

# Design and Evaluation of WMA

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## Summary

1. What is Warm Mix Asphalt (WMA)?
2. Why are we shifting to WMA?
3. How do we produce WMA?
4. Implementation
5. WMA/RAP/RAS



## What is WMA



**Asphalt mix that includes a technology which improves the production and placement of conventional asphalt mix at significantly lower temperatures.**

**What is “significant”?**



**275 F** (Production)

**or**

**235 F** (Screed)



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**Why are we shifting to WMA**



# FHWA: Every Day Counts

Identify and Deploy Innovation that:

- Shortens Project Delivery
- Enhances Roadway Safety
- Protects the Environment

WMA identified as an effective, proven, and market ready technology that the FHWA is prioritizing for accelerated use



**Message from the Administrator**

Our society and our industry face an unprecedented set of challenges. Because of our economy, we need to work more efficiently. The public wants greater accountability, to have our work done right, and to have our roads made safer. And we have an obligation to help preserve our planet for future generations.

But it's not enough to simply address those challenges. We need to do a little more, a little better. It's that quality—exactly what the title to our initiative, Every Day Counts (EDC).

EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment.

These goals are worth pursuing for their own sake. But in challenging times, it's imperative we pursue better, faster, and smarter ways of doing business.

EDC is designed to focus on a finite set of initiatives. These from the Federal Highway Administration will work with our state, local, and industry partners to deploy the initiatives and will develop performance measures to gauge their success.

The first round of initiatives described in the following pages represent what I hope will lead to a sea change in the way we do things. As you see represented in the EDC logo, it's about taking effective, proven and market-ready technologies and putting them into widespread use. By advancing 21st-century solutions, we can improve safety, reduce congestion and keep America moving and competitive.

**Shortening Project Delivery**

The sooner we can deliver projects, the sooner the public can enjoy their benefits. To deliver projects more quickly, FHWA will help the highway community make more use of innovative practices. We've put together a toolkit that includes ideas for using Best Practices in the bid and awarding efforts in the planning and environmental review process. We are also recommending that States make innovative contracting practices the standard way of doing business.

**EDC Initiatives**

We've organized EDC around three pillars. One is an internal effort to make FHWA a greater Agency and reduce our carbon footprint. The other two are directly related to our work on America's highway system.

**Accelerating Technology and Innovation Deployment**

Every Day Counts is not about meeting the need. "The thing" is about taking effective, proven and market-ready technologies and putting them into widespread use. By advancing 21st-century solutions, we can improve safety, reduce congestion and keep America moving and competitive.

**Secretary Lohnes has set the bar high at USDOT. He not only expects us to think innovatively, he understands the times demand it. Every Day Counts is FHWA's effort to provide National leadership in the quest to meet the transportation demands of the 21st Century.**

