 L				
0180	425.30 HOT STABILIZED ASPHALT BASE	2600.000 MG				
0190	425.31 HOT STABILIZED ASPHALT BASE W/ ADDITIVES	5200.000 MG				
0200	502.302 STRUCTURAL CONCRETE BOX CULVERT, REPAIR @ Sta. 4+780	LUMP	LUMP			

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0210	534.71 PRECAST CONCRETE BOX CULVERT Extension @ STA 4+780	LUMP	LUMP			
0220	534.71 PRECAST CONCRETE BOX CULVERT STA 4+120	LUMP	LUMP			
0230	534.71 PRECAST CONCRETE BOX CULVERT STA 4+410	LUMP	LUMP			
0240	603.159 300 MM CULVERT PIPE OPTION III	M 45.000				
0250	603.16 375 MM CULVERT PIPE OPTION I	M 66.000				
0260	603.17 450 MM CULVERT PIPE OPTION I	M 12.000				
0270	603.179 450 MM CULVERT PIPE OPTION III	M 100.000				
0280	603.18 525 MM CULVERT PIPE OPTION I	M 26.000				
0290	603.189 525 MM CULVERT PIPE OPTION III	M 16.000				
0300	603.19 600 MM CULVERT PIPE OPTION I	M 76.000				
0310	603.199 600 MM CULVERT PIPE OPTION III	M 101.000				

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0320	603.209 750 MM CULVERT PIPE OPTION III	49.000 M				
0330	603.219 900 MM CULVERT PIPE OPTION III	80.000 M				
0340	603.229 1050 MM CULVERT PIPE OPTION III	21.000 M				
0350	603.42 762 MM REINFORCED CONCRETE PIPE CLASS IV	29.000 M				
0360	603.45 1219 MM REINFORCED CONCRETE PIPE CLASS IV	36.000 M				
0370	605.09 150 MM UNDERDRAIN TYPE B	340.000 M				
0380	605.10 150 MM UNDERDRAIN OUTLET	60.000 M				
0390	605.11 300 MM UNDERDRAIN TYPE C	510.000 M				
0400	606.1722 BRIDGE TRANSITION - TYPE 2	4.000 EA				
0410	606.23 GUARDRAIL TYPE 3C - SINGLE RAIL	2770.000 M				
0420	606.232 GUARDRAIL TYPE 3C - OVER 4.5 M RADIUS	31.000 M				

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0430	606.353 REFLECTORIZED FLEXIBLE GUARDRAIL MARKER	84.000 EA				
0440	606.356 UNDERDRAIN DELINEATOR POST	6.000 EA				
0450	606.47 SINGLE WOOD POST	2.000 EA				
0460	606.79 GUARDRAIL 350 FLARED TERMINAL	34.000 EA				
0470	610.08 PLAIN RIPRAP	4700.000 M3				
0480	610.16 HEAVY RIPRAP	360.000 M3				
0490	610.18 STONE DITCH PROTECTION	1200.000 M3				
0500	610.210 STREAM CHANNEL ROCKS	20.000 M3				
0510	610.211 STREAM CHANNEL GRAVEL	30.000 M3				
0520	613.319 EROSION CONTROL BLANKET	3450.000 M2				
0530	618.1401 SEEDING METHOD NUMBER 2 - PLAN QUANTITY	590.000 UN				

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0540	618.1411 SEEDING METHOD NUMBER 3 - PLAN QUANTITY	280.000 UN				
0550	619.1201 MULCH - PLAN QUANTITY	870.000 UN				
0560	620.54 STABILIZATION GEOTEXTILE	3000.000 M2				
0570	620.58 EROSION CONTROL GEOTEXTILE	9900.000 M2				
0580	627.711 WHITE OR YELLOW PAINTED PAVEMENT MARKING LINE (PLAN QUANTITY)	17920.000 M				
0590	627.76 TEMPORARY PAVEMENT MARKING LINE, WHITE OR YELLOW	LUMP	LUMP			
0600	629.05 HAND LABOR, STRAIGHT TIME	50.000 HR				
0610	631.12 ALL PURPOSE EXCAVATOR (INCLUDING OPERATOR)	30.000 HR				
0620	631.13 BULLDOZER (INCLUDING OPERATOR)	20.000 HR				
0630	631.172 TRUCK - LARGE (INCLUDING OPERATOR)	40.000 HR				
0640	631.18 CHAIN SAW RENTAL (INCLUDING OPERATOR)	10.000 HR				

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0650	631.22 FRONT END LOADER (INCLUDING OPERATOR)	20.000 HR				
0660	639.18 FIELD OFFICE TYPE A	1.000 EA				
0670	652.31 TYPE I BARRICADE	20.000 EA				
0680	652.312 TYPE III BARRICADE	20.000 EA				
0690	652.33 DRUM	100.000 EA				
0700	652.34 CONE	200.000 EA				
0710	652.35 CONSTRUCTION SIGNS	75.000 M2				
0720	652.361 MAINTENANCE OF TRAFFIC CONTROL DEVICES	LUMP	LUMP			
0730	652.38 FLAGGER	8000.000 HR				
0740	656.75 TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL	LUMP	LUMP			
0750	659.10 MOBILIZATION	LUMP	LUMP			

SCHEDULE OF ITEMS

REVISED:

CONTRACT ID: 010019.00

PROJECT(S): 010019.00

CONTRACTOR : _____

LINE NO	ITEM DESCRIPTION	APPROX. QUANTITY AND UNITS	UNIT PRICE		BID AMOUNT	
			DOLLARS	CTS	DOLLARS	CTS
0760	660.21 ON-THE-JOB TRAINING (BID)	2000.000 HR				
	SECTION 0001 TOTAL					
	TOTAL BID					

SPECIAL PROVISION
SECTION 203
EXCAVATION AND EMBANKMENT

Amend Section 203 as follows:

Rock slopes shall be classified as critical and non-critical rock slopes. Critical rock slopes shall be slopes higher than 1.8 meters (6 ft) with an overburden slope steeper than 3H:1V, and all slopes greater than 3 meters (10 ft) high. Controlled blasting shall be required on all critical slopes.

203.042 Controlled Blasting Controlled blasting techniques as covered herein shall be used for forming highway rock cut slopes defined as “critical” in Section 203.01 b. or as shown on the plans or called for in the Special Provisions.

Controlled blasting is defined as a blasting method which utilizes a line of closely spaced, lightly loaded blastholes that are fired either before or after the main production blast to define a break line on the perimeter of the excavation.

The purpose of the Controlled blasting is to create a stable rock face with a fall zone to protect the traveling public from rockfall hazard, and to protect existing structures, adjacent and nearby properties, and the public from damage or injury.

1. All blasting operations including the storage and handling of explosives and blasting agents shall be performed in accordance with the applicable provisions of the standard Specifications and all other pertinent Federal, State and local regulations.
2. The Contractor shall observe the entire blast area to guard against potential hazards before commencing work in the cut. The Contractor shall not be allowed to store explosives on the project site or on State owned property unless prior approval is granted by the Department.
3. In case of conflict between regulations or between regulations and this Specification, the Contractor shall comply with the strictest applicable codes, regulations, or Specifications.
4. General Requirements
 - a. The Resident will, at all times, have the authority to prohibit or halt the Contractor’s blasting operations if it is apparent that through the methods being employed, the required slopes are not being obtained in a stable condition, or the safety and convenience of the public is being jeopardized.
 - b. Explosives shall be stored, handled and employed in accordance with Federal, State and Local regulations. No explosives, caps, detonators or fuses shall be stored on the project site during non-working hours.
 - c. The overburden shall be removed or trenches shall be excavated through the overburden at the intervals directed by the Resident, normally 7.6 meters (25 ft) but in no case closer than 13 meters (10 ft) apart to permit

cross sectioning of the rock in its original position. Rock removed prior to sectioning will be considered as Common Excavation.

5. SUBMITTALS

- a. Advance submittal – Not less than two weeks prior to commencing drilling and blasting operations, or at any time the Contractor proposes to changes drilling and blasting methods, the Contractor shall submit a Blasting Plan to the Resident for review. The Blasting Plan shall contain full details of the drilling and blasting patterns and controls the Contractor proposes to use for both the controlled and production blasting. Review of the Blasting Plan by the Department shall not relieve the Contractor of his responsibility for the safety, accuracy and adequacy of the Plan when implemented in the field. The Blasting Plan shall contain the following information.
 - i. Station limits of proposed shots.
 - ii. Plan and section views of the proposed drill pattern, including free face, burden, blasthole spacing, blasthole diameters, blasthole angles, lift height, and subdrill depth.
 - iii. Loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.
 - iv. Initiators sequence of blastholes including delay times and delay system.
 - v. Manufacturers' data sheets for all explosives, primers and initiators to be used.
 1. The delay elements in blasting caps are known to deteriorate with age. For this reason, it is required that all blasting caps used on the project be less than one year of age. No blasting product will be brought to the job site if the date codes are missing.
 2. When in the opinion of the Resident any blasting product is either of excessive age or in what appears to be a deteriorated condition, all work will cease until the product's age or quality can be determined.
 3. Explosives containing Perchlorate compounds shall not be used on Department projects.
 - vi. Details of the audible advance signal system to be employed at the job site.
- b. Daily Blasting Logs – The Contractor shall provide the Resident with a daily log of blasting operations, submitted on a weekly basis. The log shall be updated at the close of each working day. The log shall include the number of blasts, times, and dates of blasts, the blasting locations and patterns, and all information shown below:
 - i. Station limits of the shot.
 - ii. Plan and section views of drill pattern, including free face, burden blasthole spacing, blasthole diameters, lift height, and subdrill depth.
 - iii. Loading diagram showing type and amount of explosive, primers, initiators, and location and depth of stemming.
 - iv. Initiators sequence of blastholes including delay times and delay system in each blasthole.
 - v. Mats or other protection used.
 - vi. Signature of the Blaster in charge.

- c. The Contractor shall report to the Resident in writing all blasting complaints received by the Contractor within 24 hours of receipt. Each blast complaint report shall include the name and address of the complainant, time received, date and time of blast complained about, and a description of the circumstances which led to the complaint.
6. **BLAST VIBRATION CONTROL AND MONITORING**
 - a. The Contractor shall be required to monitor blasting vibrations (both ground and air concussions) and shall provide a Pre-Blast Condition survey of all structures that may be affected.
 - b. When nearby structures, utilities, or adjacent slopes may be subject to damage from blast-induced ground vibrations, the ground vibrations shall be controlled by the use of properly designed delay sequences and appropriate charge weights per delay.
 - c. When vibration damage to adjacent structures is possible, the Contractor shall monitor each blast with an approved seismograph located, as approved, between the blast area and the closest structure subject to blast damage. The seismograph used shall be capable of recording particle velocity for three mutually perpendicular components of vibration in the range generally found with controlled blasting.
7. **FLYROCK CONTROL** Before the firing of any blast in areas where flying rock or debris may result in personal injury or damage to property, the rock to be blasted shall be covered with approved blasting mats, soil, or other equally serviceable material to prevent flyrock. The method of flyrock control shall be subject to approval by the Resident.
8. **CONTROLLED BLASTING METHODS**
 - a. Production blasting refers to the main fragmentation blasting resulting from widely spaced production holes drilled throughout the main excavation area adjacent to the presplit line. Production holes shall be detonated in a controlled delay sequence.
 - b. Presplitting is defined as the establishment of a free surface of a shear plane in rock by the controlled usage of explosives and blasting accessories in appropriately aligned and spaced drill holes so that the resulting split rock is not affected by subsequent blasting and excavation operations. The purpose of presplitting is to minimize damage to the rock backslope and to help ensure long term stability. When presplitting, the detonation of the presplit line shall be before the detonation of any production holes.
 - i. Prior to drilling, all overburden and all loose and disintegrated rock shall be removed down to solid rock in the vicinity of the presplit lines. Potentially dangerous boulders beyond the excavation limits shall also be removed as directed by the Resident.
 - ii. Presplitting shall extend a minimum of 9 meters (30 feet) ahead of the limits of production blasting within the section or to the end of the cut as applicable.
 - iii. All drilling equipment used to drill the presplit holes shall have electromechanical or electronic devices affixed to that equipment to accurately determine the angle at which the drill steel enters the rock. Presplit hole drilling will not be permitted if these devices are missing or inoperative.
 - iv. The length of the presplit holes shall not exceed 9 meters (30 feet) in depth unless approved by the Resident. Rock deeper than 9 meters (30

- feet) shall usually be presplit in lifts, but no lift shall be less than 3 meters (10 feet) in depth. When the cut height will require more than one lift, a maximum 0.6 meter (2-foot) offset between lifts shall be permitted to allow for equipment clearance. No payment will be made for additional excavated quantity caused by offsetting of presplit lines for less than 6.1 meter (20 foot) lifts. Drilling 0.6 meters (2 feet) below ditch bottom will be allowed to facilitate removal of the toe berm.
- v. Before placing charges, the contractor shall determine that the hole is free of obstructions for its entire depth. All necessary precautions shall be exercised so that placing the charges will not cause caving of material from the walls of the holes.
 - vi. The diameter of the explosives used in presplit holes shall not be greater than ½ the diameter of the hole.
 - vii. Continuous column cartridge explosives manufactured especially for presplitting shall be used for all presplitting. The bottom charge of a presplit hole may be larger than the line charges, but shall not be large enough to cause overbreak. The top charge of the presplitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving. The upper portion of all presplit holes, from the top charge to the hole collar, shall be stemmed.
 - viii. The presplit slope face shall not deviate more than 0.3 meters (one foot) from a plane passing through adjacent drillholes, except where the character of the rock is such that, as determined by the Resident, irregularities are unavoidable. The 0.3 meter (one-foot) plane shall be measured perpendicular to the plane of the slope. In no case shall any portion of the slope encroach on the roadbed.
- c. Cushion blasting. Where the horizontal distance from the existing rock face to the cut face is less than 4.6 meters (15 feet), or if rock conditions warrant this approach, the contractor may use cushion blast in lieu of presplitting. Cushion blasting is similar to presplitting except that the detonation along the cut face occurs after the detonation of all production holes. With the exception of the above criteria, requirements previously given for presplitting shall also apply to cushion blasting.
 - d. Sliver Cuts – For sliver cuts, pioneering the top of cuts and preparing a working platform to begin the controlled blasting may require unusual work methods and use of equipment. The contractor may use angle drilled holes during the initial pioneering operations to obtain the desired rock face. Hole spacing shall not exceed 760 mm (30 inches).
9. Method of Measurement. Controlled Blasting shall be paid by the linear meter of presplitting holes and extra drilled holes without explosives, measured from the top of the drill hole at the rock surface to the bottom of the hole or to the elevation of the required subgrade (whichever is higher) or to an established bench elevation. Portions of holes not meeting the requirements of Subsection 8 will not be measured. Production holes will not be measured. Presplitting holes and extra drilled holes without explosives drilled where presplitting is not required by this specification will not be measured. Where presplitting is required, excavated rock will be paid only to the slope and depth lines shown on the plans or as ordered by the Resident. Where the Resident determines that the removal of additional rock is necessary due to conditions clearly not attributable to the Contractor's methods of operations, the payment lines will be adjusted to the limits ordered, to include only rock actually removed within such limits.

Madrid, Letter E Twp, Sandy River

PIN 10019.00

June 10, 2008

10. Basis of Payment. The accepted quantity of presplitting rock will be paid for at the contract unit price per linear meter under Pay Item 203.212. All costs incurred by the Contractor in preparing an approved blasting plan, in maintaining a blasting log, and in adopting revised blasting methods necessary to produce an acceptable test shot shall be considered incidental to the contract unit prices for rock excavation and presplitting rock.

Add Pay Item

Unit

203.212 Special Perimeter Control Blasting

Linear Meter

SPECIAL PROVISION
SECTION 401
HOT MIX ASPHALT PAVEMENTS
(Hot Bituminous Stabilized Base)

The Special Provision 401 – Hot Mix Asphalt Pavement, has been modified with the following revisions. All sections not revised by this Special Provision shall be as outlined in the Special Provision 400 Pavements, dated 3-12-2008, section 401 – Hot Mix Asphalt Pavement.

401.01 Description This work shall consist of the removal of all bituminous pavement from the existing roadway, hauling the bituminous pavement to an approved location, and processing as per this Specification. The gravel base of the existing roadway shall be regarded and compacted to the tolerances shown on the typicals, or as directed by the Resident. The placement, grading and compaction of additional gravel base shall be paid under the appropriate aggregate base item.

All Hot Bituminous Stabilized Base shall be placed in one or more courses on an approved base and in accordance with these specifications, and in reasonably close conformity with the lines, grades and thicknesses indicated on the plans, or as established by the Resident. Excess recycled material not used in the Hot Bituminous Stabilized Base process will become the property and responsibility of the contractor.

MATERIALS

401.03 Composition of Mixtures – (paragraph 1) - The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), and mineral filler if required. HMA shall be designed and tested according to AASHTO T312 and the volumetric criteria in Table 1. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF). The Contractor shall submit designs for approval utilizing a minimum of **20%** to a maximum of **40%** of recycled asphalt pavement (RAP) in any Hot Bituminous Stabilized Base course unless otherwise directed by the Department. The Hot Bituminous Stabilized Base shall be designed for an Air Void Target of 6.0 % at 75 Gyrations. All recycled asphalt pavement (RAP) utilized in the Hot Bituminous Stabilized Base shall be salvaged from the project, unless otherwise authorized by the Department.

REVISED TABLE 1: VOLUMETRIC DESIGN CRITERIA

Design ESAL's (Millions)	Required Density (Percent of G_{mm})			Voids in the Mineral Aggregate (VMA)(Minimum Percent)					Voids Filled with Binder (VFB) (Minimum %)	Fines/Eff. Binder Ratio
				Nominal Maximum Aggregate Size (mm)						
	$N_{initial}$	N_{design}	N_{max}	25 [1 inch]	19 [¾ in]	12.5 [½ in]	9.5 [⅜ in]	4.75 [#4]		
<0.3	≤91.5								70-80	0.6-1.4
0.3 to <3	≤90.5								65-78	
3 to <10		96.0	≤98.0	12.0	13.0	14.0	15.0	16.0	65-75*	
10 to <30	≤89.0									
≥ 30										

*For 9.5 mm [⅜ in] nominal maximum aggregate size mixtures, the maximum VFB is 76.

*For 4.75 mm [#4] nominal maximum aggregate size mixtures, the maximum VFB is 80.

401.05 Performance Graded Asphalt Binder Unless otherwise noted in Special Provision 403 - Hot Bituminous Pavement, PGAB shall be 64-28 or 58-28. The PGAB shall meet the applicable requirements of AASHTO M320 - Standard Specification for PGAB. The Contractor shall provide the Department with an approved copy of the Quality Control Plan for PGAB in accordance with AASHTO R 26-01 Certifying Suppliers of PGAB.

401.052 Repairs Repairs and maintenance for the Hot Bituminous Stabilized Base, during and after the placing operation, resulting from damage caused by traffic, weather or environmental conditions, or caused by the Contractor's operations or equipment, shall be completed at no additional cost to the Department.

Low areas will be repaired using a hot mix asphalt shim course. Areas up to 25mm [1 in] high can be repaired by milling or shimming with hot mix asphalt. Areas higher than 25mm [1 in] will be repaired using a hot mix asphalt shim. All repair work will be done with the Resident's approval at the Contractor's expense.

401.22 Basis of Payment The Department will pay for the work, in place and accepted, in accordance with the applicable sections of this Section, for each type of HMA specified.

The Department will pay for the work specified in Section 401.11, for the HMA used, except that cleaning objectionable material from the pavement and furnishing and applying bituminous material to joints and contact surfaces is incidental.

The accepted quantity of Hot Bituminous Stabilized Base will be paid under the contract unit price per Mg [Ton], complete in-place which price will be full compensation for furnishing all equipment and labor for removing existing pavement, regrading and compacting existing gravel base, processing, mixing, testing, placing, and compacting, excess material relocation, and for all incidentals necessary to complete the work. The placement, grading and compaction of additional gravel base shall be paid under the appropriate aggregate base item.

Payment for this work under the appropriate pay items shall be full compensation for all labor, equipment, materials, and incidentals necessary to meet all related contract requirements, including design of the JMF, implementation of the QCP, obtaining core samples, transporting cores and samples, filling core holes, applying emulsified asphalt to joints, and providing testing facilities and equipment.

The Department will make a pay adjustment for quality as specified below.

