



Asphalt Materials for Airfield Pavements

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Overview

- Introduction
- Asphalt Binder
- Material Considerations for FAA Item P-401 “G”
- Future?

 U.S. Department of Transportation Federal Aviation Administration		Advisory Circular
Subject: Standards for Specifying Construction Of Airports	Date: 9/30/2011 Initiated by: AAS-100	AC No: 150/5370-10F Change: NA
1. PURPOSE. This advisory circular (AC) provides standards for the construction of airports. Items covered in this AC include general provisions, earthwork, flexible base courses, rigid base courses, flexible surface courses, rigid pavement, fencing, drainage, turfing, and lighting installation. 2. APPLICATION. The Federal Aviation Administration (FAA) recommends the guidelines and specifications in this AC for materials and methods used in the construction of airports. In general, use of this AC is not mandatory. However, use of this AC is mandatory for all projects funded with federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, "Policies, Standards, and Specifications," and PFC Assurance No. 9, "Standards and Specifications." 3. CANCELLATION. This AC cancels AC 150/5370-10E, Standards for Specifying Construction of Airports, dated September 30, 2009. 4. PRINCIPAL CHANGES. This AC contains the following changes: a. Document page numbers reformatting and section number/title added to bottom of each page to facilitate searching document. Tables reformatting for clarity. Minor text edits for grammar, punctuation and acronyms throughout the AC. b. Page iii and Page i: Deleted information on obtaining printed copies of advisory circular. c. Paragraph 40-09 Final Clean Up renumbered as 40-08. d. Paragraph 50-03: Added statement about discrepancies within cited standards for testing occurring and the contractor's responsibility to bring any apparent discrepancy within standard test methods to the engineers attention. e. Paragraph 60-01, a and b: Added the Addendum and clarified manufacture statement. f. Paragraph 90-06 PARTIAL PAYMENTS replaced with new Subsection 90-06 to be consistent with the Disadvantaged Business Enterprise (DBE) retention provision requirements of 49 CFR § 26.29. g. Paragraph 90-08 PAYMENT OF WITHHELD FUNDS revised to reflect changes made to Subsection 90-06 PARTIAL PAYMENTS. h. Section 120: Updated Nuclear testing method. Deleted ASTM D 2922 Density of Soil in Place by the Nuclear Density Method. Added ASTM D 6938 In-Place Density and Water Content of Soil and		



FAA P-401 G

- **401-2.3 Asphalt cement binder.** Asphalt cement binder shall conform to ASTM D6373 Performance Grade (PG) [___]. A certificate of compliance from the manufacturer shall be included with the mix design submittal.
 - The supplier's certified test report with test data indicating grade certification for the asphalt binder shall be provided to the Engineer for each load at the time of delivery to the mix plant.



Binder Selection for Airfield Pavements

PG Selection – General Concepts

- Correct binder grade needs to be specified to obtain optimum mixture performance
- Determine grades that are available and typically being used for particular area from local authorities and/ or AI binder spec database (www.asphaltinstitute.org)
- In theory, PG system is blind to modification (modified or not, and type of modification)
 - Some states use straight PG system
 - Other states use PG-Plus tests to ensure type and amount of modification



P-401 G - PG Guidance

- P-401 G references AI MS-26 *The Asphalt Binder Handbook*.
- “Base” grade determined as grade used by state DOT for the specific project location, for Interstate Highways (no grade bump).
- “Grade bump” (high temp side only) from “base” grade per **Table A** for top 5 inches of pavement.

Grade Bumping Guidance

P-401 G, Table A

Aircraft Gross Wt. (pounds)	High Temperature Adjustment to Base Binder Grade
	All Pavement Types
$\leq 12,500$ lbs	---
$< 100,000$ lbs	1 Grade
$\geq 100,000$ lbs	2 Grades

P 401 / P-403 Table A - NOTES

- PG grades above a -22 on the low end (e.g., PG XX-16 or PG XX-10) are not recommended. Limited experience has shown an increase in block cracking with -16 or -10 grade asphalts.
- Typically, when the PG spread between the high and low temperature is 92 or more, the asphalt cement binder has been modified. A PG Plus Test will be required to determine if the asphalt cement binder has been properly modified. Use the PG Plus Test found in the Asphalt Institute's State Binder Specification Database for the project location. When a State does not specify a PG Plus Test, use ASTM D6084 with a minimum elastic recovery of 70%.