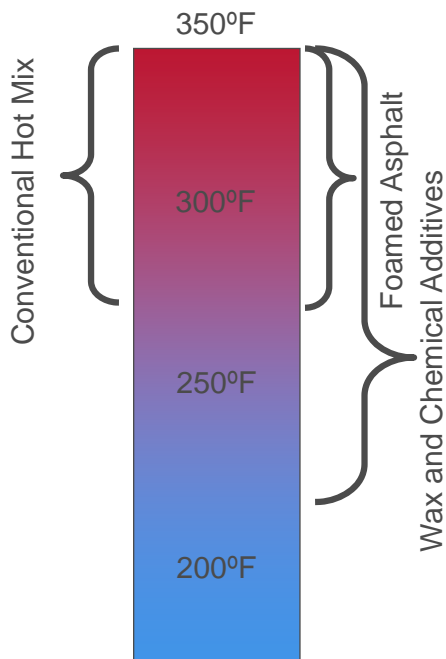
**Vicki Hester, FHWA Administrator**



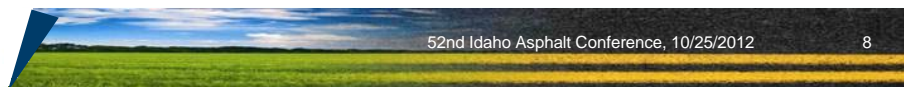
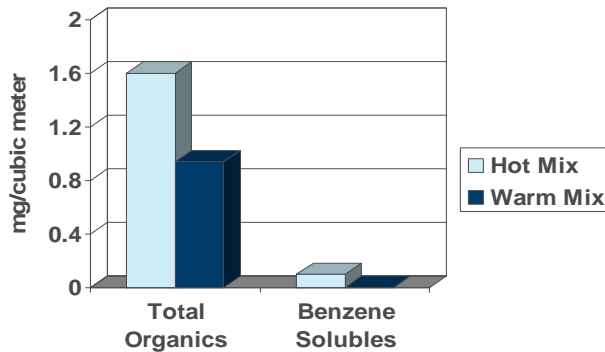
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## WMA Production Temperature Range



Every 10°degrees increase of temperature doubles exposure to asphalt fumes – BP



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# PERFORMANCE!!!

## Improvements in mix performance

- Increase use of modified binders
- Increase use of coarse mixes
- Required density

## Changes in lane closure requirements

- Night Paving
- Take a chance in cool temps



Improved Compaction = Improved Performance !!!

# Constructability

Utilizes existing asphalt paving equipment and methods

Improved Compaction

Improved Workability

Reducing RISK!!!



# Cold Weather Paving

New York City,  
8 Dec. 08,  
40% RAP PG 64-22



**EVO THERM**  
WARM MIX ASPHALT TECHNOLOGY

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## How do we produce WMA

**MWV**  
**EVO THERM**  
WARM MIX ASPHALT TECHNOLOGY

# Production BMPs

Dry the Rock!!!

To maximize energy savings:

- Tune burner and adjust drum flights to efficiently operate at lower temperatures
- Maintain baghouse temperature above condensation point



## Warm Mix, 2012

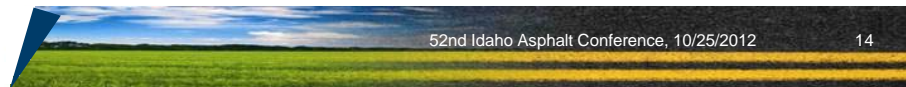
### 30+ Warm Mix Technologies

Foam warm mixes  
Wax warm mixes  
Chemical (surfactant) warm mixes

### Differences

WMA Mechanism  
Effective temperature range  
Track record of performance

How many can you name?





## WMA Implementation



### In the Beginning...

Existing HMA mix designs (drop-in technology)

What can WMA do?

How do we evaluate WMA?

Can we utilize existing specs and tests?



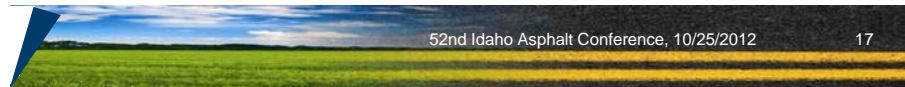


# NCHRP Projects Results in WMA Design Considerations



Published in Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 32nd Edition, 2012

Appendix to AASHTO R35 with commentary “*Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)*”

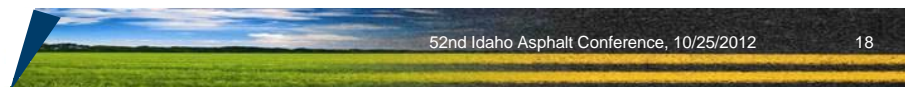


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## HMA – WMA Comparison

ITEM	HMA	WMA
OBC	AASHTO M323	AASHTO M323
Gradation	Std Spec	Std Spec
Aggregate	Std Spec	Std Spec
Binder Type	Std Spec	Std Spec
Specimen Prep	Std Spec	<b>Technology Specific</b>
Mixing Compaction Temperature	Viscosity/Binder	<b>Field Targets, Coating, &amp; Compactability</b>
Moisture Sensitivity	Std Spec	Std Spec
Rutting	APA, Hamburg, Flow	APA, Hamburg, Flow



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# WMA Technology – Which One?