401.222 Pay Factor (PF) The Department will use the following criteria for pay adjustment using the pay adjustment factors under Section 106.7 - Quality Level Analysis: Method C Testing criteria

Payments will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
425.30 – Hot Bituminous Stabilized Base	Ton [Mg]

SPECIAL PROVISION
SECTION 401
HOT MIX ASPHALT PAVEMENTS
 (Hot Bituminous Stabilized Base w/ additive)

The Special Provision 401 – Hot Mix Asphalt Pavement, has been modified with the following revisions. All sections not revised by this Special Provision shall be as outlined in the Special Provision 400 Pavements, dated 3-12-2008, section 401 – Hot Mix Asphalt Pavement.

401.01 Description This work shall consist of the removal of all bituminous pavement from the existing roadway, hauling the bituminous pavement to an approved location, and processing together with a Warm Mix Asphalt Additive as per this Specification. The gravel base of the existing roadway shall be regarded and compacted to the tolerances shown on the typicals, or as directed by the Resident. The placement, grading and compaction of additional gravel base shall be paid under the appropriate aggregate base item.

All Hot Bituminous Stabilized Base with Additive shall be placed in one or more courses on an approved base and in accordance with these specifications, and in reasonably close conformity with the lines, grades and thicknesses indicated on the plans, or as established by the Resident. Excess recycled material not used in the Hot Bituminous Stabilized Base process will become the property and responsibility of the contractor.

MATERIALS

401.03 Composition of Mixtures – (paragraph 1) - The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), **Warm Mix Additive**, and mineral filler if required. The mixture shall be designed and tested according to AASHTO T312 and the volumetric criteria in Table 1. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF). The Contractor shall submit designs for approval utilizing a minimum of **20%** to a maximum of **40%** of recycled asphalt pavement (RAP) in any Hot Bituminous Stabilized Base course unless otherwise directed by the Department. The Hot Bituminous Stabilized Base shall be designed for an Air Void Target of **6.0 % at 75 Gyration**s. **Warm Mix Additives** shall be introduced into the mixture at a in a manner and rate recommended by the additive manufacturer. All recycled asphalt pavement (RAP) utilized in the Hot Bituminous Stabilized Base shall be salvaged from the project, unless otherwise authorized by the Department.

REVISED TABLE 1: VOLUMETRIC DESIGN CRITERIA

Design ESAL's (Millions)	Required Density (Percent of G _{mm})			Voids in the Mineral Aggregate (VMA)(Minimum Percent)					Voids Filled with Binder (VFB) (Minimum %)	Fines/Eff. Binder Ratio
	N _{initial}	N _{design}	N _{max}	Nominal Maximum Aggregate Size (mm)						
				25 [1 in]	19 [¾ in]	12.5 [½ in]	9.5 [¾ in]	4.75 [#4]		
<0.3	≤91.5	96.0	≤98.0	12.0	13.0	14.0	15.0	16.0	70-80	0.6-1.4
0.3 to <3	≤90.5								65-78	
3 to <10	≤89.0								65-75*	
10 to <30										
≥ 30										

*For 9.5 mm [¾ in] nominal maximum aggregate size mixtures, the maximum VFB is 76.

*For 4.75 mm [#4] nominal maximum aggregate size mixtures, the maximum VFB is 80.

401.031 Warm Mix Additive

Option A - The use of organic additives such as a paraffin wax and or a low molecular weight esterified wax available in 2, 5, 20 or 600 kg [5, 10, 50 or 1250 lb] bags, is required. Wax derived additives shall be introduced at the rate recommended by the manufacture, typically 3 percent by weight (3%) of the mix to gain the desired reduction in viscosity, and should not exceed 4 percent due to the possible impact on the binder's low temperature properties. Wax derived additives shall be introduced into the hot asphalt binder at the asphalt plant and fully blended using a tank agitator / stirrer. Wax additives shall have a melting point of approximately 99° C [210° F]. Minimum placement temperatures shall be as per manufactures recommendations. A Quality Control Plan shall be submitted for approval by the Department.

Option B - The use of a manufactured synthetic zeolite (Sodium Aluminum Silicate), available in a very fine powdered form in 25 or 50 kg [55 or 110 lb] bags, or in bulk for silos. Sodium aluminum silicate additives shall be introduced at a rate recommended by the manufacturer, typically 0.3 percent by mass of the mix. Sodium aluminum silicate additives shall be introduced into the hot mix plant mixing chamber by mechanical means that can be controlled and tied directly to the hot mix asphalt plants rate of production. Minimum placement temperatures shall be as per manufactures recommendations. A Quality Control Plan shall be submitted for approval by the Department.

Option C - The use of a chemical additive technology and a "Dispersed Asphalt Technology" delivery system shall be required. This process utilizes chemical technology delivered into a dispersed asphalt phase (emulsion). The asphalt emulsion with chemical package is used in place of the traditional asphalt binder. The emulsion is mixed with the aggregate in the HMA plant at a rate recommended by the manufacturer. This additive shall be introduced into the hot mix plant mixing chamber by mechanical means that can be controlled and tied directly to the hot mix asphalt plants rate of production. Minimum placement temperatures shall be as per manufactures recommendations. A Quality Control Plan shall be submitted for approval by the Department.

Option D - Other products / processes approved by the Department.

401.05 Performance Graded Asphalt Binder Unless otherwise noted in Special Provision 403 - Hot Bituminous Pavement, PGAB shall be 64-28 or 58-28. The PGAB shall meet the applicable requirements of AASHTO M320 - Standard Specification for PGAB. The Contractor shall provide the Department with an approved copy of the Quality Control Plan for PGAB in accordance with AASHTO R 26-01 Certifying Suppliers of PGAB.

401.052 Repairs Repairs and maintenance for the Hot Bituminous Stabilized Base with Additive, during and after the placing operation, resulting from damage caused by traffic, weather or environmental conditions, or caused by the Contractor's operations or equipment, shall be completed at no additional cost to the Department. Low areas will be repaired using a hot mix asphalt shim course. Areas up to 25mm [1 in] high can be repaired by milling or shimming with hot mix asphalt. Areas higher than 25mm [1 in] will be repaired using a hot mix asphalt shim. All repair work will be done with the Resident's approval at the Contractor's expense.

401.06 Weather Limitations The plant mixed recycled asphalt pavement shall be performed when:

- a. Operations will be allowed between May 15th and September 15th inclusive.
- b. The atmospheric temperature, as determined by an approved thermometer placed in the shade at the recycling location, is 10°C [50⁰F] and rising.
- c. When there is no standing water on the surface.
- d. During generally dry conditions, or when weather conditions are such that proper pulverizing, adding, mixing, and curing can be obtained using proper procedures, and when compaction can be accomplished as determined by the Resident.
- e. When the surface is not frozen and when overnight temperatures are expected to be above 0°C [32⁰F].

401.22 Basis of Payment The Department will pay for the work, in place and accepted, in accordance with the applicable sections of this Section, for each type of HMA specified.

The Department will pay for the work specified in Section 401.11, for the HMA used, except that cleaning objectionable material from the pavement and furnishing and applying bituminous material to joints and contact surfaces is incidental.

The accepted quantity of Hot Bituminous Stabilized Base with Additive will be paid under the contract unit price per Mg [Ton], complete in-place which price will be full compensation for furnishing all equipment and labor for removing existing pavement, regrading and compacting existing gravel base, processing, mixing, testing, placing, and compacting, excess material relocation, and for all incidentals necessary to complete the work. The placement, grading and compaction of additional gravel base shall be paid under the appropriate aggregate base item.

Payment for this work under the appropriate pay items shall be full compensation for all labor, equipment, materials, and incidentals necessary to meet all related contract requirements, including design of the JMF, implementation of the QCP, obtaining core samples, transporting cores and samples, filling core holes, applying emulsified asphalt to joints, and providing testing facilities and equipment.

The Department will make a pay adjustment for quality as specified below.

401.222 Pay Factor (PF) The Department will use the following criteria for pay adjustment using the pay adjustment factors under Section 106.7 - Quality Level Analysis: Method C Testing criteria

Payments will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
425.31 – Hot Bituminous Stabilized Base w / Additive	Ton [Mg]

SPECIAL PROVISION
SECTION 403
HOT MIX ASPHALT

Desc. of Course	Grad. Design	Item Number	Bit Cont. % of Mix	Total Thick	No. Of Layers	Comp. Notes
<u>165mm HMA Overlay</u>						
<u>Normal Mainline Travelway Sections - Full Construction Areas</u>						
Wearing	12.5mm	403.208	N/A	40mm	1	1,5,9,12,22
Base	12.5mm	403.213	N/A	50mm	1	1,5,9
Base	19.0mm	ref: note 25	N/A	75mm	1/more	1,5,9,13,25
<u>165mm HMA Overlay</u>						
<u>Normal Shoulders - Full Construction Areas</u>						
Wearing	12.5mm	403.208	N/A	40mm	1	1,5,9,12
Base	12.5mm	403.213	N/A	50mm	1	1,5,9
Base	19.0mm	ref: note 25	N/A	75mm	1/more	1,5,9,13,25
<u>Shim</u>						
Shim	9.5mm	403.211	N/A	variable	1/more	2,5,10, 11
<u>Drives, Misc.</u>						
Wearing	9.5 mm	403.209	N/A	50mm	2/more	2,3,10,11,14

COMPLEMENTARY NOTES

- The required PGAB for this mixture will meet a **PG 58-28** to **PG 64-28** grading. The Contractor must stipulate the which PGAB grading will be used to construct the entire HMA pavement structure prior to starting work.
- The density requirements are waived.
- The design traffic level for mix placed shall be <0.3 million ESALS.
- The aggregate qualities shall meet the design traffic level of 3 to <10 million ESALS for mix placed under this contract. The design, verification, Quality Control, and Acceptance tests for this mix will be performed at **75 gyrations**.
- Section 106.6 Acceptance, Method C.
- Section 106.6 Acceptance, (2) Method D.
- The combined aggregate gradation required for this item shall be classified as a 9.5mm “**fine graded**” mixture, (using the Primary Control Sieve control point) as defined in 703.09.
- A mixture meeting the gradation of 9.5 mm hot mix asphalt may be used at the option of the contractor.
- The combined aggregate gradation required for this item shall be classified as a 19.0mm “**fine graded**” mixture (using the Primary Control Sieve control point) as defined in 703.09.
- A mixture meeting the requirements of section 703.09 Grading ‘D’, with a minimum PGAB content of 6%, and the limits of Special Provision 401, Table 9 (Drives and Sidewalks) for PGAB content and gradation may be substituted for this item. A job mix formula shall be submitted to the department for approval.
- Any areas reconstructed and exposed to traffic over winter suspension shall have the full depth, full width layers of 19.0 mm HMA base, and the 12.5mm HMA base layers placed prior to the winter suspension of work on the project. All work associated with this item will be required to be done within the standard seasonal limitations, and evaluated in accordance with all applicable specifications. Any work performed outside the seasonal limitations dates will be considered temporary, and removed and replaced at no cost to the Department when work resumes in the next working season.

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PIN 10019.00
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22. The final pavement surface shall be evaluated for smoothness in accordance with Special Provision Section 402 – Pavement Smoothness dated 3-12-08. Acceptance limits shall be as outlined under the **Level II** classification.
25. This layer shall consist of a standard 19.0mm HMA control section, a 19.0mm Hot Bituminous Stabilized Base section (Item 425.30), and two 19.0mm Hot Bituminous Stabilized Base with additive sections (Item 425.31). The length of the project will be broken into 4 approximately equal sections of the contractor's choosing for use as the Base Test Sections. Unless otherwise authorized by the Department, the individual sections should be continuous sections.

Tack Coat

A tack coat of emulsified asphalt, RS-1, Item #409.15 shall be applied to any existing pavement at a rate of approximately 0.08 L/m², and on milled pavement approximately 0.2 L/m², prior to placing a new course. A fog coat of emulsified asphalt shall be applied between shim / intermediate course and the surface course, at a rate not to exceed 0.08 L/m².

Tack used between layers of pavement will be paid for at the contract unit price for Item 409.15 Bituminous Tack Coat.

OHIO

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SUPPLEMENTAL SPECIFICATION 800
REVISIONS TO THE 2008 CONSTRUCTION & MATERIAL SPECIFICATIONS
DATED 07-17-2009

104.02.D,

On page 17, Replace the section **Significant Changes to the Character of the Work** with the following:

D. Significant Changes in Character of the Work. The Engineer may alter the Work as necessary to complete the Project. The Engineer will make appropriate adjustments according to 108.06 and 109.05, if such alterations significantly change the character of the Work.

If the Contractor disagrees as to whether an alteration constitutes a significant change, use the notification procedures specified in 104.02.G.

The term “significant change” is defined as follows:

1. when the character of the Work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or
2. when the product of the quantity in excess of the estimated quantity of a contract item and the unit price exceeds the limits set forth in Table 104.02-1.

TABLE 104.02-1

Contract Price	Contract Limits
Up to \$500,000	\$25,000
\$500,001 to \$2,000,000	5% of Total Contract Price
Over \$2,000,000	\$100,000

If the decrease in quantity of any unit price Contract Item exceeds 25 percent of the estimated quantity, and the total of all such adjustments for all Contract Items is more than \$400, then after the determination of final quantities according to 109.12.C, the Engineer will adjust the unit prices for the affected Contract item by multiplying the bid unit price by the factor obtained from Table 104.02-2.

TABLE 104.02-2

% Decrease	Factor	% Decrease	Factor
25 to 28	1.02	61	1.14
29 to 32	1.03	62	1.15
33 to 35	1.04	63	1.16
36 to 38	1.05	64	1.17
39 to 41	1.06	65	1.18
42 to 44	1.07	66	1.19
45 to 47	1.08	67	1.20
48 to 50	1.09	68	1.21
51 to 53	1.10	69	1.22
54 to 56	1.11	70	1.23
57 to 59	1.12	71	1.24
60	1.13	72 and over	1.25

When the increase in quantity or decrease in quantity of any unit price contract item does not exceed the limits set forth in Tables 104.02-1 and 104.02-2, there is no significant change in the character of the work and the change is considered a minor change. Department will pay for minor changes in the Work at the unit bid price.

104.02.H,

On Page 19, **Replace** the second sentence with: This unilateral authority to pay by the Department does not preclude or limit the rights of the Department and the contractor to negotiate and agree to the amounts to be paid to the contractor.

105.16,

On page 25, After the second full paragraph (begins with "Perform all engineering"...)**Add** the following sentence: Repairs to approved haul roads will be made in accordance with 105.13.

105.16

On page 25, **Delete** the 5th paragraph, begins with "Do not waste ..."

On page 26, **Delete** the first full paragraph, begins with "Cultural resource areas..."

On page 26, **Delete** the 6th and 7th paragraphs, beginning with "Ensure that any...", and "If the proposed..."

On page 27, after the last paragraph in the section, **Add** "Borrow and Waste Area shall adhere to CMS 107.10."

105.16,

On Page 26, **Delete** the following section and list:

If the Contract Documents require a cultural resource investigation, use an environmental consultant prequalified by the Department for cultural resource investigations to review and certify that the waste or borrow site:

- A. does not impact a cultural resource;
- B. is not a cultural resource;
- C. is not eligible for the National Register of Historic Places; or
- D. does not consist of historic or prehistoric human remains.

106.05,

On page 29, after the first paragraph, **Add** “Areas used to Store Materials shall adhere to CMS 107.10.”

107.01,

On Page 31, in the fourth paragraph **Replace** 4121:1-3 with 4123:1-3 and **Delete** the clause “effective November 1, 1979”

107.10,

On Page 33, last paragraph and continuing on Page 34, sentence one, **REVISE** to: “When specified in the plans, the Contractor will construct the Monument Assemblies with the iron pin and Reference Monuments with the iron pin and cap.”

On Page 34, third full paragraph, **DELETE** “The Engineer will provide the Contractor with a list of monuments and survey markers that the Contractor is to protect and preserve during the performance of the work and a list of monuments and survey markers that may be destroyed during the performance of the work. When specified in the plans, the contractor will construct the adjustable monument assemblies without the iron pin and cap.”

107.10,

On page 35, after the last paragraph in the section **Add** the following:

“Do not create staging areas, store materials and equipment, or borrow or waste materials in areas labeled as an environmental resources areas in the Contract Documents. All properties to be utilized by the Contractor outside the project right of way must be cleared for all environmental resource impacts prior to the beginning of work. Environmental resources include but may not be limited to:

1. Cultural Resources

- a. Buildings, structures, objects, and sites eligible for or listed on the National Register of Historic Places
- b. Historic or prehistoric human remains, cemeteries, and/or burial sites (prusuant with ORC 2909.05 and 2927.11)

2. Ecological Resources

- a. Wetlands
- b. Streams
- c. Wooded areas with trees to be removed in excess of 8 inches diameter at breast height

3. Public Lands

- a. Lands meeting the criteria of 49 U.S.C. 303, 23 CFR 771.I35: 4(f).
- b. Lands meeting the criteria of 16 U.S.C. 4601-4, 36 CFR59.1: 6(f).

4. FEMA Mapped 100 year Floodplains
5. Hazardous Waste Areas

All areas proposed to be utilized by the Contractor outside the project construction limits shall be reviewed by environmental contractor(s) that are prequalified by the Department for each environmental resource. Have the consultant(s) certify that the proposed site to be utilized for the contractor will not impact:

- Cultural Resources
- Ecological Resources
- Public Lands
- FEMA Mapped 100 year Floodplains
- Hazardous Waste Areas

Provide all documentation and the consultant certification to the Department Office of Environmental Services.

Should the areas proposed for use by the Contractor outside the project right of way limits contain environmental resources the Contractor is responsible to the Department for all environmental clearances and permits prior to the beginning of work.”

108.06.A,

On page 47, **Replace** the second sentence in section **General** with the following:

The critical path is defined as; the longest path of activities in the project that determines the project schedule completion date. The activities that make-up the critical path of activities are the “Critical Activities.”

108.07.E,

On Page 50, throughout the 108.07.E section, **Replace** "Director" with "District Deputy Director".

109.01,

On page 52, **Add** the following to the end of the first paragraph: The accuracy of individual pay item estimate payments will be one decimal more accurate than the unit of measure denoted for the pay item.

109.05,

On page 57, **Replace** the title of the section from **Extra Work** to **Changes and Extra Work**

On page 57, **Revise** the first paragraph of section 109.05.A **General** with the following:

If the Department revises the Contract under: 104.02, 105.07, 105.10, 105.13, 107.10, 107.14, 107.15, 108.09, 109.06, or 109.07, the Department will pay for changes and Extra Work with a Change Order using the sequence specified in 109.05.B through 109.05.E.

On page 57, **Revise** the third paragraph of section 109.05.A **General** with the following:

Unless otherwise stated in 109.05, the compensation provided in 109.05.B through 109.05.E constitutes payment in full for all changes and Extra Work completed by original Contract Price, agreed unit price, agreed lump sum price, and for work performed on a force account basis, including:

On page 58, **Revise** the first paragraph of section 109.05.B **Negotiated Prices** with the following:

Negotiated prices for changes and Extra Work shall be comparable to prices that would have resulted from a competitive bid contract. The Engineer and Contractor will negotiate agreed unit or lump sum prices using one or more of the following methods:

On page 58, **Replace** the paragraph of section 109.05.B.1 with the following:

1. Original Contract prices for similar work but adjusted for:
 - a. increased or decreased material costs specified in 109.05.C.3.
 - b. increased or decreased labor costs specified in 109.05.C.2
 - c. increased or decreased equipment costs specified in 109.05.C.4Adjustments of these prices for inflation or mark up for subcontractor work is not allowed.

On page 58, **Revise** the second paragraph of section 109.05.B **Negotiated Prices** with the following:

Provide proposed pricing and cost justification for changes or Extra Work within 5 business days after the Department's request. The Department will respond within 5 business days after receipt of the Contractor's proposal. The Department and the Contractor can mutually agree to extend these 5-day time limits.

109.5.C.7,

On Page 67, **Replace** the section **Additional Bonding Premium and Fees** with the following:

Final Adjustment to Premium for Contract Bonds: The final bond premium amount for the payment and performance bonds will be computed based on the actual final contract value. For the purpose of computing a bond premium adjustment the actual final contract value is defined as the whole sum of money, excluding any bond premium adjustment, which is passed from the department to the contractor as a result of the completion of the Work. If the actual final contract value is different from the original contract value, the premium shall be adjusted accordingly; either by refund of part of the original bond premium by the contractor if the original contract value is larger than the actual final contract value; or by payment of additional bond premium by the department if the original contract value is smaller than the actual final contract value. Additional payment by the department or refund by the contractor will be based on the difference between the invoiced bond premium for the original contract value and the invoiced bond premium for the actual final contract value without any markup. A final bond

premium adjustment will not be made when the actual final contract value differs from the original contract value by less than \$ 40,000.00.