Example

**Select PG grade for taxiway project at Denver
Airport, Colorado
(> 100,000 lb aircraft) using
AI State Binder Spec Database and state highway
dept reference, using P-401 G guidance**

AI Binder Spec Database

- Summary document for each of 50 States:
 - Standard template
 - PG testing requirements on page 1
 - PG-Plus test requirements on page 2
 - Lists
 - Typical grades used
 - Test methods and criteria
 - Any exclusions, required modification methods, etc
 - Agency contact
 - Website for actual spec
 - Kept current and available at:
 - www.asphaltinstitute.org



Screenshot – AI Public Homepage



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Events

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04/18/2013

[Principle of Quality HMA Pavement Construction Seminar - Philadelphia, PA](#)

04/22/2013

Asphalt magazine

ASPHALT



State Binder Specification Database

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[See also our State Emulsion Spec Database](#)

State Binder Specification Database

Description: The Asphalt Institute and PRI Asphalt Technologies have collaborated to develop this binder specification database. Available below (as downloadable pdf files) are individual documents for each of the 50 State highway agencies which summarize their respective asphalt binder specifications. A standardized format is used to list the PG requirements as well as PG-Plus requirements for grades listed in that State's specifications. Notes are included for additional details. Other information includes the State website where the specifications can be found, the State contact person, specification exclusions, descriptions, etc.

Updating: AI will periodically contact the Binder or Materials Engineer listed on the document to review the information for accuracy. Date of this last review is included. Corrections or comments may be e-mailed to us by using the link below. Changes will only be made after confirmation by the individual listed for that State.

Disclaimer: While care has been taken to provide the most accurate and current information, users are warned that there may be inaccuracies and recent specification revisions may not be reflected. **To ensure the most accurate information, the particular State agency should be contacted. In addition, this compilation of information should not infer an Asphalt Institute endorsement for any of the specifications or requirements listed.**

[Fill out the form for corrections or comments.](#)

The specifications for performance Graded (PG) asphalt binders are given by AASHTO M 320 or ASTM D6373. [Summary of the standard PG testing and criteria](#) (3mb PDF). All specs are in Adobe PDF format.

Alabama	Alaska	Arizona	Arkansas	California
Colorado	Connecticut	Delaware	Florida	Georgia
Hawaii	Idaho	Illinois	Indiana	Iowa
Kansas	Kentucky	Louisiana	Maine	Maryland
Massachusetts	Michigan	Minnesota	Mississippi	Missouri
Montana	Nebraska	Nevada	New Hampshire	New Jersey
New Mexico	New York State	North Carolina	North Dakota	Ohio
Oklahoma	Oregon	Pennsylvania	Rhode Island	South Carolina

Colorado DOT Binder Spec Summary Sheet

State: COLORADO	Materials: Re: Section 702 SUPERPAVE PG Binders, CDOT's Standard Specifications for Road & Bridge Construction
Date Last Reviewed: 5/8/12	Web Address: www.colorado.gov
Materials Engineer:	Contact Info:

ASPHALT BINDER:

702.01 (b)	Description:	Supplier must be certified in accordance with CP 11. Samples of PG Binder for acceptance shall be sampled on the project as stated in the Schedule of Field Materials Manual.
702.01 (a)	PMA's	None stated.
	Exclusions:	Asphalt shall not be Acid or Alkaline modified. Shall not contain any used oils that have not been re-refined or reprocessed. No modifiers shall be added that do not comply with Environmental rules and regulations including 40 CFR Part 261.6(a)(3)(v) and 266/Subpart C. Modifiers shall not be carcinogenic.