Contractor Selection

“Approved” Technology Lists?

Technology capabilities (target production and compaction temperatures)

## •Categories:

### • By Process:

- Additive to Binder
- Additive to Mix
- Wet Aggregate
- Foam Asphalt

### • By Type

- Chemical Additive
- Wax Additive
- Mineral Additive
- Mechanical Foam



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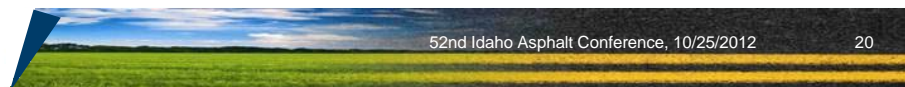
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## Mixing/Compaction/Conditioning

Mixing Temperature: Use anticipated field production temperature

Compaction Temperature: Use anticipated field compaction temperature

Conditioning: 2 hours at compaction temp



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# Compactability



Compact specimens to  $N_{des}$  (1) at field compaction temperature and (2) at 54F (30C) below field compaction temperature

Determine number of gyrations for 92% relative density

OK if  $N_{92(t-30)} / N_{92t} < 1.25$



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## WMA/RAP/RAS



# WMA and RAP/RAS

Does RAP/RAS binders blend with virgin binders at WMA temperatures?

Is it necessary to adjust the virgin binder grade when WMA includes high percentages (>25%) RAP?

# RAP Binders



**NCHRP 9-43 findings**

**Binder grading**

**PG82-xx to PG100-xx**

**Field compaction temps**

**180F to 212F**

**within WMA ranges**

# WMA Helps Increase in RAP Percentage

	WMA 35% RAP	HMA 20% RAP
Penetration	28	29
Viscosity	23,500	25,900
Ductility	42	38
DSR @ 64 C	7.56	7.35
MSCR	32	26
DSR @ 70 C	3.49	3.48