109.05.C.10,

On Page 68, **Replace** the change order web link to:

<HTTP://WWW.DOT.STATE.OH.US/DIVISIONS/CONSTRUCTIONMGT/ADMIN/PAGES/DEFAULT.ASPX>

109.12.B,

On Page 75, **Replace** the last sentence with: Failure of the Contractor to complete the punch list items by the stipulated time will result in the assessment of fifty percent of the Liquidated Damages according to 108.07 for each Calendar Day for every day beyond the stipulated time the punch list work remains incomplete and beyond the revised Completion Date.

109.12.C.,

On Page 75, **Add** the following after the existing first sentence. "The prescribed 30 Calendar Day period can be modified by mutual agreement of the Contractor and the District Construction Engineer."

204.02,

On page 99, Replace the third paragraph in the section with:

Do not use Granular Material Type D, E, or F in the location where underdrains are to be constructed.

206.02,

On page 107, Replace the fourth paragraph of 206.02 with the following:

For Curing Coat furnish rapid setting emulsified asphalt conforming to 702.04, or the curing materials specified in 451.02.

208.06,

On page 121, Replace the last two sentences in Paragraph D with:

Do not exceed 6 ¾ inches (170 mm) in diameter for the production blast holes. Delay the detonation sequence of the production holes toward a free face.

301.04, Spreading and Finishing

On page 154. **Replace** the last sentence in this section with the following sentences:

Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C) if a hot mix asphalt and 230 °F (110°C) if a warm mix asphalt according to 402.09. Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

302.02.A,

On page 156, **Replace** the properties table in the fourth paragraph with the following table:

Property	Acceptable Range of Values	
	minimum	maximum
Binder Content, % of total mix	2.0 [Virgin]	6.0 [Total]
Stability, lb (N), 70 blow	3000 (13,345)	--
Flow, 0.25 mm, 70 blow	--	28
Voids in Mineral Aggregate, %	12.0	--

302.04, Spreading and Finishing

On page 157. **Replace** the last sentence in this section with the following sentences:

Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C) if a hot mix asphalt and 230 °F (110°C) if a warm mix asphalt according to 402.09. Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

304.04,

On page 158, Replace Section 304.04 with the following:

304.04 Spreading. Spread the material on the prepared surface. Do not use frozen material and do not spread on frozen surfaces.

Do not exceed a compacted lift thickness of 8 inches (200 mm) when using vibratory rollers greater than 12 tons (11 metric tons). Do not exceed a compacted lift thickness of 6 inches (150 mm) when using 10 to 12-ton (9 to 11 metric tons) vibratory rollers. Do not exceed a maximum compacted lift thickness of 4 inches (100 mm) when these vibratory rollers are not used.

The Contractor may elect to use a lighter roller if the centrifugal force exceeds the minimum weight. In all cases, submit documentation proving the minimum weight requirements are met.

Place the material in two or more approximately equal lifts when the specified compacted thickness exceeds 8 inches (200 mm).

Place the material with self-propelled spreading machines capable of placing the material true to line and grade. Spreading machines such as spreader boxes or pavers are allowed. Do not use graders or dozers without spreader boxes to spread the material except for areas described in the next paragraph. Spread the material such that it minimizes segregation and requires minimal blading or manipulation. The Department may perform in place gradation testing in areas that are visually segregated according to Supplement 1090.

The Contractor may use hand-placing methods, dozers or graders when the total area of the material is 2000 square yards (1700 m²) or less or in small areas where self propelled spreading machines are impractical. Small areas include lane widths less than 12 feet (3.7 m) or lengths less than 1000 feet (305 m). The Department will not take in place gradation tests in these small areas.

The Department may test for in place gradation after spreading but before compaction testing according to Supplement 1090.

401.04. Reclaimed Asphalt Concrete Pavement

On page 167, **Replace** the entire section pages 167 thru 170 with the following new section 401.04:

401.04 Reclaimed Asphalt Concrete Pavement.

Provide reclaimed asphalt concrete pavement (RAP) per the following requirements when choosing to use it in a mix. Failure to follow these requirements will result in a rejection of the Contractor QCP (403.03); restriction of any RAP use at the facility; and/or a change to Unconditional Acceptance at the facility.

Job Mix Formula. The Contractor may use a blend of new materials in combination with RAP obtained from verifiable Department or Ohio Turnpike Commission projects. If the RAP is not from the above sources or the source is unknown, process and blend the RAP into a single uniform stockpile, test according to Level 3 Mix Design requirements and obtain District approval for use. Obtain Laboratory written approval for use of unusually large, old RAP stockpiles of unknown content and/or age. Include approved methods in the QCP for ongoing processing and testing of these piles. Ensure no foreign or deleterious material (703.04, 703.05) is present in RAP.

Ensure that the JMF falls within the quality, gradation and asphalt binder content limits of the required mix item. For Contractor designed mixes ensure the JMF submittal includes the percentages of RAP, virgin aggregates, and virgin asphalt binder required for the mix item. Report all RAP test results and an average in the JMF submittal. Identify the RAP in the JMF submittal as to project origin and mix type(s).

Determine RAP properties and uniformity as follows. Determine final RAP gradation and asphalt binder content on a minimum of four separate stockpile (or roadway for concurrent grinding) samples all agreeing within 0.4 percent for asphalt binder content and 5 percent passing the No. 4 (4.75 mm) sieve. If fractionated RAP is used use a suitable sieve for determining gradation uniformity.

RAP Usage Limits and Requirements. Process and use RAP by one of the following two methods. Note on the JMF submittal RAP page which of Method 1 or Method 2 methods described below apply to the RAP.

Method 1 Standard RAP Include RAP in a JMF submittal per the Standard RAP Limits Table 401.04-1 unless specified differently in the applicable mix specification. For mixes that will contain up to 10 percent RAP the JMF submittal is not required to include the RAP except when a virgin polymer asphalt binder is used in a surface course. For surface JMFs having polymer asphalt binder only submit at 0 or 10% RAP. If greater than 20 percent RAP is used in a JMF submittal include an analysis of the recovered asphalt binder and blend per Level 3 Mix Design procedures to determine the grade of virgin asphalt binder to use.

TABLE 401.04-1

Method 1-Standard RAP Limits

Asphalt Mix Application	Percent RAP by Dry Weight of Mix	Minimum Virgin Asphalt Binder Content	Comments
Heavy Traffic Polymer Surface Course	10 max		For non-polymer virgin binder allow 20% max RAP
Medium Traffic Surface Course	20 max	5.0	Polymer or non-polymer virgin.
Light Traffic Surface Course		5.2	
Intermediate Course	35 max		Any mix type used as an intermediate course.
Base Course 301	50 max		The Laboratory will establish the asphalt binder content.
Base Course 302	40 (30) max		A lower limit of 30 percent will be required if poor production mixing or coating is evident.

RAP Processing for Table 401.04-1 Method 1-Standard RAP. For surface courses process RAP to less than 0.75 inch (19 mm) and place a 0.75 inch (19 mm) screen on the cold feed. For other courses place a 2-inch (50 mm) screen on the cold feed. Ensure that the RAP is the proper size to allow for complete breakdown in the plant. If mixing is incomplete, place a smaller screen on the cold feed.

Method 2 Extended RAP. Include RAP in a JMF submittal per the Extended RAP Limits Table 401.04-2 unless specified differently in the applicable mix specification. Only use Method 2 with counter flow drum plants or mini-drum batch plant configurations meeting 402. For mixes that will contain up to 15 percent RAP the JMF submittal is not required to include the RAP unless a virgin polymer asphalt binder is used in a surface course. For JMFs having polymer asphalt binder do not submit at 1 thru 9% RAP.

If greater than 25 percent RAP is used in a JMF submittal include an analysis of the recovered asphalt binder and blend per Level 3 Mix Design procedures to determine the grade of virgin asphalt binder to use. If the blending shows a grade change is required use a PG64-28 for heavy intermediate courses or PG 58-28 or 64-28 for medium intermediate or base courses. No grade change is required with RAP at 26% to 40% if Warm Mix Asphalt (WMA) technology is used in a manner to maintain the mix temperature below 275 °F (135°C). Use WMA technology meeting 402.09. Other WMA technologies must be approved by the Laboratory. If desired, WMA may be used to control plant temperatures when producing mixes using RAP above 40% but a grade change is required if shown necessary by the blending index.

**TABLE 401.04-2
Method 2-Extended RAP Limits**

Asphalt Mix Application	Percent RAP by Dry Weight of Mix	Minimum Virgin Asphalt Binder Content	Comments
Heavy Traffic Polymer Surface Course	15 max	5.0	For non-polymer binder allow 25% max RAP and 4.6 min virgin.
Medium Traffic Surface Course	25 max	4.8	Polymer or non-polymer virgin.
Light Traffic Surface Course		5.0	
Intermediate Course	40 max	3.0	Any mix type used as an intermediate course.
Base Course 301	55 max		The Laboratory will establish the asphalt binder content.
Base Course 302	45 (40) max	1.8	A lower limit of 40 percent will be required if poor coating is evident. The virgin requirement of 302.02 does not apply.

RAP Processing for Table 401.04-2 Method 2-Extended RAP. Process RAP by means of fractionation or by additional in line processing. Include in the QCP additional methods and procedures to dictate how this is to be accomplished at plants. Specify documentation method for RAP measurement. Fractionation is the process of creating separate piles of RAP from one pile when split over a specific sieve or sieves. Test fractionated piles to show uniformity. For additional in line processing only process RAP from a uniform, tested and approved stockpile by passing the RAP over a double deck screen placed in-line between the RAP cold feed bin and the mixer. Use a 9/16 inch (14.3 mm) screen for surface and intermediate mixes and a 1.5 inch screen for base mixes. Do not use concurrent project RAP in a stream process.

RAP QC and Management Requirements. Always note on the daily quality control report how much RAP is actually being used. Apply a tolerance of +/-5.0% on the amount of RAP used if needed for a quality control adjustment but do not exceed the limits of Table 401.04-1 or Table 401.01-2, whichever applies. If this adjustment is not adequate for maintaining control of the mix submit a new JMF for approval.

Include in the QCP methods to be used to meet Method 1 and Method 2 requirements above and the following requirements:

Provide enough space for meeting all RAP handling requirements at a hot mix facility. Provide a clean, graded base for stockpiles that does not collect water. Test blended RAP stockpiles to assure uniform gradation and asphalt binder content. Ensure uniform stockpile properties match the JMF submitted RAP properties unless the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing.

If the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing determine the processed RAP properties for use in the mix design. Record in the JMF submittal both the uniform stockpile and in line processed RAP properties.

If desired, when applying Method 1 Standard RAP requirements, use concurrent Department project RAP in a stream process in place of stockpiling and testing for uniformity but do so in the following manner. Concurrent project RAP must be taken from one existing mix type on the concurrent project or two existing mix types if both mix types are taken at the same time in one pass of the milling machine. Submit a new JMF for each existing mix type on the project (or each milling pass of two types) desired for use as concurrent project RAP. Include in the QCP methods of validating RAP properties when using concurrent project RAP. If these requirements are not met blend and test for uniformity and apply the stockpile requirements of this specification.

Maintain in the plant lab and control room an up to date and dated site map of all tested and untested RAP stockpiles. Give each stockpile a unique identification. Provide in the plant lab RAP properties for each uniform, blended stockpile cross referenced with its identification. In addition, provide the date the stockpile processing was completed and the stockpile estimated size in tons. The DET may require RAP pile staking for failure to maintain the above. Do not add to a stockpile once it is tested for uniformity. Provide signage at all uniform stockpiles to inform haulers that uniform piles are not to be added to.

Stockpiles and processing methods are subject to inspection and approval by the DET at any time. Rejection of stockpiles can occur for the presence of foreign or deleterious materials, lack of uniformity, incomplete mixing in the asphalt mixture, adding to piles, or moving RAP in a way not traceable thru the QCP records and methods. The Laboratory will resolve disputes over acceptability of RAP.

401.05, Mixing Plants

On page 170.

Add as a last sentence in this section the following sentence: Asphalt mixtures may be produced using the warm mix asphalt method according to 402.09 except as restricted by specification.

401.08, Asphalt Binder

On page 171, **Replace** the 2nd sentence in this section with the following sentence: Do not use asphalt binder while it is foaming in a storage tank.

401.10, Mixing

On page 171.

Add to the end of the 1st sentence in this section the following words: or per specification.

401.19,

On pages 178, **Replace** the third paragraph with the following:

Do not vary the surface of each completed intermediate or surface course from the testing edge of a 10-foot (3 m) rolling straightedge by more than 1/4 inch (6 mm). Furnish straightedges, straightedges equipped with levels, or other devices such as approved profilers conforming to S1058 and using ProVAL software. Equipment will be satisfactory to the Engineer.

Check the surface course for variations in slope or surface when directed by the Engineer.

402, Table of Contents

On page 180, **Add** to the end of the table of contents the following new section title:

402.09 Water Injection System for Warm Mix Asphalt

402.08, Polymer Binders

On page 184, **Add** after the last paragraph in 402.08 the following new section:

402.09 Water Injection System for Warm Mix Asphalt.

When allowed by specification use a Department approved water injection system for the purpose of foaming the asphalt binder and lowering the mixture temperature. Only use equipment that has been proven stable and effective thru project use on non-ODOT projects. Ensure equipment for water injection meets the following requirements:

- Injection equipment computer controls are in the plant control room and are tied to the plant computer metering.
- Injection equipment has variable water injection control controlled by the plant operation rate and the water injection can never exceed 1.8% by weight of asphalt binder.
- Water injection rate cannot be manually overridden by the plant operator once in the computer.
- Injection equipment stops water flow when a control or equipment failure in the injection system occurs.
- The water injects into the asphalt binder flow before the asphalt binder spray hits aggregate. Do not allow water to touch aggregate before the binder spray.
- Injection equipment includes water storage and pump control tied to the injection computer controls.
- Water storage low water alarm installed in the control room.
- Provide a PG binder sampling valve between the last piping tee on the tank side of the line and the injection equipment to sample PG binder before water is injected.
- Provide a PG Binder sampling valve at the injection equipment to sample binder prior to spray.

403.03,

On page 184 **Replace** the **second sentence** in the **First paragraph of 403.03** with the following sentence:

The QCP will cover processes conducted to provide an asphalt mixture at the paving site that is uniform in composition, conforms to the specification requirements and that when placed is free of any defect (ex. segregation, lack of mixture and texture uniformity, raveling, rutting, holes, debris etc.) within the Contractor's control at project completion.

403.03,

On page 185 **Replace section 403.03.C** with the following:

C. Procedures for extra testing when tests are outside warning band limits of the QCP (e.g., job start, responses to poor test results or field mix problems, aggregate stock testing, reclaimed asphalt concrete pavement checks, moistures) and any other testing necessary to control materials not already defined in these Specifications.

403.03, Quality Control Plan (QCP)

On page 185. **Replace items H thru L** with the following sections:

H. All procedures to meet the processing, testing and documentation requirements for RAP in 401.04 including test forms, record keeping, technician responsibilities, etc..

I. Procedure for ensuring that every Contractor employee involved in the testing of asphalt mix and operation of the asphalt plant facility has read the QCP and has on site access to all applicable Department specifications, proposals, policies, and the current approved JMF.

J. Means to meet the handling and storage requirements of 402.08 and asphalt binder suppliers for all asphalt binders.

K. Means to meet delivered mixture uniformity/coating and hauling/trucking requirements.

L. Define the roles and responsibilities of the Field Quality Control Supervisors. List approved Field Quality Control Supervisors.

M. Signature of the Quality Assurance Manager and, if different, the person in authority to enforce all operations covered by the QCP as outlined in this subsection.

403.03,

On page 185 **Add** the following section 403.03.N:

N. Specify in the QCP warning bands to be used by technicians for all tests and give specific instruction how they will be used for tests in concert with Table 441.10-1 specification requirements.

403.06.A,

On page 188; in the first paragraph on that page; before the first full sentence that starts with the word "Split", **add** the following additional sentence:

For partial Lots of 1500 tons or less sample and test at least two subplot samples regardless of the tons produced.

403.06.B

On page 188. **Reporting, Insert** in the first paragraph between the first and second sentences the following additional sentence: Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.09 or another approved method.

403.07,

On page 192 **replace section A** with the following:

A. The required number of test series is a minimum of four each per production day or night. If a production day is less than 6 hours, the Department may reduce the frequency but not less than one test series per every 3 production hours.

403.08,

On page 193 replace **TABLE 403.08-1 Deviation from the JMF and Range Tolerances** with the following table:

TABLE 403.08-1 DEVIATION FROM THE JMF AND RANGE TOLERANCES^[1]

Mix Property	Deviation from JMF (Percent)	Range (Percent)
Asphalt Binder Content	0.3	1.0
1/2 inch (12.5 mm) sieve	6	15
No. 4 (4.75 mm) sieve	5	15
No. 8 (2.36 mm) sieve	4	15
[1] Based on mean of four Lot Acceptance tests.		

On page 194 replace **TABLE 403.08-2 448 ACCEPTANCE SCHEDULE** with the following table:

TABLE 403.08-2 448 ACCEPTANCE SCHEDULE^[1]

Mix Property	Pay Factor	2 Tests	3 Tests	4 Tests
Asphalt Binder Content	1.00	0 to 0.47	0 to 0.36	0 to 0.30
	0.98	0.48 to 0.54	0.37 to 0.42	0.31 to 0.35
	0.90	0.55 to 0.61	0.43 to 0.48	0.36 to 0.40
	0.80	0.62 to 0.68	0.49 to 0.54	0.41 to 0.45
	0.60	0.69 to 0.75	0.55 to 0.59	0.46 to 0.50
	[2]	> 0.75	> 0.59	> 0.50
1/2 inch (12.5 mm) sieve	1.00	0 to 8.5	0 to 6.9	0 to 6.0
	0.99	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.97	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.94	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	0.90	12.8 to 14.1	10.5 to 11.5	9.1 to 10.0
	[3]	> 14.1	> 11.5	> 10.0
No. 4 (4.75 mm) sieve	1.00	0 to 7.1	0 to 5.8	0 to 5.0
	0.99	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.97	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.94	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.90	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	[3]	> 12.7	> 10.4	> 9.0
No. 8 (2.36 mm) sieve	1.00	0 to 5.7	0 to 4.6	0 to 4.0
	0.99	5.8 to 7.1	4.7 to 5.8	4.1 to 5.0
	0.97	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.94	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.90	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0

	[3]	> 11.3	> 9.2	> 8.0
[1] Based on mean of Lot Acceptance tests from the JMF.				
[2] Remove and replace material				
[3] Engineer will determine if the material may remain in place. Pay factor for material allowed to remain in place is 0.70.				

409.02,

On page 198 **Replace** section **409.02 Materials** with the following:

409.02 Materials. Use joint sealant conforming to 705.04 and approved by the Laboratory before shipment to the project. Use a ½ in. (13mm) diameter closed cell foam backer rod that will form and maintain a reservoir of sealant as specified in 409.03.

401.20,

Starting on page 178 **Replace 401.20 Asphalt Binder Price Adjustment** with the following new section:

401.20 Asphalt Binder Price Adjustment. A contract item is eligible for a price adjustment when the contract's proposal specifically includes an asphalt Binder Price Adjustment note and the contract item meets the quantity limitations of the proposal note.

422.02, Materials

On page 210, **Replace** the 2nd paragraph in 422.02 on page 210 and the Table with the following paragraphs and table:

Provide cover aggregate for the Chip Seal Job Mix Formula (JMF) of washed limestone or dolomite meeting 703.05 and the following:

Stockpile the material to be used for the chip seal at the aggregate source.

Obtain five (5) samples from the stockpile and perform gradation testing on each sample and determine the percent passing for each sieve size listed in Table 422.02-1

1. Calculate the total range for the No. 8 (2.36 mm) sieve for all five samples. The range will not exceed 6%
2. Calculate the percent passing the No. 200 (75 µm) sieve for each sample. No single sample value will exceed 2.0 percent.
3. Calculate the average of each sieve for all five samples. Assure the average value for each sieve is less than the value in Table 422.02-1

Submit a letter to the Engineer and DET containing the Job Mix Formula (JMF) gradations and the calculations to show the cover aggregate meets requirements.