PROPERTY		Test Method AASHTO or Other	Requirements by Performance Grade, PG (Common Grades)					
			58-28	58-34	64-22	64-28	70-28	76-28
ORIGINAL:								
Flash Point, °C		T 48	230 min.					
Rotational	135°C	T 316	3.0 max.					
Dynamic Shear, kPa (G* /sin *, 10 rad./sec.)	At grade temperature	T 315	1.0 min.					
RTFOT RESIDUE:								
Mass Loss, %		CP-L	1.0 max.					
Dynamic Shear, kPa (G* /sin *, 10 rad./sec.)	At grade temperature	T 315	2.2 min.					
PAV RESIDUE:		R 28	100°C; 20 hrs; 300 psi					
Dynamic Shear, kPa (G* • sin *, 10 rad./sec.)	At test temperature	T 315	5,000 max.					
			19°C	16°C	25°C	22°C	25°C	28°C
Creep Stiffness	At test		Stiffness 300 max. MPa & m Value 0.300 min.					

Colorado DOT Binder Spec

Summary Sheet

PROPERTY		Test Method AASHTO or Other	Requirements by Performance Grade, PG (Common Grades)					
			58-28	58-34	64-22	64-28	70-28	76-28
ORIGINAL:								
Flash Point, °C		T 48	230 min.					
Rotational	135°C	T 316	3.0 max.					
Dynamic Shear, kPa (G* /sin *, 10 rad./sec.)	At grade temperature	T 315	1.0 min.					
RTFOT RESIDUE:								
Mass Loss, %		CP-L	1.0 max.					
Dynamic Shear, kPa (G* /sin *, 10 rad./sec.)	At grade temperature	T 315	2.2 min.					
PAV RESIDUE:		R 28	100°C; 20 hrs; 300 psi					
Dynamic Shear, kPa (G* • sin *, 10 rad./sec.)	At test temperature	T 315	5,000 max.					
			19°C	16°C	25°C	22°C	25°C	28°C
Creep Stiffness	At test temperature	T313	Stiffness 300 max. MPa & m Value 0.300 min.					
			-18°C	-24°C	-12°C	-18°C		
Direct Tension ¹ , °C, 1 mm/min., where failure strain > or =	At test temperature	T314	-18°C	-24°C	-12°C	-18°C		
PG PLUS REQUIREMENTS: YES								
ORIGINAL:								
Ductility, (5 cm/min.),	4°C	T 51	--	--	--	50 min.	--	--
Toughness & Tenacity	Toughness, 25°C Tenacity,	CP-L 2210	--	--	--	110 min.	--	--
			--	--	--	75 min. (8.5)	--	--
Acid or Base Modification ²		CP-L	Pass					
RTFOT PROPERTIES:								
Elastic Recovery, %	25°C	T 301	--	--	--	--	50 min.	
Ductility, cm (5		T 51	--	--	--	20 min, 4°C.		--
Notes: Notes: 1. Direct tension measurements are required when needed to show conformance to AASHTO M 320 2. The Department will test for acid and alkaline modification during binder certification process. Thereafter, the Department will randomly test for acid and alkaline modification.								

Checking with CDOT, PG 64-22 is standard base grade for the Denver area.

Now Grade Bump per Table A in P-401

Aircraft Gross Wt. (pounds) (pounds)	High Temperature Adjustment to Base Binder Grade
	All Pavement Types
$\leq 12,500$ lbs	---
$< 100,000$ lbs	1 Grade
$\geq 100,000$ lbs	2 Grades