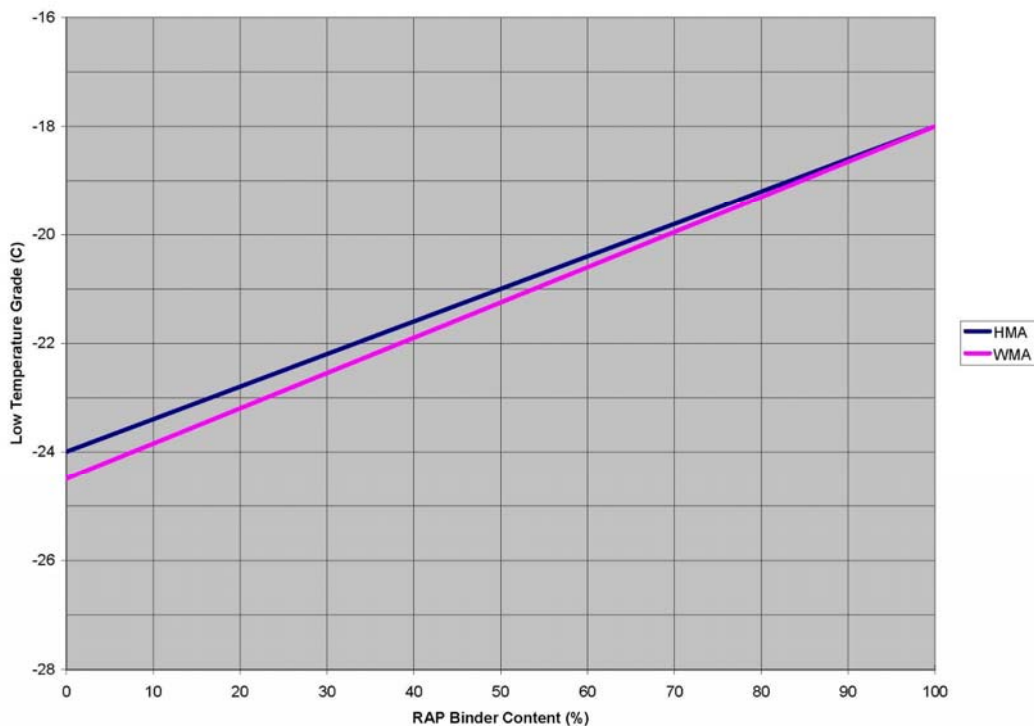
I-44 in Eureka, MO near St. Louis

12.5-mm Superpave mix with  
PG70-22 binder

Increased RAP content while  
maintaining mix properties.

Excellent workability in the lab  
and in the field.

Low Temperature Improvement for Blending Chart

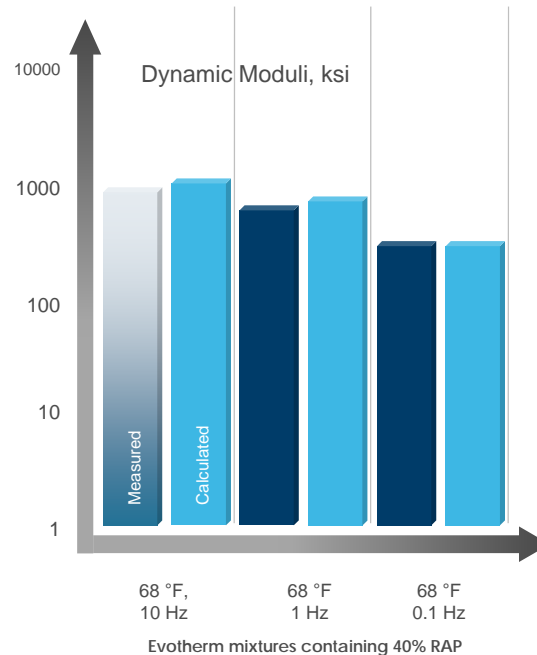


# Blending of RAP and Virgin Asphalt

Thorough blending of virgin and RAP binders is important, especially when high levels of RAP are used.

WMA mix formulations containing various high percentages of RAP were evaluated in MWV's Asphalt Innovations laboratory

- Dynamic moduli were measured with an AMPT and calculated using the Hirsch model protocol.
- Thorough blending of the RAP binder and virgin binder was observed.
- Excellent correlation between measured and calculated values was shown.



# Asphalt Mixture Performance Tester (AMPT)

AKA the "Simple Performance Tester"

- Product development
  - High RAP/RAS chemistries
  - Processing aides (rubberized mixes)
- Added value to contractor
  - Increase RAP without grade-dump using warm-mix
  - Prove effective blending at lower temperatures
- Sample prep per AASHTO PP60
- Tested per AASHTO PP61



# Hirsch Equation

$$|E^*| = f(VMA, VFA, G^*)$$

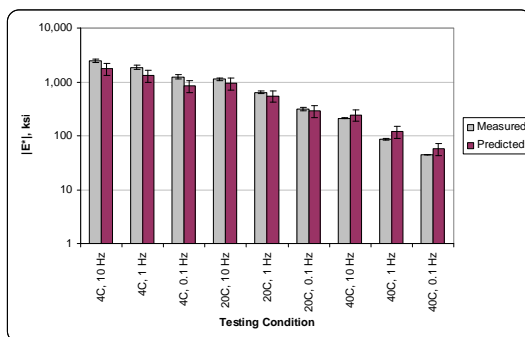
## Maryland Example: RAP Blending?