If a staging location will be used for the chip seal aggregate first move the initially tested aggregates from the aggregate source stockpile to the staging location and construct a staging stockpile. Then obtain five (5) aggregate samples from the staging location stockpile and perform gradation testing on each sample to determine the percent passing for each sieve size listed in Table 422.02-1.

Evaluate the staging location aggregate samples the same as the aggregate source samples except allow an average for the No. 200 (75 µm) sieve not greater than 1.7 percent.

Submit the Job Mix Formula (JMF) gradations from the staged stockpile and the calculations to show the cover aggregate meets requirements in letter form to the Engineer and DET.

If the chip seal aggregates fail to meet requirements, either at the aggregate source or the staging location, re-wash and/or rework the aggregate materials and retest the new stockpiles.

TABLE 422.02-1

Sieve Size	Total Percent Passing
1/2 inch (12.5 mm)	100
3/8 inch (9.5 mm)	85 to 100
No. 4 (4.75 mm)	5 to 25
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5
No. 200 (75 µm)	1.5 max [1]
[1] Washed gradation value	

The District may obtain and test validation samples of the JMF aggregates at any time. If a single validation sample is either outside the values in TABLE 422.02-1 with the exception that the No. 200 (75 µm) value is not greater than 2.0 percent, the district will obtain five (5) samples and retest to determine if the aggregate JMF falls within the limits of TABLE 422.02-1. If the JMF verification test doesn't meet the source or staging location limits the stockpile is not acceptable.

422.02,

On pages 210, In the first sentence **Replace** bind with binder.

422.05, Test Strip

On page 211 and 212, **Replace** section 422.05 with the following section:

422.05 Test Strip. Construct a continuous 1000-foot (300 m) long by lane width test strip. Do not waive test strips regardless if the same materials have been used on another project.

Determine the initial binder application rates and aggregate application rates for the test strip. For a single chip seal, an initial target rate of 0.37 +/- 0.03 gallon per square yard (1.68 L/m²) is recommended for the test strip. For double chip seal, a target rate of 0.36 +/- 0.03 gallon per square yard (1.54 L/m²) for the first course and 0.33 +/- 0.05 gallon per square yard (1.68 L/m²) for the second course is recommended for the test strip . Notify the Engineer of the initial target rates.

Calibrate the aggregate spreader and verify the application rates with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate. Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Amounts of loose aggregate that create a nuisance to the public will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and

apply cover aggregate at the new rate. Verify the aggregate gradation during the test strip and give results to the Engineer.

The Engineer and Contractor will review the test strip the next workday for streaking, ridging, bleeding, aggregate loss or other problems. If the review shows the test strip meets the requirements of 422.11 and the application rate and quality control tests show all is in control compared to the JMF, then progress with the work. Should problems be noted, the Engineer may require another test strip.

422.07 , Binder Application

On page 211 and 212, **Replace** the first three paragraphs of 422.07 with the following paragraphs:

Before applying binder, ensure that sufficient cover aggregate is available for immediate application. Apply the binder at the target rate(s) established during the test strip.

Maintain the binder temperature from 150 to 185 °F (65 to 85 °C) during construction, including the start of each day. Reheat the binder at a rate of no more than 25 °F (14 °C) per hour, when the binder is allowed to cool below 150 °F (65 °C).

If the target application rates are not the optimum application rates to achieve proper stone embedment during the actual application, immediately notify the Engineer. Proper stone embedment is typically 1/2 to 2/3 of the stone chip height and can be checked by pulling out several chips by hand. Adjust and document the new application rate by stationing. Recheck stone embedment after adjustment and obtain the Engineers approval of the new rate.

Do not allow the binder to streak on the road surface. If the Engineer determines that streaking is occurring, cease operations until the Engineer is satisfied that streaking has been eliminated.

422.08,

On pages 212, Before the first sentence **Add** the following:

Verify the application rate with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate before placing binder. Adjust if necessary and re-verify. Record final results and inform the Engineer.

422.08,

On pages 213, In the second full paragraph **Add** the following after the first sentence:

Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Nuisance to the public amounts of aggregate will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and apply cover aggregate at the new rate.

422.09,

On pages 213, **Replace** the fourth paragraph with the following:

After the binder sets, and before placing a second course for double chip seals, and within 4 hours, sweep the pavement using a power broom or pickup sweeper as needed to remove all loose aggregate. If the pavement cannot be swept within the 4-hour period due to problems

associated with the stone moisture, binder, breaking, humidity, or other unknown, the Engineer may suspend the operation until the problem is resolved or more suitable conditions are obtained to maintain the 4-hour time frame for sweeping. Extend sweeping 1 foot (0.3 m) beyond the edge of the pavement to help prevent migration of loose aggregate back onto the pavement. Do not re-use aggregate from a chip seal that is swept from the pavement or that is already loose off the pavement edge.

422.09,

On page 213. **Replace** the sixth paragraph in 422.09 with the following paragraphs:

Wait at least 24 hours before placing the second course of a double chip seal. Ensure that the first course meets requirements of this specification and is cured, swept and capable of withstanding construction traffic without damage.

Correct damage to the underlying chip seal before placing the final chip seal.

422.10.A,

On pages 214, **Replace** the last sentence with the following:

The Department can obtain samples of materials at any time. Aggregate samples can be taken from sources, on-hand stockpiles or the aggregate spreader box. Work can be stopped and materials can be rejected on the basis of poor Department test results.

422.10.C,

On pages 214, **Replace** the first paragraph with the following:

At a minimum test one sample taken from the aggregate spreader box at production start and sample and test one sample from the aggregate spreader box randomly during the day. An aggregate spreader box sample may be taken by laying a piece of suitable material under the spreader as it moves forward. Include additional testing when directed to sample and test by the Engineer. Sample and test aggregate according to AASHTO T 2, AASHTO T 248, and Supplement 1004 (AASHTO T 11 where required). Use washed gradations for determining the No. 200 (75 µm) sieve. The Contractor may use additional tests. These may include dry gradations for control purposes but acceptance of on hand aggregate will be based on washed gradations only. Reject and do not use aggregate creating nuisance to the public dusting on the project.

422.10.C,

On pages 214, in the table **Replace** 2.5% with 2.05%

422.10.D.7,

On pages 215, **Replace** with:

7. Gradation, moisture content, and station (One sample from spreader box at production start, one random sample during the day and any other samples when directed by the Engineer).

422.11, Acceptance

On page 214, **Replace** item G with the following:

- G. Typical stone chip embedment is 1/2 to 2/3 of typical stone chip height.

441.09,

On pages 229 and 230 **replace** the last paragraph starting on page 229 that continues as the first paragraph on page 230 with the following paragraphs:

Perform more sampling and testing than the minimum specified at the start of production. Additionally perform more sampling and testing than the minimum during production when the quality control tests show the asphalt concrete being produced is outside the warning bands as shown in the Contractor's approved QCP. Immediately resolve problems indicated by any out of warning band test and immediately retest to validate corrections have returned the materials to within the warning band limits. The Contractor may determine the method of testing of the asphalt concrete beyond the minimum specified, and will detail the methods technicians will follow in the Contractor's approved QCP.

Should additional testing as required above not be performed the DET, after consultation with the Laboratory, will require the testing frequency be increased to all tests each two hours of production for the remainder of the project. If this occurs, the DET will request an opinion from the QCQC for action(s) against the technician and/or Contractor including but not limited to warning, removal and/or a change of the facility to Unconditional Acceptance.

Record the results of every test performed.

441.09.A,

On page 230 **replace** the first paragraph of 441.09.A Asphalt Binder Content with the following:

A. Asphalt Binder Content. Determine the asphalt binder content of a sample of asphalt concrete by performing an Asphalt Content (AC) Gauge test according to Supplement 1043. Make all printouts available for review by the Monitoring Team at any time. Offset the AC Gauge for each JMF on each project at the project's start. Perform the offset using solvent extraction methods for every QC sample according to Supplement 1038 and the AC Gauge Verification and Offset Record. Use solvent extraction according to Supplement 1038 when an AC Gauge problem exists and for testing cooled samples that cannot adequately be tested in an AC Gauge test.

441.09.B,

On page 230 **replace the first sentence in the first paragraph of 441.09.B Gradation** with the following:

Perform at least one gradation test each production day on aggregate remaining after removing the asphalt binder with a solvent from an asphalt concrete sample used in an AC Gauge test (solvent sample) or on aggregate remaining after removing the asphalt binder with a preapproved asphalt ignition oven according to Supplement 1054 and from an asphalt concrete sample used in an AC Gauge test (ignition oven sample).

441.09.C, Air Voids and MSG

On page 231.

Replace the first paragraph in 441.09.C with the following paragraph:

C. Air Voids and MSG. Determine the air voids of the asphalt concrete by analyzing a set of compacted specimens and a corresponding MSG determination. Use the MSG to calculate the

air voids of the compacted specimens. Ensure that the cure temperature and specimen compaction temperature are the same. Use a 1-hour cure for all mix samples used in voids analysis. The Contractor may use a 2-hour cure time if voids are consistently near the low void warning band. In this case, use the 2-hour cure for all voids testing through the remainder of the project. For hot mix asphalt use the JMF lab compaction temperature. For warm mix asphalt according to 402.09 use a lab compaction temperature 30.0 °F (16.7 °C) less than the JMF lab compaction temperature for hot mix asphalt. Use a compaction temperature tolerance of +/- 5.0 °F (3.0 °C). Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.09 or another approved method.

441.10,

On pages 232 and 233 **replace the total section 441.10 Control Charts** with the following section:

441.10 Control Charts. Maintain up to date control charts showing each individual test result and also the moving accumulative range as follows:

- A. Plot tests showing the percent passing for the 1/2 inch (12.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), and No. 200 (75 µm) sieves the percent asphalt binder content, the MSG and the percent air voids. Round all percentages to the nearest whole percent; except, round asphalt binder content, the No. 200 (75 µm) sieve, and air voids to the nearest 0.1 percent.
- B. Show the out of specification limits specified in Table 441.10-1 and QCP Warning Band Limits on the control charts.
- C. Label each control chart to identify the project, mix type and producer.
- D. Record the moving accumulative range for three tests under each test point on the chart for air voids and asphalt binder content. Accumulative range is defined as the positive total of the individual ranges of two consecutive tests in three consecutive tests regardless of the up or down direction tests take. If more than the minimum required testing (i.e. two tests per production day or night, 441.09 first paragraph) is performed do not include the result in accumulative range calculations.

Stop production and immediately notify the Monitoring Team when either A or B occurs:

- A. Any two tests in a row or any two tests in two days are outside the out of specification limits of Table 441.10-1.
- B. Any four consecutive moving accumulative ranges greater than specification limits of 2.50 percent for air voids or 0.60 percent for asphalt binder content occur.

Any mixture sent to the paving site without stopping production and notifying the Monitoring Team when required by this specification will be considered non-specification material.

Do not restart production until an adequate correction to remedy problems is in place and the Monitoring Team is satisfied. Following a shutdown restart production in a manner acceptable to the DET. When production problems cannot be solved within one day after a plant shut down a Contractor's representative holding a Level 3 Asphalt Department approval is required to be at

the asphalt plant until a full production day is achieved with results satisfactory to the Monitoring Team.

TABLE 441.10-1

Mix Characteristic	Out of Specification Limits
Asphalt Binder Content ^[1]	-0.3% to 0.3%
1/2 inch (12.5 mm) sieve ^[1]	-6.0% to 6.0%
No. 4 (4.75 mm) sieve ^[1]	-5.0% to 5.0%
No. 8 (2.36 mm) sieve ^[1]	-4.0% to 4.0%
No. 200 (75 µm) sieve ^[1]	-2.0% to 2.0%
Air Voids ^[2]	2.5 to 4.5
Air Voids ^[3]	3.0 to 5.0
MSG ^[4]	-0.012 to 0.012

[1] deviation from the JMF
 [2] for Design Air Voids of 3.5%
 [3] for Design Air Voids of 4.0%
 [4] deviation from the MTD

441.12,

On pages 233 and 234 **replace the total section 441.12 Mixture Deficiencies** with the following section:

441.12 Mixture Deficiencies. Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition; within the specification requirements and limits; conforms to the JMF: and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s control. Correct obvious pavement problems according to 401.15. If any suspicion that other mixture composition or pavement problems exist, the Monitoring Team will conduct an initial investigation thru review of data and sampling of the asphalt pavement. Should a Department investigation determine that the Contractor’s QCP is not controlling the mixture in a manner to achieve mixture quality as described above the Contractor quality control data may be rejected. In that case the Department will conduct a thorough test investigation based on samples from the roadway and use those test results in determining disposition of the non specification material.

A mixture is not uniform in composition if multiple random non-specification individual tests or any four consecutive non-specification moving accumulative ranges exist. The mixture can be rejected, production can be stopped and/or a redesign can be called for by the Department. The Laboratory will not approve any redesign it determines is unsatisfactory to provide acceptable mix performance. Submit this new design for approval according to 441.02 and at no additional cost to the Department.

When any out of specification material, based on quality control tests not within the limits of Table 441.01-1, is sent to the paving site the Engineer will determine disposition of the material according to the Department non specification material policy.

442.01

On page 234. **Description, Add** to the end of second paragraph in 442.01 the following sentence: Do not use the warm mix asphalt method for 12.5mm mixtures.

443.01,

On page 238. **Description, Add** to the end of second paragraph in 443.01 the following sentence: Do not use the warm mix asphalt method (402.09) for this item.

446.05,

On page 243, **Replace** the first paragraph with the following:

The requirements of 401.13 do not apply. However, rollers must fully and satisfactorily provide the required compaction, be mechanically sound, and meet Hot Mix Asphalt industry standards. The Department retains the right to reject the use of rollers which are not in good repair, or are not designed to do the work required. A three-wheel roller per 401.17 is not required.

446.05,

On page 246, **Replace** the table number with: **TABLE 446.05-2**

448.03,

On page 247, **Replace** the entire section 448.03 with the following:

448.03 Density. Conduct density gauge quality control testing on the asphalt mat according to Supplement 1055. Conduct density gauge testing on uniform surface courses of 0.75 inch (19mm) or more and uniform intermediate courses of 1.0 in (25mm) or more plan thickness. Conduct density gauge testing on projects of two adjacent lanes or more and with at least one continuous mile (1.6 kilometers) of paving (excepting bridges, intersections etc.).

When Supplement 1055 density gauge testing is required, the requirements of 401.16, except the last four paragraphs, are waived. The requirements of 401.13 do not apply. However, rollers must fully and satisfactorily provide the required compaction, be mechanically sound, and meet Hot Mix Asphalt industry standards. The Department retains the right to reject the use of rollers which are not in good repair, or are not designed to do the work required. A three-wheel roller per 401.17 is not required.

448.03,

On page 247, **Replace** the first paragraph with the following:

448.03 Density. Conduct density gauge quality control (QC) testing on the asphalt mat according to Supplement 1055 (S 1055). Conduct density gauge testing on uniform courses of 1.0 in (25mm) or more plan thickness. Conduct density gauge testing on projects of 2 adjacent lanes or more and with at least one continuous mile (1.6 kilometers) of paving (excepting bridges, intersections etc.).

451.08, Joints

On page 253 **Replace** the last three (3) paragraphs of 451.08 with the following:

Provide the completed file and the printout to the Engineer. When HIPERPAV predicts early age slab cracking will occur, whether due to standard construction practices, joint sawing methods, mix design or curing, either do not start construction until modifications have been made to eliminate HIPERPAV's predicted slab cracking or do not pave.

Perform a HIPERPAV analysis for each pour.

If software analysis determines joint sawing could exceed twenty four (24) hours, assure all joints are sawed by the 24th hour.

A HIPERPAV analysis showing paving can proceed does not eliminate the requirements of 451.16.A.

451.08.A, Longitudinal Joint

On page 254 **Replace** the first paragraph with the following:

When using early-entry (dry cut, light weight) saws to make the longitudinal joint between simultaneously placed lanes, only use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Perform the early entry sawing after initial set and before final set. Saw the joint 1/8 inch (3 mm) wide and 2 1/4 to 2 1/2 inches (56 to 63 mm) deep.

451.08.D, Contraction Joint

On page 256 **Replace** the first and second paragraphs of 451.08.D with the following:

D. Contraction Joint. For pavement less than or equal to 10 inches (225 mm) thick, saw contraction joints with a standard (water cooled diamond bladed) concrete saw to a minimum depth of one-fourth of the specified pavement thickness. For pavement greater than 10 inches (255 mm) thick, saw contraction joints to a minimum depth of one-third the specified pavement thickness. When cutting joints using a standard (water cooled diamond blade) saw assure the joint is $1/4 \pm 1/16$ inch (6 ± 1.6 mm) wide when measured at the time of sawing.

When using the option of early-entry (dry cut, light weight) saws, only use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Perform the early entry contraction joint sawing after initial set and before final set. Saw the contraction joint 2-1/4 to 2-1/2 inches (56 to 63 mm) deep. Ensure any early entry saw joints are approximately 1/8 inch (3 mm) wide at the time of sawing.

451.09, Finishing

On page 257 **Replace** the first paragraph with the following:

Texture the surface in the longitudinal or transverse direction using a broom to produce a uniform, gritty, texture. Immediately following the broom drag texture, tine the pavement in the transverse direction using an approved device that produces a random pattern of grooves [0.05 inch (1.3 mm) to 0.08 inch (2.0 mm) deep and 0.10 inch (3 mm) wide] spaced at 3/8 to 1-3/4 inches (10 to 45 mm), with 50 percent of spacings less than 1 inch (25 mm).

Use longitudinal tining of pavement will only be approved by the Director and may require experimental feature designation. If longitudinal tining is authorized the tine spacing will be a uniform 3/4 inches wide (19 mm), 1/8 inch deep (3 mm) and 1/8 inch wide (3 mm). Do not tine within 3 inches (75 mm) of pavement edges or longitudinal joints. Only use equipment that will tine the full width of the pavement in one operation and uses stringline controls for line and grade to assure straight tining texture.

451.16, Opening to Traffic

On page 259 **Replace** the first paragraph full paragraph with the following:

A Pavement Repairs before Department Acceptance. Repair transverse or diagonally cracked full depth pavement; longitudinally cracked full depth pavement; spalled pavement surfaces and any portland cement concrete pavement panels with cement balls or mudballs; at no cost to the Department. Perform the repairs until the Department's Form C-85 (Report of Final Inspection and Acceptance) or partial C-85 is issued for the pavement. The issuance of a final C-85 will occur within 30 days after all of the pavement items, including all safety items, are completed and accepted, and the pavement is open to traffic. The issuance of a partial C-85 will occur within 30 days after the pavement is completed and accepted, and all safety items are in place to allow the pavement to be safely open to traffic during the winter months from December 1 to April 30.

501.04,

On page 278, in the sentence after the term **Shop Drawings**, after the phrase according to: **Add** the appropriate

501.05,

On page 280, **replace** the entire section with the following:

Design and perform all procedures as directed by the AASHTO STANDARD SPECIFICATIONS or the AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS except as modified herein: Perform daily inspections to ensure the work governed by the construction plan is functioning as designed. Report malfunctioning work to the Engineer immediately.

A. Projects with Railroad Involvement. Prepare and provide plans listed in this section as follows:

Have an Ohio Registered Engineer prepare, sign, seal and date each plan. Submit plans to all involved railway companies at least 50 days before construction begins. Obtain acceptance from all involved railroad companies. Furnish the Engineer copies of all correspondence with the railroad, documentation of railroad acceptance and the plans accepted by the railroad. Department acceptance is not required.

Perform all work in accordance with the accepted plans. Immediately cease all operations that deviate from the accepted plan. If a deviation is necessary, furnish the Engineer a copy of a revised plan including documentation of acceptance from all involved railroad companies as least 24 hours before construction on deviated work begins. The revised plan shall be sealed and dated by an Ohio Registered Engineer. Department acceptance of revised plans is not required. The Department will consider delays resulting from construction plan deviations as non-excusable in accordance with 108.06.E.

This section applies to construction plans for the following:

1. Sheeting and bracing of excavations adjacent to the railroad tracks. Perform work according to 501.05.B.1.

2. Demolition of structures over or within 14 feet of railroad tracks. Perform work according to 501.05.B.2.

3. Erection of structural members over or within 14 feet of railroad tracks. Perform work according to 501.05.B.4.

B. Projects without Railroad Involvement. Prepare and provide plans listed in this section as follows:

Have an Ohio Registered Engineer prepare, sign, seal and date each plan. Have a second Ohio Registered Engineer check, sign, seal and date each plan. The preparer and checker shall be two different Engineers.