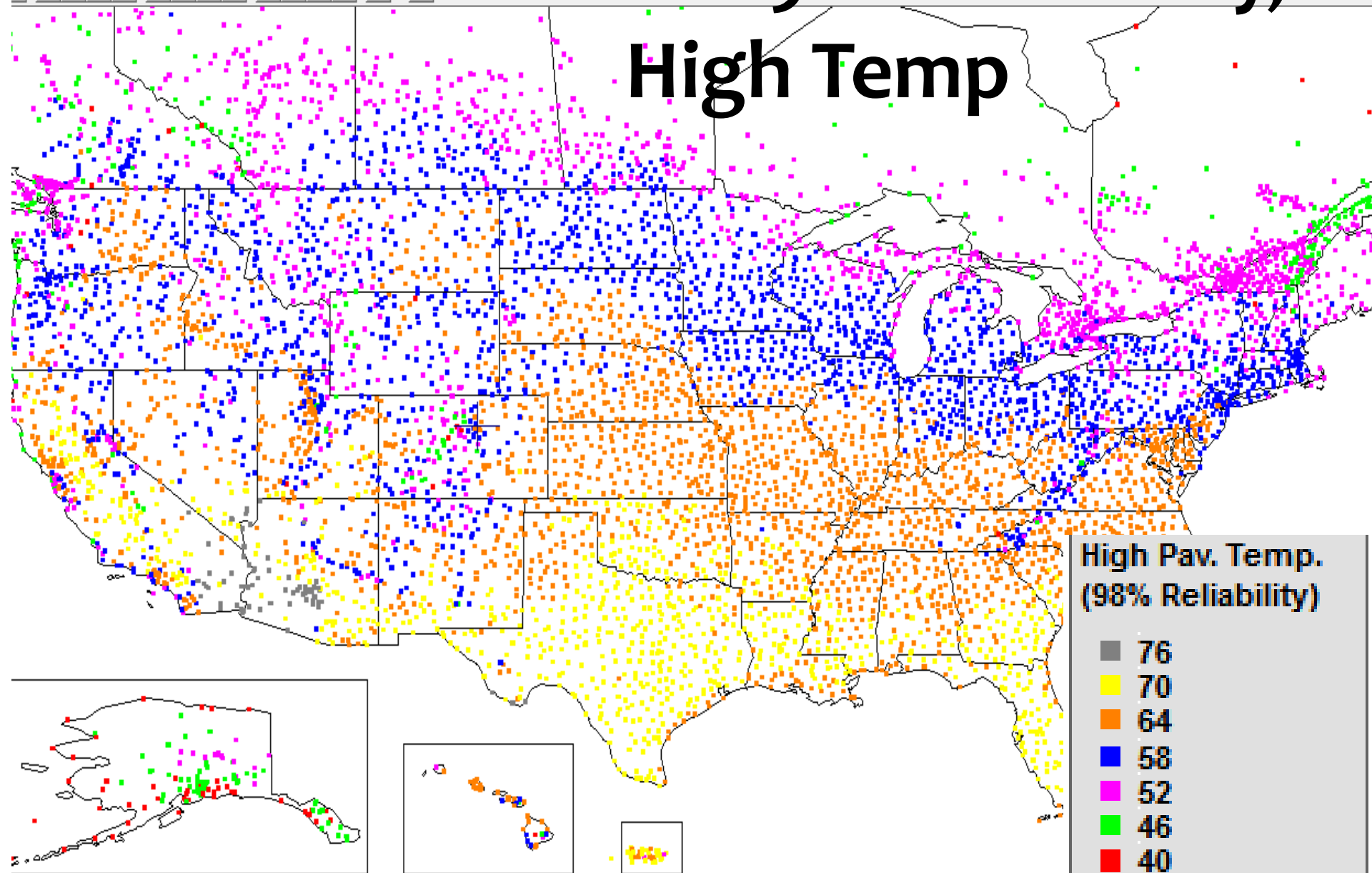
Bump from 64-22 to 76-22



Similar Example

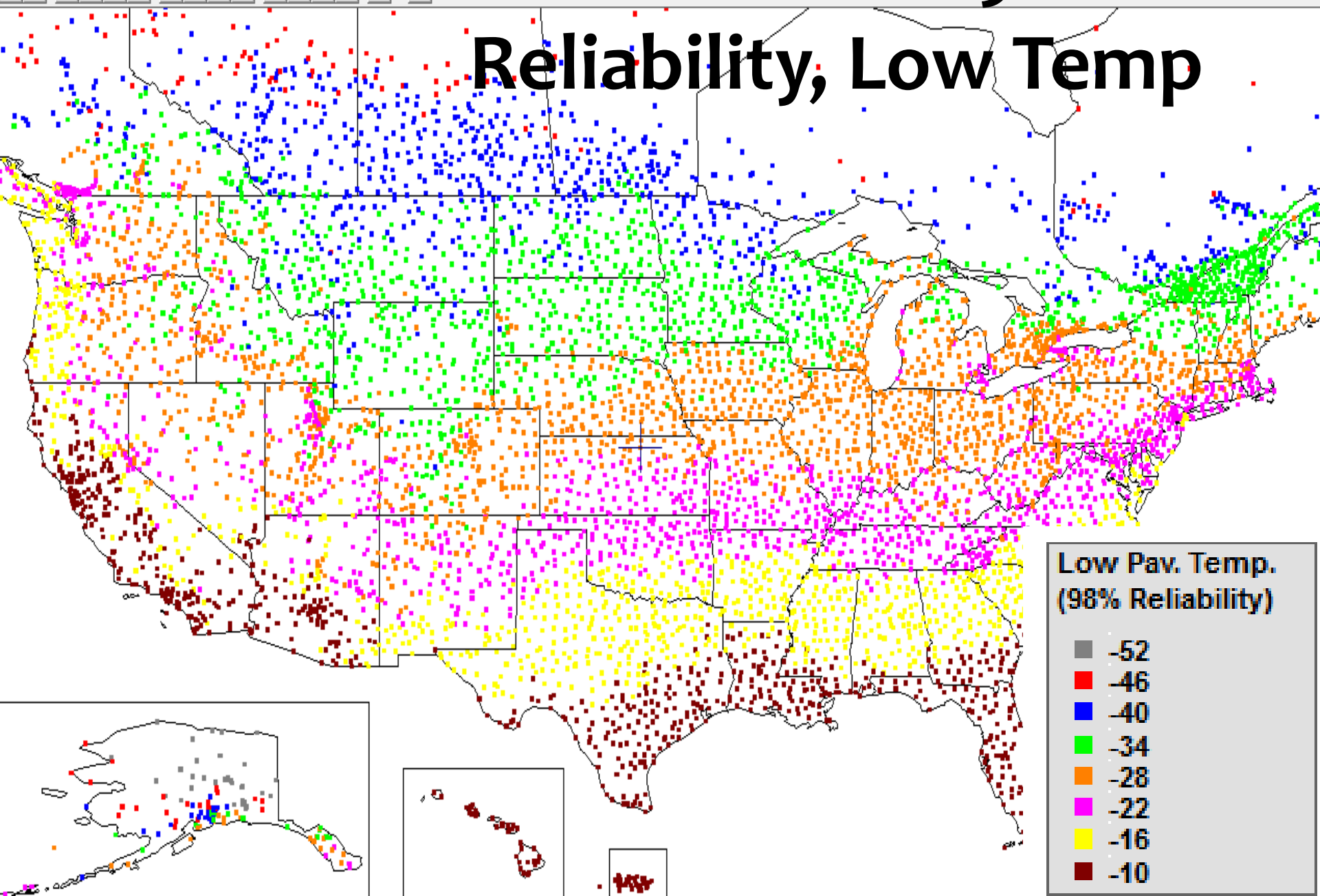
Select PG grade for same project, but now use LTPPBind software (@ 98% reliability) to determine base binder grade

LTPPBind - 98% Reliability, High Temp



LTPPBind - 98%

Reliability, Low Temp



LTPPBind – Denver Airport Weather Station

Report - 170 Selected Weather Stations

State/Province: CO

Weather Station: DENVER STAPLETON AP

Station ID	CO2220	Latitude	39.77
County / District	DENVER	Longitude	104.87
Last Year Data Avail.	1997	Elevation, m	1496

Air Temperature	Mean	Std Dev	Min	Max	Years
High Air Temperature, Deg. C	34.7	1.3	31	38.1	35
Low Air Temperature, Deg. C	-24.3	3.4	-31.5	-19.5	35
Low Air Temp. Drop, Deg. C	29.8	2.8	24	36	35
Degree Days over 10 Deg. C	2910	187	2452	3352	35

Pavement Temperature and PG	HIGH	LOW	High Rel	Low Rel
Pavement Temperature, C	55.8	-16.6	50	50
50% Reliability PG	58	-22	97	95
>50% Reliability PG	58	-28	97	98
=	64	-28	98	98
=				
=				
=				

? PG Chart PG Distribution Save Cancel

LTPPBind – Denver Airport

Pavement Temperature and PG	HIGH	LOW	High Rel	Low Rel
Pavement Temperature, C	55.8	-16.6	50	50
50% Reliability PG	58	-22	97	95
>50% Reliability PG	58	-28	97	98
=	64	-28	98	98
=				
=				

- For 50% reliability (not conservative: binder contributes to failure every other year at both high and low ends), the “true” grade necessary is PG 55.8 -16.6 (but must be in 6° increments).
- The “standard” grade of PG 58-22 gets high temp reliability to 97% and low temp reliability to 95%.
- If engineer wants above 98% reliability on both ends (typical), then need PG 64-28.