MixType:

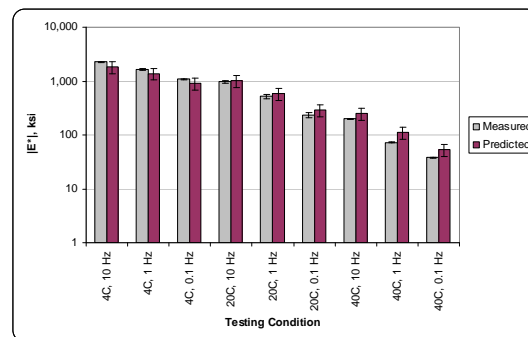
AC: 5.3%

RAP: 32%

PG 64-22

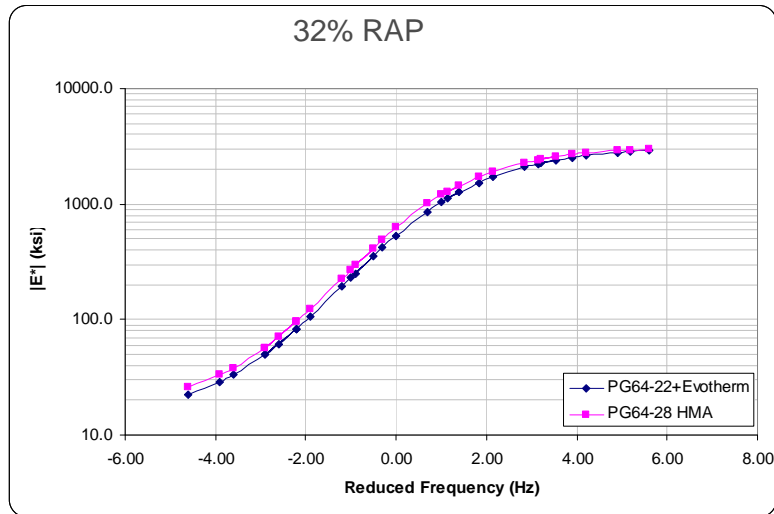


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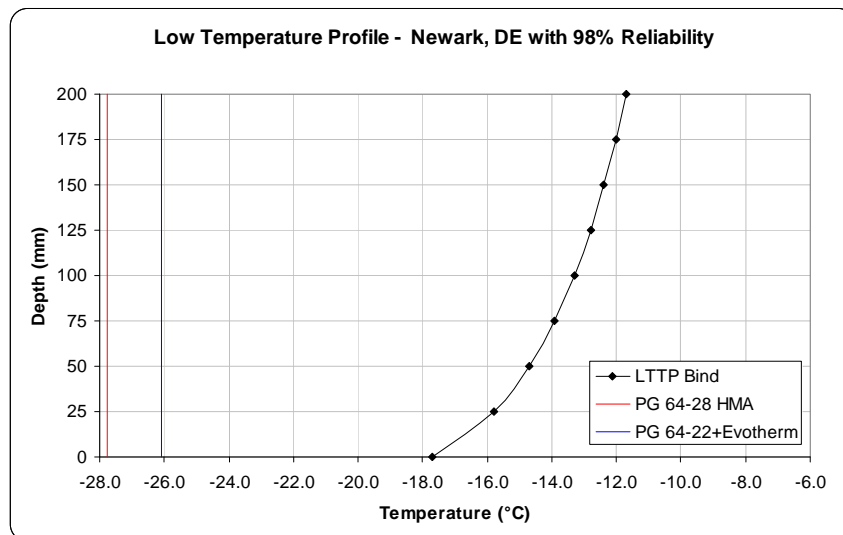


PG64-22 EVT

# Master Curve Comparison



# Binder Grade Check



Recovered binder evaluated per AASHTO R29





## Conclusion



## Conclusions

**The future of asphalt paving is available TODAY!!!**

**Properly condition materials prior to testing**

**Adequate binder blending occurs at WMA temperatures**

**High RAP mixes produced at WMA temperatures do not require a change in virgin binder grade**

**Thank you!**



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