Submit the plan to the Engineer at least 7 days before construction begins. Department acceptance is not required.

Perform all work in accordance with the prepared plans. Immediately cease all operations that deviate from the prepared plans. If a deviation is necessary, furnish the Engineer a copy of a revised plan at least 24 hours before construction on the deviated work begins. The revised plan shall be signed, sealed and dated by an Ohio Registered Engineer and checked, signed and sealed and dated by a Second Ohio Registered Engineer. Department acceptance of revised plans is not required. The Department will consider delays resulting from construction plan deviations as non-excusable in accordance with 108.06E.

This section applies to construction plans for the following:

1. Sheeting and bracing other than designs completely detailed in the contract plans adjacent to active traffic when required by contract. Perform all work as specified below:

- a. Locate sheeting and bracing per contract, if shown.
- b. Maintain temporary horizontal and vertical clearances per contract.
- c. Include the effects of AASHTO live and dead load surcharges as necessary.
- d. Design sheeting and bracing in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 4

2. Demolition of structures over or adjacent to active traffic. Perform all work as specified below:

a. Provide temporary devices or structures necessary to protect traffic during all demolition activities. Provide traffic protection when demolition is located less than 12' horizontally from active traffic on structures of less than 25' vertical clearance. Increase the 12' minimum horizontal distance 1 foot for each 2 feet of additional height greater than 25'.

b. Never lift the portions of structure being removed over active traffic. Before releasing traffic make the remaining structure stable.

c. Design traffic protection devices or structures for a minimum load of 50 pounds per square foot plus the weight of equipment, debris and any other load to be carried. Include any portion of the deck that cantilevers beyond the fascia beams or girders.

d. In lieu of temporary devices or structures required in "a" above, provide a vertical barrier. Design the vertical barrier with rigid or flexible materials specifically designed for demolition containment. Extend the enclosure up to the bottom of the deck and down to the ground. Maintain all materials free of tears, cuts and holes.

- e. Maintain temporary horizontal and vertical clearances per contract.
- f. Locate structural members to be reused before performing any removal operations.
- g. Do not damage structural members being reused during any removal operation.
- h. Perform work so that all members are stable during all operation and loading conditions.
- i. Perform work per 501.05.B.6.

3. Falsework for cast-in-place concrete slab superstructure. bridges . Perform all work per 508 and as specified below:

a. Provide a camber table to account for the deflection of the falsework loaded with its self weight and the weight of wet concrete. Also include in the table, the specified camber to compensate for slab deflection after the falsework is released.

b. Maintain temporary horizontal and vertical clearances per contract.

c. As a minimum design falsework over waterways for a five year flood or with 75% of the effective waterway opening of the proposed structure. The Contractor is responsible for any damages caused by upstream flooding due to insufficient temporary structure size or the accumulation of debris or sediment in the channel.

d. Support falsework foundations located within the ten year flood limits on rock, shale or piles driven to a minimum depth of 15 feet, and to sufficient penetration to carry superimposed loads or until refusal on rock.

e. The incorporation of structural steel shapes, used as temporary support members, into a finished concrete slab superstructure is prohibited.

f. Design falsework in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 2.

4. Erection of steel or precast concrete structural members as specified below:

a. Never lift structural members over active traffic. Before releasing traffic make structural members stable.

b. Supply any temporary supports or braces necessary to maintain structural stability and prevent lateral movement until completion of all construction activities.

c. Perform work per 501.05.B.6, 513 or 515.

d. Do not field weld temporary members to permanent steel members.

e. Maintain temporary horizontal and vertical clearances per contract.

f. Provide drawings with at least the following information:

i. Plan of the work area showing permanent support structures (piers and abutments); roads; railroad tracks; waterways; overhead and underground utilities; and other information pertinent to erection.

ii. Erection sequence for all members, noting any temporary support conditions, such as holding crane positions, temporary supports, falsework etc. Member reference marks, when reflected on the erection plans, should be the same used on the shop drawings.

- iii. Primary member delivery location and orientation.
 - iv. Maintenance of Traffic during erection operations.
 - v. Location of each crane for each primary member pick, showing radius and crane support (barges, mats, etc.).
 - vi. Capacity chart for each crane configuration and boom length used in the work.
 - vii. Center of gravity locations for primary member.
 - viii. Rigging weights, capacity and arrangement for primary member picks.
 - ix. Lifting weight of primary member picks, including all rigging and pre-attached elements.
 - x. Details of any temporary lifting devices to be bolted or welded to permanent members, including method and time (shop or field) of attachment; capacity; and method, time, and responsibility for removal.
 - xi. Blocking details for bridge bearings.
- g. Provide calculations for the following:
- i. Load capacity and stability of temporary supports and crane(s) for each pick and release.
 - ii. Structural adequacy and stability of members for each step of erection.
 - iii. Capacity of fabricated rigging, such as lift beams, welded lugs, spreader beams, beam clamps, etc. Submit manufacturers' certifications of catalog cuts for pre-engineered devices.

5. Jacking and support of existing structures as specified below:

- a. Support the structure on temporary supports and brace as necessary to maintain structural stability and prevent lateral movement until completion of the permanent supports. Do not use jacks alone to support the structure except during the actual jacking operation. Remove all temporary supports upon completion of the jacking procedure.
- b. Maintain a maximum differential jacking height of 1/4 inch between any adjacent beam lines.
- c. Maintain a maximum differential jacking height of 1 inch between any adjacent abutments or piers.
- d. Place jacks and any load plates at least 2 inches from the edges of any concrete substructure seats.
- e. Do not field weld temporary members to permanent steel members.
- f. Maintain temporary horizontal and vertical clearances per contract.

6. Placing or moving equipment having a gross weight in excess of 60,000 pounds (27,000 kg) on or across a structure as follows:

- a. Do not allow equipment having a gross weight in excess of the posted limit to be placed on or driven across a structure.

b. Do not allow erection and construction methods, or use or move erection or construction equipment on or across the uncompleted or completed structure, to subject any part of the structure to unit stresses that exceed by more than one-third the allowable unit stresses, as given in AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.

7. Structures for maintaining traffic in accordance with Item 502.

a. For structures located over or within 14 feet of railroad tracks, submit plans in accordance with 501.05.A.

b. Perform work per 501.05.B.6.

C. Welded Attachments. Prepare and provide a detailed request showing weld size, length, type and location for welding permanent or temporary attachments to main structural members not shown or permitted by contract. Submit request to the Office of Structural Engineering for acceptance at least 20 days before construction begins. Perform work per 501.05.B.6 and 513.

D. Corrective Work. Before performing corrective work on structure items, prepare a Corrective Work Plan (CWP) including supporting calculations. Submit three copies of the CWP to the Engineer for acceptance. Have an Ohio Registered Engineer prepare, sign, seal and date each CWP. The Engineer will submit the CWP to the Office of Structural Engineering for review. Obtain Department acceptance before beginning corrective work.

Perform all work in accordance with the accepted CWP. Immediately cease all operations that deviated from the accepted CWP. If a deviation is necessary, furnish the Engineer three copies of a revised CWP. The revised CWP shall be signed, sealed and dated by an Ohio Registered Engineer. Obtain Department acceptance of revised CWP prior to performing corrective work.

Perform all corrective work, including the preparation of the CWP and revisions at no expense to the Department. The Contractor shall reimburse the Department for all CWP review costs of the Designer of Record.

503.03,

On page 285, in the first sentence, after the word plan, **Add** the phrase: according to 501.05.

503.04,

On page 286, in the last sentence, of the first paragraph in this section, **Change** 503.09 to 503.08.

503.10,

On page 288, **Replace** the first sentence with, If an Item for Cofferdams, Cribs, and Sheeting is not included in the Contract for payment, perform work according to 503.03 and the Department will pay for cofferdams, cribs, and sheeting under the contract unit price for excavation.

503.10,

On page 289, **replace** the 3rd and 4th paragraphs of 503.10 with the following:

The Department will consider additional excavation to a maximum depth of 1 foot (0.3 m) within the lateral limits described in 503.09 as incidental to the lump sum price. Excavation

deeper than 1 foot (0.3 m) below plan elevation may be provided for as Extra Work, as described in 109.05.

If Cofferdams, Cribs, and Sheeting is a separate pay item, the lump sum price includes any extra cost involved for cofferdams for additional depth up to 3 feet (0.9 m) below plan elevation. Excavation deeper than 3 feet (0.9 m) below plan elevation and the additional cofferdams necessitated by this excavation may be provided for as Extra Work, as described in 109.05.

508.02,

On page 299, **Delete** the last sentence of the third paragraph,” If, due to vertical clearance or spanning an existing road or channel, unusual requirements exist, the Director may approve falsework with excessive deflection.”

Also **Delete** the last sentence of the seventh paragraph,” If, due to vertical clearance or spanning an existing road or channel, unusual requirements exist, the Director may approve falsework with excessive deflection provided the concrete properly reforms.”

On page 300, **Replace** the thirteenth paragraph of 508.02 with: Submit falsework plans for cast-in-place concrete slab superstructures according to 501.05.

514.02,

On page 358, **Replace** the third paragraph of 514.02 with the following:

For caulking, use a single pack moisture cured polyurethane based material, which will not shrink or sag, capable of filling voids greater than 1/8 inch (3mm) and up to 1 inch (25mm) wide. Only material that is listed on the OMM Qualified Product List website may be used.

514.13,

On page 369, **Replace** the thirteenth paragraph of Subsection **D.** with: Test composite samples for lead, chromium, cadmium and arsenic according to the U.S. EPA Publication SW 846 Method 1311 (TCLP). Provide the Chain of Custody and test results to the District Regulated Waste Engineer (DRWE) immediately after the test results are available. If the DRWE determines the blasting debris is hazardous, as defined below, provide the Engineer with the names of the hauler and treatment facility. Perform all sampling and testing required by the hauler, treatment facility, or disposal facility.

In the next paragraph, in the last sentence, **Delete** the phrase, (see bid proposal note, entitled “Safety”).

On page 370, **Replace** the paragraph under bullet **2. Non-Hazardous Solid Waste.** with: For all waste that is determined to be a Non-Hazardous Solid Waste by the DRWE, the Contractor is required to:

- a. Haul and dispose of the waste to a facility licensed to accept non-hazardous solid waste.
- b. Before disposing of any material, provide the Engineer with documentation that the disposal facility is licensed by the EPA to accept non-hazardous solid waste.

- c. Obtain from the disposal facility and provide the Engineer with a receipt that documents disposal of waste material at the approved disposal facility.
- d. Properly dispose of all waste within 60 days after it is generated.

516.03,

On page 392, **replace** the 3rd, 4th, 5th, 6th and 7th paragraph of 516.03 with the following:
Repair metallized coatings damaged during fabrication by removal of the damaged coating and reapplication as specified above. Repair metallized or galvanized coatings damaged during shipping, construction, or field welding according to 711.02.

515.17,

On page 389, in the table for Beam Sweep and Camber Tolerances, **replace** the Camber – Deviation from Design camber (DC)* for I Beam with the following:

For member lengths ≤ 80 ft: ± 1/8” per 10 ft (1 mm/m) max ± 1/2” (13 mm)

For member lengths > 80 ft: ± 1/8” per 10 ft (1 mm/m) max ± 1” (25 mm)

In the table for Reinforcing Steel Tolerances, **replace** the Stirrup extension above top flange for I Beam with the following:

+1/4” (6mm) – 3/4” (19mm)

523.03,

On page 408, **Replace** the second sentence of 523.03 with the following:

Supply personnel with an Advanced, Master, or Expert Level Certification in High Strain Dynamic Pile Testing (HSDPT) from Foundation QC to operate this equipment.

524.04,

On page 411, replace the last two sentences of 524.04.C with the following text:

Extract casing at a slow, uniform rate with the pull in line with the shaft axis. Rotate, tap, push down, or vibrate the casing when necessary to extract it. Rotate the casing as little as possible to avoid deforming the reinforcing steel cage.

602.03,

On page 425, **Replace** the first paragraph of 602.03 D with the following:

D. Pre-cast structures are half height headwalls for conduits up to a maximum of 78 inches (1980 mm). These pre-approved pre-cast structure drawings are on file in the Office Material Management. With the submission of the TE-24 from an approved manufacturer furnish stamped, approved from the Office of Structural Engineering design drawing sheets. Pre-cast half-height headwalls for elliptical and pipe arch conduits may be constructed from templates of the actual conduit being supplied, up to a maximum 78 inch (1980 mm) (round equivalent) to the project to ensure the opening is OD plus one inch. Submit drawings to the Office of Structural Engineering for approval, on a project by project basis, of pre-cast half-height headwalls for elliptical and pipe arch conduit. Non-pre-approved drawings are required to be submitted to the Office of Structural Engineering for approval. Allow 4 weeks for approval. Failure to furnish the stamped, approved design drawing sheets will result in rejection of the pre-cast structure. The drawings will include the following:

603.02,

On page 417, after the Joint Wrap.... ASTM C877, **Add** the following:
Buried Liner Waterproofing Membrane 711.22

603.04,

On page 433, **Replace** section H with the following:

H. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on footers, the Contractor may substitute each one for the other upon structure approval for hydraulics and cover. The manufacturer shall submit shop drawings and hydraulic calculations by a Registered Engineer for review and approval before manufacture. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on pedestal walls, the Contractor may substitute each one for the other upon structure approval for hydraulics, cover and pedestal wall design. 706.051 or 706.052 require different pedestal wall designs.

I. All 706.051 or 706.052 shop drawings require a Registered Engineer signature for design and check. The manufacturer shall submit shop drawings and hydraulic calculations to the Department for review and approval before manufacture.

J. For metal pipe 54 inch (1350 mm) diameter or larger and pipe-arch, ensure the manufacturer provides match marked ends and a layout drawing.

603.08,

On page 436, **add** the following before 603.08 A:

Install conduit so that match marks align and in accordance with the layout drawings supplied by the manufacturer.

603.08,

On page, 436 **delete** the following from 603.08 A.1:

Securely strut the end of each pipe section for pipe diameters 54 inches (1350 mm) or greater that have a wall thickness of less than 0.109 inch (2.77 mm). Install the ties or strapping in the first or second valley of the annular corrugations on each end of each piece of pipe. Install two struts per end such that they are perpendicular to one another and cross at their midpoints. Strut by using wire ties or other approved methods. Remove the strutting after securing the coupling bands.

603.08.A.2,

On page 436, **Revise** the heading from Concrete Pipe to Rigid Pipe.

603.09,

On page 438, **Replace** the entire first paragraph with the following:

Apply waterproofing to 707.03, 707.15, 707.23, and 707.25 conduits with less than eight feet of cover by one of the following methods.

A. Coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. The coating material and

application shall conform to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

B. Construct Buried Liner Waterproofing Membrane protection in the fill per the manufacturer's recommendations. The Buried Liner Waterproofing Membrane protection will be a seamless continuous sheet placed over the conduit and extend at least 10 feet (3.3m) outside of the paved shoulder and for the width of the trench.

603.11.C,

On page 440, **Replace** the entire section with the following:

C. For Structural Backfill Type 2, compact each lift of material according to 603.11.E using flood compaction or mechanical devices, hoe packs, jumping jacks, hand devices, vibrating plates, or other equipment that meets the restrictions in 603.10. Provide compaction equipment that compacts the material under the haunch of the pipe. If the compaction equipment cannot fully compact the material under the haunch, supplement the compaction equipment by using shovel slicing, spud bars, or mechanical spud bars to compact the material under the haunch of the pipe. Use shovel slicing and spud bars in conjunction with the compaction operations to compact the material and to manipulate the material under the haunch of the pipe.

603.13,

On page 441, **Replace** the last paragraph with the following:

Provide a paving that is 3 inches (75 mm) thick measured from the top of the corrugations of the conduit to a height equal to 1/3 of the rise. Provide galvanized reinforcing steel support chairs beneath the mesh where necessary. Give special care to the mesh during concrete placement. After placing the concrete, strike it off with a template to produce the proper radius, and finish with a float to produce a smooth finish. Cure the concrete according to 451.10.

604.04.B.2,

On page, 444 **replace** the term "approved adjusting device" with the term "acceptable adjusting device".

613.02,

On page 466, **Add** the following paragraph to the end of the section.

Furnish an air-entraining admixture that is designed for use in low strength mortar mixtures (also called controlled density fill or flowable fill).

613.03,

On page 467, In Note 2, **Replace** “(Approximately 5 percent)” with “(Approximately 25 percent)”.

614.03,

On Page 471, **Add** the following paragraph at the end of the section:

All temporary traffic control devices shall conform to the Quality Standards for Temporary Traffic Control Devices available at the following address:

<http://www.dot.state.oh.us/Divisions/HighwayOps/Traffic/publications2/qualityguidelines/Pages/default.aspx>

614.03,

On Page 470, **Add** the following to the end of the fifth paragraph: Use standard orange or fluorescent orange reflective sheeting for the orange portions of drums, barricades and vertical panels.

614.03,

On Page 470 - 471, **Replace** the sixth paragraph with the following: Furnish drums with reboundable reflective sheeting complying with the requirements of 730.191. Ensure that owner identification markings on construction drums are no more than 1 inch (25 mm) in character height and are located at least 2 inches (50 mm) below the reflectorized bands or on the top or bottom horizontal surfaces of the drum. Ballast the drums according to the manufacturer’s recommendations.

614.11,

On Page 475, In Table 614.11-2, in the Arrows, Symbols, and Words row, **Replace** the “.075” with “.75”.

614.11.B

On page 474, **Replace** the second paragraph with:

Unless otherwise shown on the plans, the Contractor may use 740.02 Type 1 paint or 740.06 Type I or Type II preformed material for work zone pavement markings. Furnish painted markings according to Item 642 except that:

614.11.G.1

On page 476, in section 614.11.G.1, **Replace** the section with the following:

1. Removal and Covering of Markings.

a. Removal Methods. Remove the markings so that less than 5% of the line remains visible. Repair damage to the pavement that results in the removal of more than 1/8 inch of pavement thickness. Remove the markings by using methods specified in the below table:

Type of Pavement		Removal Method	
		grinder ^[1]	sand, shot or water blast
Existing Asphalt	Temporary	Y	Y

	Permanent	N	Y
New Asphalt	Temporary	Y	Y
	Intermediate	Y	Y
	Permanent	N	Y
Existing Concrete	Temporary	Y	Y
	Permanent	N	Y
New Concrete	Temporary	Y	Y
	Permanent	N	Y
Y - method is permitted to be used			
N - method is not permitted to be used			
[1] – when a drum is mounted to a skid steer loader, the drum must be able to accommodate a minimum of 150 teeth			

b. Covering Conflicting Markings. With the Engineer’s approval, use removable, nonreflective, preformed blackout tape according to Supplement 1187 to cover conflicting markings. Remove or replace the blackout tape within 15 days of installation. Furnish products according to the Departments Qualified Products List (QPL).

614.16,

On page 482, **Add** the following paragraph before the first paragraph:

The Department will make partial payments according to 109.09 and as modified by the following schedule:

If the project duration from first day of physical work to original completion date is greater than or equal to 45 calendar days,

A. The Department will pay 30 percent of the lump sum amount bid for Maintaining Traffic with the first estimate, but not sooner than 15 days after the start of work at the project site.

B. The Department will pay the remaining 70 percent of the lump sum amount bid for Maintaining Traffic according to 109.09.

614.16,

On page 484, **Revise** the following pay unit for Portable Changeable Message Sign from Each, Sign Month to Day

619.02,

On page 492, **Revise** the Table 619.02-1 Field Office as follows:

Revise the All weather parking spaces to:

All-weather parking spaces	8	16	20
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Revise the Copy Machine to:

Copying machine capable of scanning documents to a computer ^[2]	1, 11x17	1, 11x17	1, 11x17
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625.12

On page 507 **add** the following sentence after the first paragraph:

When not otherwise specified, all conduit and fittings on an individual run of conduit shall be of the same material except for approved manufactured transition fittings required at end of the run when the item into which the conduit terminates is not of the same material as the conduit.

On page 508, **revise** the eleventh paragraph to read

After installation of the conduit and prior to installing the cables, run a mandrel whose diameter is at least 90% of the interior diameter of the conduit through the conduit.

625.14

On page 509 **revise** Section 625.14 to read as follows:

625.14 Jacking and Boring. In addition to the requirements of 625.12 to furnish and install conduit, use jacking or horizontal boring when the plan calls for such methods to be used. Use these methods in lieu of trenching only with the approval of the Engineer.