Now Grade Bump per Table A in P-401

Aircraft Gross Wt. (pounds) (pounds)	High Temperature Adjustment to Base Binder Grade
	All Pavement Types
$\leq 12,500$ lbs	---
$< 100,000$ lbs	1 Grade
$\geq 100,000$ lbs	2 Grades

Bump from 64-28 to 76-28



Summary – Binder Selection

- **Selecting the correct PG binder is critical to ensure pavement performance**
- **Guidance in P-401 G**
 - **Determine “base grade”, then bump high temp side per Table A to address tougher loading conditions**
 - **Two methods for determining “base grade”**
 - **Consult with Local DOT**
 - **LTPPBind software**
 - **Make sure binder grade is available locally**



Modified Binders

- Unmodified (neat) binders often adequate for low to moderate climates and light loading situations
- Modified binders often needed for more severe climates and/or heavier loading conditions
 - More expensive but improved performance
- Various types of modification types, including polymers (elastomers and plastomers) and chemicals

Guidance on Modified Binders

- Typically, when the PG spread between the high and low temperature is 92 or more, the asphalt cement binder has been modified. **A PG Plus Test will be required to determine if the asphalt cement binder has been properly modified.** Use the PG Plus Test found in the **Asphalt Institute's State Binder Specification Database** for the project location. **When a State does not specify a PG Plus Test, use ASTM D6084 with a minimum elastic recovery of 70%.**