Jack only rigid galvanized steel conduit. Use only a machine designed for jacking conduit not the bucket or blade of a machine designed for earthwork.

Horizontal boring may be used to install any conduit or duct which has the adequate strength, flexibility and joints to withstand the process. Make the diameter of the bore no more than 5 percent larger than the outside diameter of the conduit or duct being installed.

630.12,

On page 528, **Replace** in the last sentence of the second paragraph “603.10” with “603.12”.

632.03,

On page 538, in Section 632.03 **Add** the following to the list in the fourth paragraph:

Tether Wire.....732.185

632.03,

On page 538, **Replace** in the 4th paragraph “725.04, 725.05” with “725.04, 725.051, 725.052”.

632.225

On page 544, **Add** the following after the 632.22 section:

632.225 Tether Wire. Arrange tether wire with accessories to stabilize signal heads and prevent excessive swinging. Accessories included with tether wire include anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, lock wire, safety tie wire, lead sheet, and signal head tether anchors and extenders.

Adjust the tether span to be horizontal on simple spans. On complex spans, the tether span shall be essentially parallel to the overlying messenger span. Bull Rings will be used at all

internal corners of the tether span. Safety ties shall be installed at all yielding (S-hook) locations to prevent the span end from dropping into the roadway if the S-hook opens. No electrical or communication cables of any kind shall be attached to the tether wire. No signs or other devices shall be suspended from or attached to the tether wire.

632.29,

On page 549, In Section 632.29, **Add** the following after the fourth paragraph:

The Department will measure tether wire by the number of feet (meters) in place, and will include all necessary accessories such as anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, lock wire, safety tie wire, lead sheet, and signal head tether anchors and extenders. The Department will measure from pole center to pole center, or pole center to bullring, or bullring to bullring. The Department will not measure any length of tether wire for attachment to poles or bullrings by bending, lapping or wrapping.

632.30,

On page 550, In Section 632.30, **Add** the following:

632	Foot (Meter)	Tether Wire, with Accessories
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633.03,

On page 552, **Replace** in the 4th paragraph “725.04, 725.05” with “725.04, 725.051, 725.052”.

641.02,

On page 573, **Add** the following after the fourth paragraph:

Any materials delivered without a TE-24 and applied without laboratory approval will be removed. Laboratory tested materials not meeting specifications will be removed from the project site.

641.06,

On page 576, **Revise** the second sentence in the first paragraph to the following:

Do not start marking operations until the Engineer or the Engineer’s representative has approved the layout and premarking lines.

641.07

On Page 576, In Section 641.07, **Replace** the second sentence with the following: The Engineer will not allow any deviation greater than 3 inches (75 mm).

641.08.A

On Page 577, In section 641.08.A, in the second sentence, **Delete** "a minimum of".

642,

Replace the existing section with the following:

ITEM 642 TRAFFIC PAINT

642.01 Description

642.02 Materials

642.03 Equipment

642.04 Application

642.05 Basis of Payment

642.01 Description. This work consists of furnishing and applying fast dry water-based traffic paint or fast dry water-based traffic paint for cold weather applications according to Item 641, 740.01, 740.02, 740.09, and the additional requirements specified below.

642.02 Materials. Furnish materials from the Department’s Approved List conforming to:

Traffic Paint	740.02
Glass Beads, Type A.....	740.09

The Engineer may obtain random samples from the application equipment. Furnish the manufacturer’s identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer’s production ranges. Samples not meeting the manufacturer’s production ranges will require the Contactor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved and will either require testing or re-application.

Do not apply paints that have exceeded the manufacturer’s shelf life. Do not use glass beads that are wet.

642.03 Equipment. Use equipment capable of applying the traffic paint as recommended by the manufacturer and applying glass beads at the time of line placement. Furnish a calibrated measuring device acceptable to the Engineer to measure the traffic paint in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent.

Furnish written documentation to the Engineer for the equipment’s operational capabilities from the equipment manufacturer.

642.04 Application. Apply pavement markings only when the surface is clean and dry in accordance with the paint manufacturer’s written application instructions.

If application is required when air and pavement temperatures are between 35 °F (2 °C) and 50 °F (10 °C) obtain approval from the Engineer and apply only pre-qualified Type 1A cold weather traffic paint materials. Apply traffic paint per manufacturer’s recommendations and protect line from tracking..

Keep the paint thoroughly mixed during application.

Apply 20 mil (0.51 mm) thick traffic paint Type 1 at the following rates:

20 Mil Thickness	Line Width (inch)				24
	4	6	8	12	
Gallon per Mile of Line					
Solid Line	22	33	44	66	132
Broken Line	5.5	8.25	11	16.5	33
Dotted Line	5.5	8.25	11	16.5	33
Areas, Symbols, Words	1.25 gallon per 100 square feet				

0.51 mm Thickness	Line Width (mm)				600
	100	150	200	300	
Liter per Kilometer of Line					
Solid Line	50	75	100	150	300
Broken Line	12.5	19	25	38	75
Dotted Line	12.5	19	25	38	75
Areas, Symbols, Words	0.51 L/m ²				

Apply 15 mil (0.38 mm) thick traffic paint Type 1A at the following rates:

15 Mil Thickness	Line Width (inch)				24
	4	6	8	12	
Gallon per Mile of Line					
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				600
	100	150	200	300	
Liter per Kilometer of Line					
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m ²				

Do not dilute the paint. However, the Contractor may add spent traffic paint solvents, generated during performance of this work, to virgin traffic paint. If adding spent solvents, add them in a maximum ratio of 1:50 of spent solvents to virgin paint. Ensure that the maximum concentration of spent solvents in the striping equipment tanks is maximum 2 percent. Add spent solvents during the loading of the striping equipment.

Apply glass beads to the wet paint so that the beads are embedded and retained in the paint and provide uniform retroreflectivity in the paint surface. Apply glass beads at a minimum rate of 15 pounds per 100 square feet (7.3 kg per 10 m²) for Type 1 traffic paint. Apply glass beads at a minimum rate of 8.0 pounds per 100 square feet (3.9 kg per 10 m²) for Type 1A traffic paint.

Ensure temperature of the paint at the discharge point is within the range recommended by paint manufacturer.

Replace unsatisfactory markings as per 641.11.

Furnish the Engineer daily, biweekly and final DLS reports as per 641.04..

Perform traffic control operations for all 642 pavement markings according to 614.12 and MT-99.20M, but provide for center line, edge line, lane line and channelizing line traffic control equipment according to MT-99.20M equipment requirements for center line, longer than 2 minute dry.

Payment for this work shall be included in the 642 price per mile for Center Line, Edge Line and Lane Line and the 642 price per foot for channelizing Line.

642.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
642	Mile (Kilometer)	Edge Line, Type ____
642	Mile (Kilometer)	Lane Line, Type ____
642	Mile (Kilometer)	Center Line, Type ____
642	Foot (Meter)	Channelizing Line, Type ____
642	Foot (Meter)	Stop Line, Type ____
642	Foot (Meter)	Crosswalk Line, Type ____
642	Foot (Meter)	Transverse/Diagonal Line, Type ____
642	Foot (Meter)	Curb Marking, Type ____
642	Square Foot (Square Meter)	Island Marking, Type ____
642	Each	Handicap Symbol Marking, Type ____
642	Each	Railroad Symbol Marking, Type ____
642	Each	School Symbol Marking, ____ inch (____ mm), Type ____
642	Foot (Meter)	Parking Lot Stall Marking, Type ____
642	Each	Lane Arrow, Type ____
642	Each	Word on Pavement, ____ inch (____ mm), Type ____
642	Foot (Meter)	Dotted Line, ____ inch (____ mm), Type ____
642	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
642	Lump Sum	Two-Way Radio Equipment

642.04

On page 579, **delete** the following:

If any project safety requirements require application below 50 °F (10 °C), obtain approval from the Engineer and apply only pre-qualified alkyd type materials. Apply paint and block from traffic tracking per alkyd paint manufacturer’s recommendations.

643,

Replace the existing specification with the following:

ITEM 643 POLYESTER PAVEMENT MARKING

- 643.01 Description
- 643.02 Materials
- 643.03 Equipment
- 643.04 Application
- 643.05 Basis of Payment

643.01 Description. This work consists of furnishing and applying polyester pavement markings according to Item 641, 740.01, 740.03, 740.09, and the additional requirements specified below.

643.02 Materials. Furnish materials from the Department’s Approved List conforming to:

- Polyester Pavement Marking..... 740.03
- Glass Beads, Type B..... 740.09

The Engineer may obtain random samples from the application equipment. Furnish the manufacturer’s identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer’s production ranges. Samples not meeting the manufacturer’s production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that have exceeded the manufacturer’s shelf life. Do not use glass beads that are wet.

643.03 Equipment. Use application equipment capable of mixing the polyester components in proportions recommended by the manufacturer and applying glass beads at the time of marking placement. Use equipment (striper) capable of applying polyester long-lines at the thickness specified for solid and broken lines while moving on the highway at a speed of not less than 7 miles per hour (11 km/h). Furnish a calibrated measuring device acceptable to the Engineer to measure the polyester resin in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. The DLS shall measure the polyester resin material component and glass beads only. Catalyst will be calculated as 2 percent of the resin used.

Furnish written documentation to the Engineer for the equipment’s operational capabilities from the equipment manufacturer.

Furnish written documentation for the equipment's operational capabilities from the equipment manufacturer.

643.04 Application. Apply polyester only when the pavement surface is clean and dry and the pavement and air temperature are above 50 °F (10 °C).

If project safety requirements require marking application below 50°F (10°C), obtain approval from the Engineer and apply cold weather traffic paint, Type 1A, as per Item 642 instead of the polyester.

After sampling of resin is completed, transfer the entire contents of each material container to the striper tanks. Ensure that the polyester is thoroughly mixed at all times during application. Apply polyester (catalyst plus resin) uniformly to the pavement at the following rates:

15 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m ²				

Do not dilute the material.

Apply glass beads to the uncured polyester in sufficient quantity so that the beads completely fill the polyester film from the film-pavement interface to the top surface of the film to the extent that there are loose beads on the surface of the uncured line. Apply glass beads at a minimum rate of 16.5 pounds per 100 square feet (8 kg per 10 m²) of polyester applied in a manner that provides uniformly retroreflective lines.

If the applied polyester becomes tacky and causes marking discoloration and darkening, cease marking application until the Inspector agrees that the problem is corrected.

If any marking is in a tracking condition 45 minutes after application, cease marking application until the Inspector agrees that the problem is corrected.

Do not apply polyester pavement markings to new asphalt concrete until at least 2 weeks after the pavement is placed. Assure curing compound is removed from portland cement concrete pavements.

Replace unsatisfactory markings as per 641.11.

Furnish the Engineer daily, biweekly and final DLS reports as per 641.04.

643.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
643	Mile (Kilometer)	Edge Line
643	Mile (Kilometer)	Lane Line
643	Mile (Kilometer)	Center Line
643	Foot (Meter)	Channelizing Line
643	Foot (Meter)	Stop Line
643	Foot (Meter)	Crosswalk Line
643	Foot (Meter)	Transverse/Diagonal Line
643	Foot (Meter)	Curb Marking
643	Square Foot	Island Marking (Square Meter)
643	Each	Handicap Symbol Marking
643	Each	Railroad Symbol Marking
643	Each	School Symbol Marking, ___ inch (___ mm)
643	Foot (Meter)	Parking Lot Stall Marking
643	Each	Lane Arrow
643	Each	Word on Pavement, ___ inch (___ mm)
643	Foot (Meter)	Dotted Line, ___ inch (___ mm)
643	Foot or Square Foot	Removal of Pavement Marking (Meter or Square Meter), or Each
643	Lump Sum	Two-Way Radio Equipment

643.04,

On page 583, **delete** the following:

If project safety requirements require marking application below 50°F (10°C), obtain approval from the Engineer and apply alkyd traffic paint type 2 as per Item 642 instead of the polyester.

701.09, Slag Modified Portland Cement.

On Page 668 **Replace** 701.09 with the following:

701.09 Slag Modified Portland Cement Provide slag modified portland cement according to ASTM C 595, Type IS (< 25).

703.01.E,

On page 680, **Replace** Section 703.01.E with the following:

E. Steel Slag Aggregate. Provide open-hearth (OH), basic oxygen furnace (BOF,) and electric arc furnace (EAF) steel slag aggregate (known as steel slag) according to the following requirements when 703.04 aggregate for asphalt concrete base or 703.05 aggregate for asphalt intermediate course is specified. Do not use OH, BOF, or EAF slag as the fine or coarse aggregate (virgin or recycled) for asphalt surface courses.

Supply all steel slag from sources according to Supplement 1071. Furnish steel slag to a size meeting the specified grading requirements. Provide steel slag aggregate meeting the specified coarse or fine aggregate quality requirements. Ensure that measurements of soft pieces includes soft lime, lime oxide, or magnesia agglomerations or any foreign materials prone to rapid

disintegration under construction processing and weathering conditions. Ensure that additional testing beyond those listed are performed or required any time poor quality steel slag is suspected due to visual inspection, testing, or field performance problems.

Provide a letter of certification to the Engineer from the steel slag processor for every shipment of steel slag to the Contractor. In addition the steel slag processor must provide the Engineer with the following:

Quality control records (created in accordance with Supplement 1071).

Documentation of the steel slag production, processing, and stockpile retrieval

Failure to follow the processor QC plan or continued problems with performance recognized by the Laboratory attributable to steel slag is cause for limiting steel slag use from that processor.

703.02.A,

On page 684, **Delete** the last sentence in 703.02.A.1 that begins “Natural sand is required...”

703.10,

On page 689, **Replace** the words “air-cooled slag” with “ACBFS” in Section 703.10.A.

703.11,

On page 689, **Replace** the word “limestone” with “CCS” in the first sentence of Section 703.11.

703.15,

On page 694, **Replace** Section 703.15 with the following:

703.15 Open-Hearth, Electric Arc Furnace, and Basic Oxygen Furnace Steel Slag Aggregate Used for Items 410, 411, and 617.

A. Non-confined Applications. When using OH, EAF, and BOF slag in applications where the steel slag will not be confined, ensure that the slag meets the requirements in 703.14.A (deleterious substances and crushing), and in 703.14.D (aging and stockpiling requirements). Recycled OH, EAF, or BOF slag from Department or non-Department projects may be used in applications where the recycled steel slag will not be confined.

B. Confined Applications. When using 410, 411, or 617 in applications where OH slag will be confined, ensure the OH slag meets all requirements of 703.14. Do not use BOF and EAF slag for 410, 411, or 617 where the BOF and EAF slag will be confined. However, BOF and EAF slag may be used for embankment material when blended in accordance with 703.16.

706.14,

On page 741, **Replace** Section 706.14 with the following.

706.14 Preformed Flexible Joint Sealant. Provide preformed flexible joint sealant for concrete conduit according to ASTM C 990.

Furnish materials according to the Department's Qualified Product List (QPL).

707.01,

On page 742, in the minimum wall thickness table, **delete** the 0.079 Wall Thickness (in) value for 54 inch diameter pipe, and replace it with 0.109. Delete the 2.01 Wall Thickness (mm) value for 1350 mm diameter pipe, and replace it with 2.77.

707.02,

On page 744, in the minimum wall thickness table, **replace** the wall thickness values for pipe 54 inches to 108 inches with the following:

Diameter (in)	Wall Thickness (in)
54	.079
60	.079
66	.109
72	.109
78	.109
84	.109
90	.109
96	.109
102	.109
108	.109

On page 745, in the minimum wall thickness table, **replace** the wall thickness values for pipe 1350 mm to 2550 mm with the following:

Diameter (mm)	Wall Thickness (mm)
1350	2.01
1500	2.01
1650	2.77
1800	2.77
1950	2.77
2100	2.77
2250	2.77
2400	2.77
2550	2.77

707.12,

On page 747 in the minimum wall thickness table, **replace** the wall thickness values for 54 inch and 60 inch pipe diameters with the following:

Diameter (in)	Wall Thickness (in)
54	.109
60	.109

On page 747 in the minimum wall thickness table, **replace** the wall thickness values for 1350 mm and 1500 mm pipe diameters with the following:

Diameter (mm)	Wall Thickness (mm)
1350	2.77
1500	2.77

707.22,

On page 751, in the minimum wall thickness table, **replace** the wall thickness values for 54 inch through 78 inch pipe diameters with the following:

Diameter (in)	Wall Thickness (in)
54	.075
60	.105
66	.105
72	.105
78	.105

On page 751, in the minimum wall thickness table, **replace** the wall thickness values for 1350 mm through 1950 mm pipe diameters with the following:

Diameter (mm)	Wall Thickness (mm)
1350	1.91
1500	2.67
1650	2.67
1800	2.67
1950	2.67

707.31,

On page 753, **Replace** the first sentence of 707.31 with the following:

Provide corrugated polyethylene drainage tubing according to AASHTO M 252 Type C and CP.

707.33,

On page 753, **Replace** the first paragraph of 707.33 with the following:

This specification covers smooth lined corrugated polyethylene pipe, closed profile polyethylene pipe, couplings, and fittings which shall conform to AASHTO M 252 or AASHTO M 294, Type S, SP, or D, with the following modifications to AASHTO M 294:

711.02,

On page 771, **Replace** the first paragraph of 711.02 with the following:

Furnish galvanize steel according to ASTM A 123 after cutting, bending, and welding. At the discretion of the Engineer, replace, re-galvanize, or repair damaged galvanized material. If a

repair is authorized, perform work according to ASTM A 780 except the Department will not allow aerosol spray applications of paints containing zinc dust.

725,

On page 789, **Replace** “725.05 Polyvinyl Chloride Conduits and Fittings” with “725.051 Polyvinyl Chloride Conduits and Fittings

On page 789, **Add** “725.052 Polyethylene Conduits and Fittings”

On page 791, Replace 725.05 with the following

725.051 Polyvinyl Chloride Conduits and Fittings. Furnish polyvinyl chloride conduit EPC-40-PVC conforming with NEMA Standard TC-2 for normal above ground or below ground, either concrete encased or direct burial. Use fittings conforming to NEMA Standard TC-2 references.

Furnish materials according to the Department’s Qualified Products List (QPL).

On page 791 **Add** the following:

725.052 Polyethylene Conduits and Fittings. Furnish polyethylene conduit EPEC-40-HDPE conforming with NEMA Standard TC-7 for below ground only, whether concrete encased or direct burial. Use fittings conforming to ASTM D3350.

Furnish materials according to the Department’s Qualified Products List (QPL).

730.04,

On page 810, Replace entire section with the following:

730.04 Base and Arm Plates. Furnish support or pole anchor bases and arm attachment plates fabricated from steel plate according to ASTM A 36 (A 36M) or ASTM A 572 (A 572M), Grade 42. Weld plates to supports, poles, or arms both inside and outside with fillet or full penetration welds equal to the wall thickness, or by AWS prequalified welding joints TC U4a-S or TC U4c-GF. The Contractor may use a cast steel base of equivalent strength.

Furnish certified material according to Supplement 1093.

730.191,

On Page 812, **Replace** the title with the following: **730.191 Reflective Sheeting Reboundable.**

730.191,

On Page 812, **Replace** the first paragraph with the following: Furnish reboundable reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type III, IV, VII, VIII, IX or X, including supplemental requirements S1 and S2, with watermarks or other identification marks inconspicuously incorporated into the face of the sheeting on a repeating pattern if necessary to distinguish the sheeting from other similarly appearing sheetings.

732.02,

On page 818, In Section 732.02, **Delete** the third paragraph (begins with “Ensure that the housing...”).

732.04,

On page 825, **Replace** in the last line of paragraph b, “120 ** 3 volts RMS” with "120 ± 3 volts RMS".

732.04.C.1.i,

On Page 822, **Replace** this section with the following:

If red or yellow lenses are tinted, they shall match the wavelength (chromaticity) of the LED. Do not furnish green tinted lenses.

732.07.A,

On page 830, **Add** the following paragraph between the third and fourth paragraphs:

Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

732.07.B,

On page 830, **Add** the following paragraph between the first and second paragraph:

Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

732.08,

On page 830, **Add** the following paragraph between the first and second paragraph:

Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

732.185,

On page 833, **Add** the following section after section 732.18:

732.185 Tether Wire. Furnish Utilities Grade tether wire, ¼-inch (6 mm), twisted strand galvanized steel according to ASTM A475, Class B, with the exception that tags according to Section 19.2 are not required on lengths less than 1000 feet (300 m). Ensure that all accessories except S-hooks have rated load strength equal to or greater than the tether wire minimum breaking strength. S-hooks shall be made of mild low-carbon galvanized steel and of the wire size indicated on the plans; larger wire sizes and higher-strength steel S-hooks shall not be substituted. Safety tie wire shall be 304 or 316 stainless steel, 1x19 stranded, 1/8-inch (3 mm) with stainless steel wire rope clips. Lead sheet to wrap tether wire in breakaway anchors shall be commercially pure lead of thickness 0.030 to 0.042 inches (0.75 to 1.0 mm).

732.19,

On Page 835, Replace the existing table 732.19-1 with the following table:

TABLE 732.19-1 CABLE AND WIRE					
Cable or Wire	Number of Conductors	Wire Gage	Specification or type	Conductor Type	Notes
Signal Cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
Interconnect cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
	Twisted pairs as specified	As specified	RUS PE-39 IMSA 19-2 IMSA 20-2	Copper, color coded, solid	
Interconnect cable, integral, messenger type	As specified	As specified	IMSA 19-3 IMSA 20-3	Copper, color coded, stranded	
	Twisted pairs as specified	As specified	IMSA 19-4 IMSA 20-4	Copper, color coded, solid	ANSI/ICEA Cable shall have: 1) Solid insulations 2) Full count color coding 3) 8-mil shield 4) 772 kHz attenuation compliance All other specifications are manufacturers option unless specified.
Loop detector wire	Single conductor	14 AWG	IMSA 51-5	Copper, stranded	
Loop detector lead-in cable	Two conductor	14 AWG	IMSA 50-2	Copper, twisted pair, stranded, shielded	
Magnetometer lead-in cable	Four conductor	18 AWG	Heavy duty, direct burial type	Copper, color coded, solid	Jacket : High density polyethylene, Thickness 0.026 in(0.66 mm)(min.) Low conductor to conductor capacitance [2]
Power cable	Two conductor	As specified	UL: RHH/RHW/USE or XHHW, cross linked polyethylene w. an insulation thickness of 0.045 in(1.14 mm) (min.)	Copper, stranded	Three-conductor cable may be specified. Permitted substitution: 2 (or 3) single conductor cable
Service cable	Two conductor (duplex)	As specified		Aluminum, [1] twisted, stranded	
Ground Wire	Single conductor		UL: RHH/RHW/USE or XHHW, cross linked polyethylene	Copper, stranded	Minimum size is equal to the power or service cable, whichever is larger.
Loop detector lead-in cable, direct burial	As specified	12 or 14 AWG, or as specified	IMSA 19-6 IMSA 20-6	Copper, stranded	
Loop detector lead-in cable, Integral messenger type	As specified	12 or 14 AWG, or as specified	IMSA 19-4 IMSA 20-4	Copper, stranded	
[1] Copper Conductors may be substituted					
[2] 18 picofarads per foot (59 pF/m), 15 picofarads per foot (49 pF/m)					

733.02.B,

On Page 840, **Replace** the paragraph that begins with “Furnish controllers with 24 month warranties or for the manufacturers...” with the following:

Furnish 60-month warranties or for the manufacturers’ standard warranty, whichever is greater for the following equipment:

1. NEMA Controller Equipment
 - a. TS-2 Controller Units
 - b. Bus Interface Units
 - c. Malfunction Management Units
 - d. TS-1 Conflict Monitors
2. CalTrans Controller Equipment
 - a. Model 2010 Conflict Monitor Units
 - b. 170E Controller Units including the following subassembly item:
 - (1)CPU Board
 - c. 2070L and 2070LC Controller Units including the following subassembly units:
 - (1)2070-1B CPU Board
 - (2)2070-2A Field I/O Module
 - (3)2070-3B Front Panel.

Ensure that the warranty period begins on the date of shipment to the project. Ensure that each unit has a permanent label or stamp indicating the date of shipment.

733.02.D,

On page 842, In Section 733.02.D. **Add** the following to the first paragraph:

3. Furnish a serial communication cable to be used to establish periodic automatic time sync between the 2070 controller software and the conflict monitor. The cable shall consist of six feet (2 m) of unshielded 4- conductor cable, minimum 24 gauge stranded conductors with protective jacket. End connectors shall be 9-pin D-subminiature with backshell, male and female, with pin assignments shown in the table below.

9-pin Male	9-pin Female
3	3
5	5
2	2
1	4
8	4

733.03.A.2.m,

On page 848, **Add** the following at the end of the first paragraph:

The following overrides NEMA requirements for signal bus relays. A solid-state relay shall be used for the signal bus relay. The signal bus relay shall maintain output equal to or above the rating of the cabinet main overcurrent protection device over the NEMA TS-2 Environmental Operating Range of -50 to +185 degrees F (-45 to +85 degrees C).

733.03.A.2.p,

On page 849, **Add** the following:

(7) Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

733.03.B.3,

On page 850, **Add** the following paragraph:

Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

733.09.E,

On Page 870, **Add** the following sentence at the end of the section:

Furnish materials according to the Department's Qualified Products List (QPL).

740.02,

Replace the existing section 740.02 with the following:

740.02 Traffic Paint. Furnish white and yellow ready-mixed traffic paint suitable for marking various types of pavement. Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish paint that is a suitable binder for glass beads, 740.09 Type A, on pavement exposed to traffic. Furnish paint that will not deteriorate in storage, within one year after date of receipt, to the extent that it cannot be readily broken up with a paddle to a smooth uniform paint capable of easy application by spray.

Furnish paint that does not bleed or discolor when sprayed on asphalt concrete surfaces.

Type 1 paint is the fast dry, water-based, 100 percent acrylic type.

Type 1A paint is fast dry, water-based, 100 percent acrylic type, used for cold weather applications.

Ensure that Type 1A paint conforms to the following requirements:

Property	Test Method	Requirements (Applies to both White and Yellow, unless noted))
Total Solids	ASTM D2369	70% minimum by weight
		58% minimum by volume
Titanium Dioxide, rutile type II	ASTM D1394	1 lb/gal (120 g/l) minimum, White 0.2 lb/gal (24 g/l) minimum, Yellow
Pigment % by Weight	ASTM D3723	+/- 2% of qualifying sample
Weight per Gallon	ASTM D1475	+/- 0.3 lb/gal (36 g/L) of qualifying sample
Color	SS 1047	Appendix A
Viscosity (krebs units)	ASTM D562	70 minimum and 95 maximum @ 77°F (25°C)
Lab Drying Time	ASTM D711	10 minutes max. @ 77°F (25°C), 50% RH 12 minutes max. @ 50°F (10°C), 50% RH 14 minutes max. @ 35°F (1.7°C), 50% RH

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

740.02,

On page 871, delete the following sentence in the first paragraph
Ensure that the manufacturer formulates the traffic paint Type 2 in such a manner as to meet the requirements of this specification

740.02,

On page 871, delete the following sentences and table in the third paragraph:
Type 2 paint is the fast dry, alkyd type.
Ensure that all Type 2 paint conforms to the following requirements:

		Minimum	Maximum
1.	Consistency, Krebs units ASTM D 562. Procedure A:	90	110
2.	Field Dry Time (No Track), minutes:	--	2
<p>Furnish pavement marking material that will be in “no tracking condition” in two minutes. The “no tracking condition” will be determined by applying the markings and beads at the specification requirements to dry pavements at a low temperature of 45°F (7 °C) and high temperature of 120 °F (49 °C). Run tests at the manufacturer’s highest and lowest recommended application humidity. The marking materials will be applied at the manufacturer’s recommended application temperature. The “no tracking” time will be determined by passing over the line with a passenger car at a speed of 25 to 35 mph (44 to 55 kmph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed at a distance of 50 ft (15 m) will be considered as showing “no tracking” and conforming to this requirement for time to “no track”.</p>			
3.	Prime Pigment Content, percent by weight of paint:		
	white ASTM D 1394	17.0	--
	yellow ASTM D 126 or Department approved lab method	17.0	--
4.	Pigment Content, percent by weight of paint ASTM D 2698:		
	white	--	61
	yellow	--	61
5.	Nonvolatile Vehicle Solids Content, percent by weight of paint Fed. STD. 141 C Method 4053.1:		
	white	12	--
	yellow	12	--
6.	Fineness of Dispersion, ASTM D 1210 micrometers :		
		50	--
7.	Bleeding Ratio, Fed. Std. TT-P-115F, Section 4.3.2:		
	white	0.95	--
	yellow	0.93	--
8.	Color,		
	a. White, Daylight Directional Reflectance, ASTM D 1347:	91	--
	b. Yellow	50	
	1. Refer to Highway Yellow Color Tolerance Chart PR Color No. 1, June, 1965 U.S. Dept. of Transportation, FHWA: Yellow, Color Difference 595-33538, ASTM D 2244		
	I Measure E, L, a, b as Cielab, Source “C”		
	Type 2		
	L	+1.5	+5.5
	a	+0.5	+9.0
	b	+0.5	+15.0
9.	Condition in container, Fed Std, 141 No. 3011.2 hand stirring by spatula, in minutes		5

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STANDARD SPECIAL PROVISION

Detail

Index or Category: Item Related	Status: Active
Sequence ID: 4111	District: CO
Version: A	
Provision Name: c04111 ITEM 9411-____ (ITEM 9411-____) WARM MIX ASPALT (WMA), PLANT-MIXED BITUMINOS CONCRETE	

Usage Information

Measurement: Dual	Include on all projects: No
Edit Body: No	Include on all federally funded projects: No
Edit Header: Yes	Include on all 100% State funded projects: No
Edit Project Specific Details: No	

Instructions for Usage: Bid Warm-Mix Asphalt (WMA) bituminous concrete pavement courses in lieu of bidding Superpave Asphalt Mixture Design, HMA paving courses as instructed in Strike-off Letter 421-08-09, dated December 17, 2008. Consider the additional material and/or plant processing modification requirements and associated costs, before bidding. Refer to the following website for more information on WMA. <http://www.warmmixasphalt.com>

Effective From: 12/19/2008
To: 01/01/2199

Associated Items

Item Number	Description
<i>No records found.</i>	

Header

ITEM 9411-__ (9411-__) WARM MIX ASPHALT (WMA), PLANT-MIXED BITUMINOUS CONCRTE, _____ COURSE, PG __-__, _____ MILLION ESALS, _____ mm MIX, _____ mm (____") DEPTH, SRL-__

Provision Body

I. DESCRIPTION - This work is the Standard and RPS construction of plant-mixed, dense-graded Warm Mix Asphalt (WMA) on a prepared surface using a volumetric mixture design developed with the Superpave Gyrotory Compactor (SGC) using prescribed manufactured additives and/or plant process modifications in accordance with these specifications and detail drawings. Use of reclaimed asphalt pavement (RAP) materials, consisting of cold milled or crushed hot-mix bituminous mixture is permitted using current criteria and policy as specified in Bulletin 27.

II. MATERIAL - Section 409.2 with additions and modifications as follows:

(e) Composition of Mixtures.

1. Virgin Material Mixtures. Replace the first paragraph with the following:

Size, uniformly grade, and combine virgin aggregate fractions, bituminous material, and either WMA additive(s) or no special additives, if mixture temperature and viscosity reduction is achieved solely through plant modification to produce foamed asphalt, in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, for the specified nominal maximum aggregate size and design ESALs except as modified by the WMA Additive/Process Technical Representative to address and incorporate WMA additive(s) or processes into the laboratory mix design process and to achieve a uniform blend.

1.d. Production. Add the following:

Prepare and test WMA mixtures, including SGC specimens for quality control using the same test methods, procedures and frequencies as specified for HMA, except as modified by the WMA Additive/Process Technical Representative. Maintain records of the testing of WMA and make available for review by the Representative when directed.

Table A

Job-Mix Formula

Composition Tolerance Requirements of the Completed Mix

Revise the Temperature of Mixture as follows:

Temperature of Mixture (°C (F))			
Class of Material	Type of Material	Minimum	Maximum
PG 58-28	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
PG 64-22	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
PG 76-22	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
All other PG Binders	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	

Add the following new subsection:

(g) WMA Additive(s), WMA Processes, and WMA Manufacturers. Include a description of the plan to control WMA additive(s) or WMA process in the quality control plan. Use only approved additives/processes as specified and recommended by the manufacturers herein. WMA additives/processes approved for use are as follows:

1. Organic Additives.

1.a Sasol Wax Americas, Inc.: Sasobit

2. Foaming Additives or Processes.

2.a Astec Industries. Double Barrel Green System

2.b Gencor Industries. Green Machine

2.c McConnaughay Technologies. Low Emission Asphalt

2.d Terex Roadbuilding. Warm Mix Asphalt System

2.e PQ Corporation. Advera WMA

3. Chemical Additives

3.a MeadWestvaco Asphalt Innovations. Evotherm

3.b Akzo Nobel. Rediset WMX

For more information on the above approved technologies, refer to the Internet website <http://www.warmmixasphalt.com/WmaTechnologies.aspx>

Ensure that a Technical Representative from the specified WMA additive or process manufacturer is present during production and placement of all WMA pavement sections. Submit any proposed deviations to this requirement in writing to the Representative for approval either before or at the pre-construction conference

III. CONSTRUCTION - Section 409.3 with additions and modifications as follows:

(a) Paving Operation QC Plan: Add the following:

Prepare and submit additional information specifically related to all aspects of the field control of WMA concrete paving operations to the Representative as part of the paving operation QC Plan that address all recommendations and direction from the WMA Additive/Process Technical Representative. Describe the construction equipment and methods necessary to control the WMA paving operations including the testing, delivery, placement, compaction, and protection of the WMA concrete courses for all placement applications including handwork as specified in Section 409.3.

(b) Weather Limitations. Revise completely as follows:

Do not place WMA paving mixtures when surfaces are wet or when the air or surface temperature is 2°C (35F) or lower. If work is halted because of weather conditions, the Representative may allow limited quantities of base course that are en route to the project to be placed.

(c) Bituminous Mixing Plant. Add the following:

Make any plant modifications needed to introduce WMA additives or processes in accordance with specific recommendations and direction from the WMA Additive/Process Technical Representative or process manufacturer to achieve a uniform blend of the additive or foaming process and produce a WMA mixture meeting these specifications.

1. Batch Plant. Add the following:

Dry the aggregate(s) according to the specific recommendations and direction from the WMA Additive/Process Technical Representative and heat to a suitable temperature so that the resulting complete mix temperature is within the temperature limits recommended or directed by the WMA Additive/Process Technical Representative. Ensure that the virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

2. Drum mixer Plant. Add the following:

Produce a completed mixture that is within the temperature limits recommended or directed by the WMA Additive/ Process Technical Representative.

IV. MEASUREMENT AND PAYMENT - Section 409.4 with replacements as follows:**(a) Standard WMA Construction****1. WMA Courses.****1.a Warm Mix Asphalt, Wearing Course.** Square Meter (Square Yard) or Tonne (Ton)**1.b Warm Mix Asphalt, Wearing Course (Scratch).** Tonne (Ton)**1.c Warm Mix Asphalt, Wearing Course (Leveling).** Tonne (Ton)**1.d Warm Mix Asphalt, Binder Course.** Square Meter (Square Yard) or Tonne (Ton)**1.e Warm Mix Asphalt, Binder Course (Leveling).** Tonne (Ton)**(b) WMA RPS Construction.** Square Meter (Square Yard) or Tonne (Ton)**Project Specific Details****Audit Information**

Created By	Created On	Modified By	Modified On
Nikki L Krise/PennDOT	12/05/2008 02:58:32 PM	Jeffrey A Bordner/PennDOT	01/30/2009 10:21:32 AM

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	 TIMOTHY L. RAMIREZ		

STANDARD SPECIAL PROVISION

Detail

Index or Category: Item Related

Status: Active

Sequence ID: 3111

District: CO

Version: A

Provision Name: c03111 ITEM 9311-____ (ITEM 9311-____) WARM MIX ASPHALT (WMA), PLANT-MIXED BITUMINOUS CONCRETE, BASE

Usage Information

Measurement: Dual

Edit Body: No

Include on all projects: No

Edit Header: Yes

Include on all federally funded projects: No

Edit Project Specific Details: No

Include on all 100% State funded projects: No

Instructions for Usage: Bid Warm-Mix Asphalt (WMA) bituminous concrete pavement courses in lieu of bidding Superpave Asphalt Mixture Design, HMA paving courses as instructed in Strike-off Letter 421-08-09, dated December 17, 2008. Use on non-federal and non-NHS projects. Consider the additional material and/or plant processing modification requirements and associated costs, before bidding. Refer to the following website for more information on WMA. <http://www.warmmixasphalt.com>

Effective From: 12/19/2008

To: 01/01/2199

Associated Items

Item Number	Description
<i>No records found.</i>	

Header

Item 9311-____ (9311-____) WARM MIX ASPHALT (WMA), PLANT-MIXED BITUMINOUS CONCRETE, BASE COURSE, PG _____ MILLION ESALS, _____ mm Mix, _____ mm (____") DEPTH

Provision Body

I. DESCRIPTION - This work is the Standard construction of a plant-mixed, dense-graded Warm Mix Asphalt (WMA) base course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor (SGC) and using prescribed manufactured WMA additives and/or plant process modifications in accordance with these specifications and detail drawings. Use of reclaimed asphalt pavement (RAP) materials, consisting of cold milled or crushed hot-mix bituminous mixture is permitted using current criteria and policy as specified in Bulletin 27.

II. MATERIAL - Section 409.2 with additions and modifications as follows:

(e) Composition of Mixtures.

1. Virgin Material Mixtures. Replace the first paragraph with the following:

Size, uniformly grade, and combine virgin aggregate fractions, bituminous material, and either WMA additive(s) or no special additives, if mixture temperature and viscosity reduction is achieved solely through plant modification to produce foamed asphalt, in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, for the specified nominal maximum aggregate size and design ESALs except as modified by the WMA Additive/Process Technical Representative to address and incorporate WMA additive(s) or processes into the laboratory mix design process and to achieve a uniform blend.

1.d. Production. Add the following:

Prepare and test WMA mixtures, including SGC specimens for quality control using the same test methods, procedures and frequencies as specified for HMA, except as modified by the WMA Additive/Process Technical Representative. Maintain records of the testing of WMA and make available for review by the Representative when directed.

Table A

Job-Mix Formula

Composition Tolerance Requirements of the Completed Mix

Revise the Temperature of Mixture as follows:

Temperature of Mixture (°C (F))			
Class of Material	Type of Material	Minimum	Maximum
PG 58-28	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
PG 64-22	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
PG 76-22	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	
All other PG Binders	Asphalt Cement	As recommended or directed by the WMA Additive/Process Technical Representative	

Add the following new subsection:

(g) WMA Additive(s), WMA Processes, and WMA Manufacturers. Include a description of the plan to control WMA additive(s) or WMA process in the quality control plan. Use only approved additives/processes as specified and recommended by the manufacturers herein. WMA additives/processes approved for use are as follows:

1. Organic Additives.

1.a Sasol Wax Americas, Inc.: Sasobit

2. Foaming Additives or Processes.

2.a Astec Industries. Double Barrel Green System

2.b Gencor Industries. Green Machine

2.c McConnaughay Technologies. Low Emission Asphalt

2.d Terex Roadbuilding. Warm Mix Asphalt System

2.e PQ Corporation. Advera WMA

3. Chemical Additives

3.a MeadWestvaco Asphalt Innovations. Evotherm

3.b Akzo Nobel. Rediset WMX

For more information on the above approved technologies, refer to the Internet website <http://www.warmmixasphalt.com/WmaTechnologies.aspx>

Ensure that a Technical Representative from the specified WMA additive or process manufacturer is present during production and placement of all WMA pavement sections. Submit any proposed deviations to this requirement in writing to the Representative for approval either before or at the pre-construction conference.

III. CONSTRUCTION - Section 409.3 with additions and modifications as follows:

(a) Paving Operation QC Plan: Add the following:

Prepare and submit additional information specifically related to all aspects of the field control of WMA concrete paving operations to the Representative as part of the paving operation QC Plan that address all recommendations and direction from the WMA Additive/Process Technical Representative. Describe the construction equipment and methods necessary to control the WMA paving operations including the testing, delivery, placement, compaction, and protection of the WMA concrete courses for all placement applications including handwork as specified in Section 409.3.

(b) Weather Limitations. Revise completely as follows:

Do not place WMA paving mixtures when surfaces are wet or when the air or surface temperature is 2°C (35F) or lower. If work is halted because of weather conditions, the Representative may allow limited quantities of base course that are en route to the project to be placed.

(c) Bituminous Mixing Plant. Add the following:

Make any plant modifications needed to introduce WMA additives or processes in accordance with specific recommendations and direction from the WMA Additive/Process Technical Representative or process manufacturer to achieve a uniform blend of the additive or foaming process and produce a WMA mixture meeting these specifications.

1. Batch Plant. Add the following:

Dry the aggregate(s) according to the specific recommendations and direction from the WMA Additive/Process Technical Representative and heat to a suitable temperature so that the resulting complete mix temperature is within the temperature limits recommended or directed by the WMA Additive/Process Technical Representative. Ensure that the virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

2. Drum mixer Plant. Add the following:

Produce a completed mixture that is within the temperature limits recommended or directed by the

WMA Additive/ Process Technical Representative.

(h) Spreading and Finishing. Revise as follows:

1.b Spreading and Finishing. Add the following:

If the indicated compacted depth of a WMA 25.0 mm base course is more than 150 mm (6 inches), place the WMA base course in two or more layers of approximately equal compacted depth, with no layer less than 80 mm (3 inches) or more than 150 mm (6 inches). If the indicated compacted depth of a WMA 37.5 mm base course is more than 200 mm (8 inches), place the WMA base course in two or more layers of approximately equal compacted depth, with no layer less than 100 mm (4 inches) or more than 200 mm (8 inches).

(i) Surface Tolerance. Replace the requirement for defective pavement with the following:

The pavement is defective if irregularities are more than 6 mm (1/4-inch).

(m) Tests for Depth. Replace with the following:

Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance. On the top lift and in the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 2500 m² (3,000 square yards) of completed base course and at other locations the Inspector suspects are deficient.

The Inspector will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 13 mm (1/2 inch) or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 13 mm (1/2 inch) of the design depth.

IV. MEASUREMENT AND PAYMENT-Section 409.4(a), with modifications as follows:

(a) Bituminous Mixtures (Standard). Replace and revise as follows:

1. WMA Courses. Add the following:

1.f Warm Mix Asphalt, Base Course. Square Meter (Square Yard) or Tonne (Ton)

Project Specific Details

Audit Information

Created By	Created On	Modified By	Modified On
Nikki L Krise/PennDOT	12/05/2008 02:54:37 PM	Jeffrey A Bordner/PennDOT	01/30/2009 10:21:06 AM

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Wed Apr 08 11:54:46 EDT 2009
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TEXAS

SPECIAL PROVISION

341---020

Dense-Graded Hot-Mix Asphalt (QC/QA)

For this project, Item 341, “Dense-Graded Hot-Mix Asphalt (QC/QA),” of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 341.2. Materials, Section A. Aggregate is voided and replaced by the following:

A. Aggregate. Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The Engineer will designate the plant or the quarry as the sampling location. Samples must be from materials produced for the project. The Engineer will establish the surface aggregate classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests listed in Table 1. Document all test results on the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II. Do not add material to an approved stockpile from sources that do not meet the aggregate quality requirements of the Department’s *Bituminous Rated Source Quality Catalog* (BRSQC) unless otherwise approved.

Article 341.2. Materials, Section A. Aggregate, Section 1. Coarse Aggregate. The second paragraph is voided and replaced by the following:

Provide coarse aggregate with at least the minimum SAC as shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes. When shown on the plans, SAC requirements apply to aggregates used on surfaces other than travel lanes. The SAC for sources on the Department’s Aggregate Quality Monitoring Program (AQMP) is listed in the BRSQC.

Article 341.2. Materials, Section A. Aggregate, Section 2. RAP is voided and replaced by the following:

2. RAP. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Crush or break RAP so that 100% of the particles pass the 2-in. sieve.

Use of Contractor-owned RAP including HMA plant waste is permitted, unless otherwise noted in the plans. Department-owned RAP stockpiles are available for the Contractor’s use when the stockpile locations are shown on the plans. Department-owned RAP generated through required

work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor or Department-owned RAP is appropriate for use. Unless otherwise shown on the plans, the Department will not perform any tests or assume any liability for the quality of the Department-owned RAP. When shown on the plans, the contractor will retain ownership of RAP generated on the project.

Fractionated RAP is defined as having two or more RAP stockpiles, whereas the RAP is divided into coarse and fine fractions. The coarse RAP stockpile will contain only material retained by processing over a 3/8 in. screen or 1/2 in. screen, unless otherwise approved. The fine RAP stockpile will contain only material passing the 3/8 in. screen or 1/2 in. screen, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 3/8 in. screen or 1/2 in. screen to fractionate the RAP. The maximum percentages of fractionated RAP may be comprised of coarse or fine fractionated RAP or the combination of both coarse and fine fractionated RAP. Utilize a separate cold feed bin for each stockpile of fractionated RAP used.

Determine asphalt content and gradation of RAP stockpiles for mixture design purposes. Perform other tests on RAP when shown on the plans. Use no more than 10% unfractionated RAP in surface mixtures and no more than 20% unfractionated RAP in non-surface mixtures that are placed within 8 in. of the final riding surface. Use no more than 30% unfractionated RAP in non-surface mixtures that are placed 8 in. or more from the final riding surface. Use no more than 20% fractionated RAP in surface mixtures and no more than 30% fractionated RAP in non-surface mixtures that are placed within 8 in. of the final riding surface. Use no more than 40% fractionated RAP in non-surface mixtures that are placed 8 in. or more from the final riding surface. "Surface" mixtures are defined as mixtures that will be the final lift or riding surface of the pavement structure. "Non-Surface" mixtures are defined as mixtures that will be an intermediate or base layer in the pavement structure. The allowable percentages shown above may be decreased or increased when shown on the plans. Do not use Department or Contractor owned RAP contaminated with dirt or other objectionable materials. Do not use Department or Contractor owned RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with Tex-406-A, Part I. Determine the plasticity index in accordance with Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

Article 341.2. Materials, Section F. Additives is supplemented by the following:

Warm Mix Asphalt (WMA) is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. WMA is allowed for use at the Contractor's option unless otherwise shown on the plans. The use of WMA is required when shown on plans. When WMA is required by the plans, produce an asphalt mixture within the temperature range of 215°F and 275°F. When WMA is not required as shown on plans, produce an asphalt mixture within the temperature range of 215°F and 350°F. Unless otherwise directed, use only WMA additives or processes listed on the Department's approved list maintained by the Construction Division.

Article 341.4. Construction, Section D. Mixture Design. The first paragraph and Table 7 are voided and replaced by the following:

The Contractor may elect to design the mixture using a Texas Gyrotory Compactor (TGC) or a Superpave Gyrotory Compactor (SGC), unless otherwise shown on the plans. Use the typical weight design example given in Tex-204-F, Part I when using a TGC or the Superpave mixture design procedure given in Tex-204-F, Part IV when using a SGC. Design the mixture to meet the requirements listed in Tables 1, 2, 3, 6, 7, and 8. When using the TGC, design the mixture at a 96.0% target laboratory-molded density or as noted in Table 7. When using the SGC, design the mixture at 75 gyrations (Ndesign). Use only a target laboratory-molded density of 96.0% when using the SGC to design the mixture; however, adjustments can be made to the Ndes value as noted in Table 7.

Use an approved laboratory to perform the Hamburg Wheel test and provide results with the mixture design or provide the laboratory mixture and request that the Department perform the Hamburg Wheel test. The Construction Division maintains a list of approved laboratories. The Engineer will be allowed 10 working days to provide the Contractor with Hamburg Wheel test results on the laboratory mixture design.

**Table 7
Laboratory Mixture Design Properties**

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	96.0 ¹
Design gyrations (Ndesign)	Tex-241-F	75 gyrations ²
Tensile strength (dry), psi	Tex-226-F	85-200 ³
Boil test ⁴	Tex-530-C	-

1. May be adjusted within a range of 96.0–97.5% when shown on the plans or allowed by the Engineer when using the TGC (Tex-204-F, Part I).

2. May be adjusted within a range of 50–100 gyrations when shown on the plans or allowed by the Engineer when using the SGC (Tex-204-F, Part IV).

3. May exceed 200 psi when approved and may be waived when approved.

4. Used to establish baseline for comparison to production results. May be waived when approved.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval. The first paragraph is voided and replaced by the following:

2. Job-Mix Formula Approval. The job-mix formula (JMF) is the combined aggregate gradation and target asphalt percentage used to establish target values for hot mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When WMA is used, JMF1 may be designed and submitted to the Engineer without including the WMA additive. When WMA is used, document the additive or process used and recommend rate on the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch, unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (1) Providing Texas Gyrotory Compactor is voided and replaced by the following:

(1) Providing Gyrotory Compactor. Use a Texas Gyrotory Compactor (TGC) calibrated in accordance with Tex-914-K when electing or required to design the mixture in accordance with Tex-204-F, Part I, for molding production samples. Furnish a Superpave gyrotory compactor (SGC) calibrated in accordance with Tex-241-F when electing or required to design the mixture in accordance with Tex-204-F, Part IV, for molding production samples. If the SGC is used, locate the SGC at the Engineer's field laboratory and make the SGC available to the Engineer for use in molding production samples.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (2) Gyrotory Compactor Correlation Factors is voided and replaced by the following:

(2) Gyrotory Compactor Correlation Factors. Use Tex-206-F, Part II, to perform a gyrotory compactor correlation when the Engineer uses a different gyrotory compactor. Apply the correlation factor to all subsequent production test results.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (6) Ignition Oven Correction Factors is voided and replaced by the following:

(6) Ignition Oven Correction Factors. Determine the aggregate and asphalt correction factors from the ignition oven in accordance with Tex-236-F. Provide the Engineer with split samples of the mixtures, including all additives (except water) and blank samples used to determine the correction factors. Correction factors established from a previously approved mixture design may be used for the current mixture design, provided that the mixture design and ignition oven are the same as previously used, unless otherwise directed.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Section (8) Trial Batch Approval is voided and replaced by the following:

(8) Trial Batch Approval. Upon receiving conditional approval of JMF1 from the Engineer, provide a plant-produced trial batch including the WMA additive or process, if applicable for verification testing of JMF1 and development of JMF2.

Article 341.4. Construction, Section D. Mixture Design, Section 2. Job-Mix Formula Approval, Section a. Contractor's Responsibilities, Table 9 is voided and replaced by the following:

**Table 9
Operational Tolerances**

Description	Test Method	Allowable Difference from Current JMF Target	Allowable Difference between Contractor and Engineer¹
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.0 ²	±5.0
Individual % retained for sieves smaller than #8 and larger than #200		±3.0 ²	±3.0
% passing the #200 sieve		±2.0 ²	±1.6
Asphalt content, %	Tex-236-F	±0.3 ³	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0
In-place air voids, %		N/A	±1.0
Laboratory-molded bulk specific gravity		N/A	±0.020
VMA, %, min		Note 4	N/A
Theoretical maximum specific (Rice) gravity	Tex-227-F	N/A	±0.020

1. Contractor may request referee testing only when values exceed these tolerances.
2. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
3. Tolerance between trial batch test results and JMF1 is not allowed to exceed 0.5%, unless otherwise directed. Tolerance between JMF1 and JMF2 is allowed to exceed ± 0.3%.
4. Test and verify that Table 6 requirements are met.

Article 341.4. Construction, Section D. Mixture Design, Section 2, Job-Mix Formula Approval, Section b. Engineer’s Responsibilities, Section (1) Gyrotory Compactor is voided and replaced by the following:

(1) Gyrotory Compactor. For mixtures designed in accordance with Tex-204-F, Part I, the Engineer will use a Department TGC, calibrated in accordance with Tex-914-K, to mold samples for trial batch and production testing. The Engineer will make the Department TGC and the Department field laboratory available to the Contractor for molding verification samples, if requested by the Contractor.

For mixtures designed in accordance with Tex-204-F, Part IV, the Engineer will use a Department SGC, calibrated in accordance with Tex-241-F, to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location. The Engineer will make the Contractor-provided SGC in the Department field laboratory available to the Contractor for molding verification samples.

Article 341.4. Construction, Section E. Production Operations, Section 2. Mixing and Discharge of Materials is supplemented with the following:

When WMA is specified on the plans, produce the mixture and monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 275°F or is less than 215°F. When WMA is specified, the Department will not pay for or allow placement of any WMA produced at more than 275°F or less than 215°F, unless otherwise directed.

Article 341.4. Construction, Section G. Placement Operations is voided and replaced by the following:

G. Placement Operations. Collect haul tickets from each load of mixture delivered to the project and provide the Department’s copy to the Engineer approximately every hour, or as directed by the Engineer. Measure and record the temperature of the mixture as discharged from the truck or material transfer device prior to entering the paver and an approximate station number on each ticket. Unless otherwise directed, calculate the daily and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day. The Engineer may suspend production if the Contractor fails to produce haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 10, unless otherwise shown on the plans or allowed.

Article 341.4. Construction, Section G. Placement Operations, Section 1. Weather Conditions is voided and replaced with the following:

1. Weather Conditions. Place mixture when the roadway surface temperature is equal to or higher than the temperatures listed in Table 10A, unless otherwise approved or as shown on the plans. Measure the roadway surface temperature with a handheld infrared thermometer. The Engineer may allow mixture placement to begin prior to the roadway surface reaching the required temperature requirements if conditions are such that the roadway surface will reach the required temperature within 2 hrs. of beginning placement operations. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

Article 341.4. Construction, Section G. Placement Operations, Section 1. Weather Conditions is supplemented by the following:

**Table 10A
Minimum Pavement Surface Temperatures**

Minimum Pavement Surface Temperatures in Degrees Fahrenheit		
High Temperature Binder Grade	Subsurface Layers or Night Paving Operations	Surface Layers Placed in Daylight Operations
PG 64 or lower	45	50
PG 70	55 ¹	60 ¹
PG 76 or higher	60 ¹	60 ¹

1. Contractors may pave at temperatures 10°F lower than the values shown in Table 10A when utilizing a paving process including WMA or equipment that eliminates thermal segregation. In such cases, the contractor must use either an infrared bar attached to the paver, a hand held thermal camera, or a hand held infrared thermometer operated in accordance with Tex-244-F to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

Article 341.4. Construction, Section G. Placement Operations, Section 3. Lay-Down Operations. The first paragraph is voided and not replaced.

Article 341.4. Construction, Section G. Placement Operations, Section 3. Lay-Down Operations. Table 11 is voided and not replaced.

Article 341.4. Construction, Section I. Acceptance Plan, Section 1. Referee Testing. The second paragraph is voided and replaced with the following:

The Construction Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer's average maximum theoretical specific gravity for the lot. With the exception of "remove and replace" conditions, referee test results are final and will establish pay adjustment factors for the subplot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement pay adjustment factor for any subplot results in a "remove and replace" condition. Sublots subject to be removed and replaced will be further evaluated in accordance with Article 341.6, "Payment."

Article 341.4. Construction, Section I. Acceptance Plan, Section 2. Production Acceptance, Section c. Production Testing. The first paragraph is voided and replaced with the following:

The Contractor and Engineer must perform production tests in accordance with Table 12. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. The Engineer may use asphalt content results from quality control testing performed by the Contractor to determine VMA. Determine compliance with operational tolerances listed in Table 9 for all sublots.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section a. Placement Lot, Section (2) Incomplete Placement Lots is voided and replaced by the following:

(2) Incomplete Placement Lots. An incomplete placement lot consists of the area placed as described in Section 341.4.I.2.a(2), "Incomplete Production Lot," excluding miscellaneous areas as defined in Section 341.4.I.3.a(4), "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production subplot.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section b. Placement Sampling. The third and fifth paragraphs are voided and replaced by the following:

Unless otherwise determined, the Engineer will witness the coring operation and measurement of the core thickness. Unless otherwise approved, obtain the cores within 1 working day of the time the placement subplot is completed. Obtain two 6-in. diameter cores side by side from within 1 ft. of the random location provided for the placement subplot. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer.

Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to ensure that an adequate bond will be achieved during subsequent placement operations. For Type D and Type F mixtures, 4-in. diameter cores are allowed.

If the core heights exceed the minimum untrimmed values listed in Table 10, trim and deliver the cores to the Engineer within 1 working day following placement operations, unless otherwise approved. Trim the bottom or top of the core only when necessary to remove any foreign matter and to provide a level and smooth surface for testing. Foreign matter is another paving layer, such as hot mix, surface treatment, subgrade, or base material. Trim no more than 1/2 in. of material. Do not trim the core if the surface is level and there is not foreign matter bonded to the surface of the core.

Article 341.4. Construction, Section I. Acceptance Plan, Section 3. Placement Acceptance, Section c. Placement Testing is voided and replaced by the following:

c. Placement Testing. Perform placement tests in accordance with Table 12. After the Engineer returns the cores, the Contractor has the option to test the cores to verify the Engineer's test results for in-place air voids. The allowable differences between the Contractor's and Engineer's test results are listed in Table 9.

Article 341.6. Payment. The first paragraph is voided and replaced by the following:

The work performed and materials furnished in accordance with this Item and measured as provided under Article 341.5, "Measurement," will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the type, surface aggregate classification, and binder specified. When shown on the plans, "level up" may be specified. Pay adjustments for bonuses and penalties will be applied as determined in this Item except for level ups where a pay adjustment factor of 1.000 will be assigned for all production and placement sublots. These prices are full compensation for surface preparation, materials including tack coat, placement, equipment, labor, tools, and incidentals.

Article 341.6. Payment, Section A. Production Pay Adjustment Factors is supplemented by the following:

When WMA is specified on the plans, at the Contractor's request the Engineer has the option to assign all sublots a production pay adjustment factor of 1.000. When the Engineer elects to assign all sublots a production pay adjustment factor of 1.000, control mixture production to yield a laboratory-molded density with an absolute deviation no greater than 1.0 percent from the target laboratory-molded density as defined in Table 7 or as shown on plans, as tested by the Engineer. The Engineer may suspend production and shipment of mixture if the laboratory-molded density deviates more than 1.0 percent from the target laboratory-molded density for two consecutive sublots.

Article 341.6. Payment, Section B. Placement Pay Adjustment Factors, Section 2. Placement Sublots Subject to Removal and Replacement is voided and replaced by the following:

2. Placement Sublots Subject to Removal and Replacement. If after referee testing the placement pay adjustment factor for any subplot results in a “remove and replace” condition as listed in Table 15, the Engineer will choose the location of two cores to be taken within 3 ft. of the original failing core location. The Contractor will obtain the cores in the presence of the Engineer. The Engineer will take immediate possession of the untrimmed cores and submit the untrimmed cores to the Materials and Pavements Section of the Construction Division, where they will be trimmed and tested for bulk specific gravity within 10 working days of receipt. The average bulk specific gravity of the cores will be divided by the Engineer’s average maximum theoretical specific gravity for that lot to determine the new pay adjustment factor of the subplot in question. If the new pay adjustment factor is 0.700 or greater, the new pay adjustment factor will apply to that subplot. If the new pay adjustment factor is less than 0.700, no payment will be made for the subplot. Remove and replace the failing subplot. Replacement material meeting the requirements of this Item will be paid for in accordance with this Article.

VIRGINIA

SPECIAL PROVISION COPIED NOTE

WARM MIX ASPHALT (WMA) — At the Contractor's option, Warm Mix Asphalt (WMA) additive or process may be used. When such additive or process is used the following shall apply:

Section 211—Asphalt Concrete of the Specifications is amended as follows:

Section 211.02(h) antistripping additive is amended by adding the following to the second paragraph:

When a warm mix asphalt additive or process, as described in 211.02(i) of the Specifications, is used in lieu of hot mix asphalt in the production of asphalt concrete, the minimum TSR requirement shall be 0.60 for the design and production tests.

Section 211.02—Materials is amended by adding the following:

(k) **Warm Mix Asphalt (WMA)** additives or processes shall be approved by the Department prior to use. Approved materials and processes shall be obtained from in the Department's approved list which is included in the Materials Division's Manual of Instructions.

Section 211.03—Job-Mix Formula is amended to add the following to the first paragraph of (f):

For warm mix asphalt (WMA), SUPERPAVE properties will be determined by the Department and Contractor once the WMA has been allowed to cool to 100 degrees F or less and reheated based on the mix designation in Section 211.03(d)6 of the Specifications.

Section 211.15—Initial Production is amended to replace the first sentence with the following:

At the start of production of a warm mix asphalt, the Contractor shall place no more than 500 tons or up to one day's production as directed by the Engineer at an approved site, which may be the project site, so the Engineer can examine the process control of the mixing plant, the Contractor's placement procedures, surface appearance of the mix, compaction patterns of the Contractor's roller(s), and correlation of the nuclear density device.

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