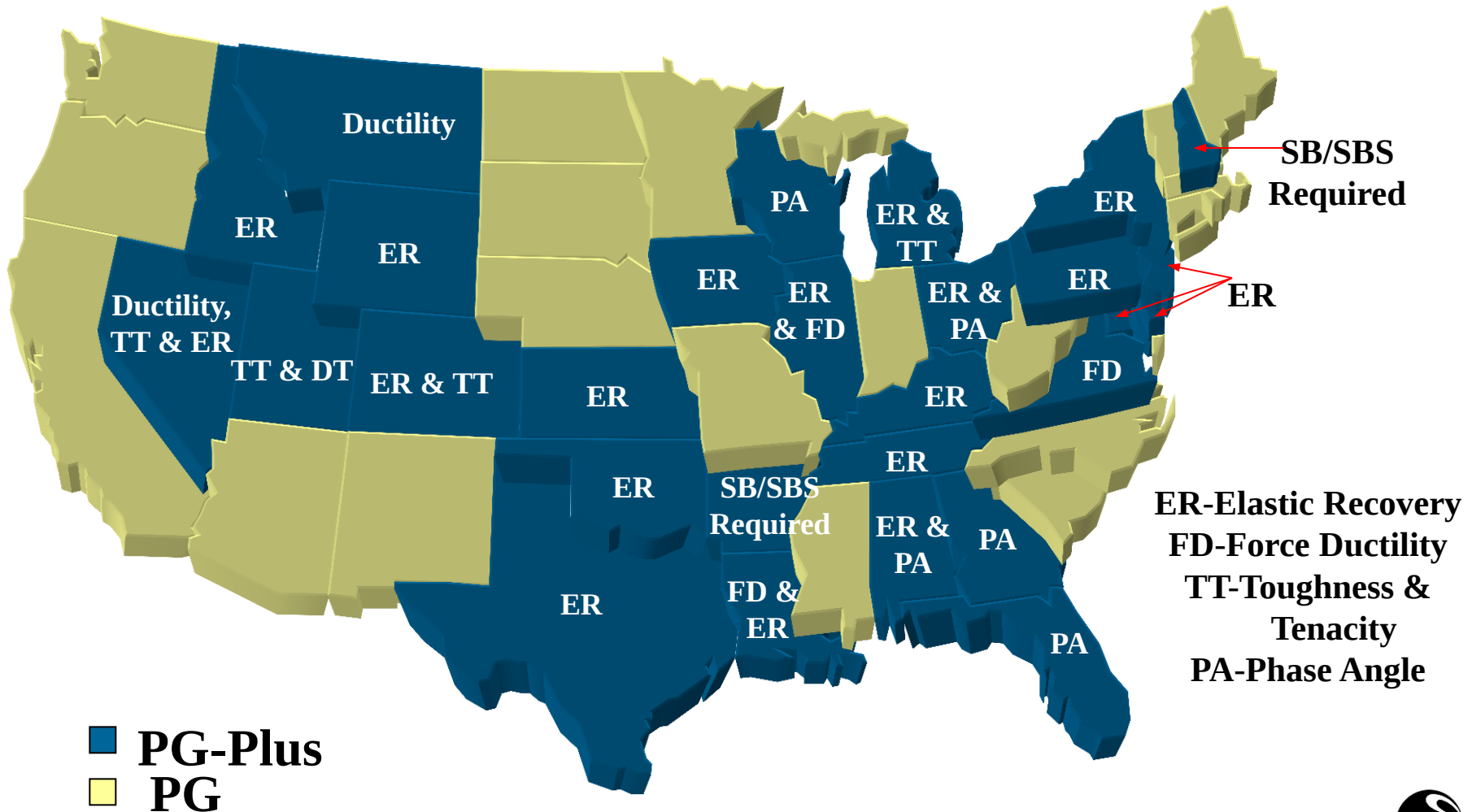


Polymer Modified Asphalt (PMA)

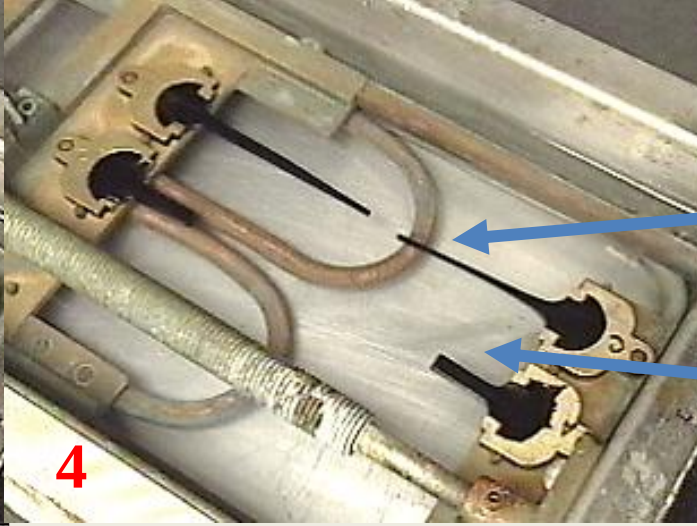
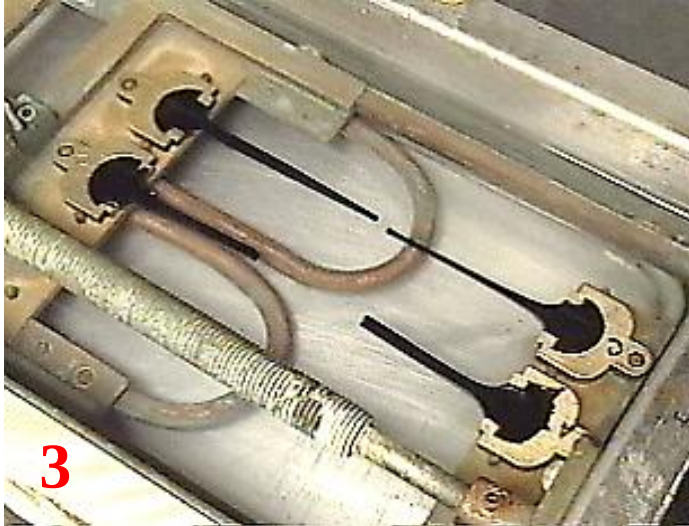
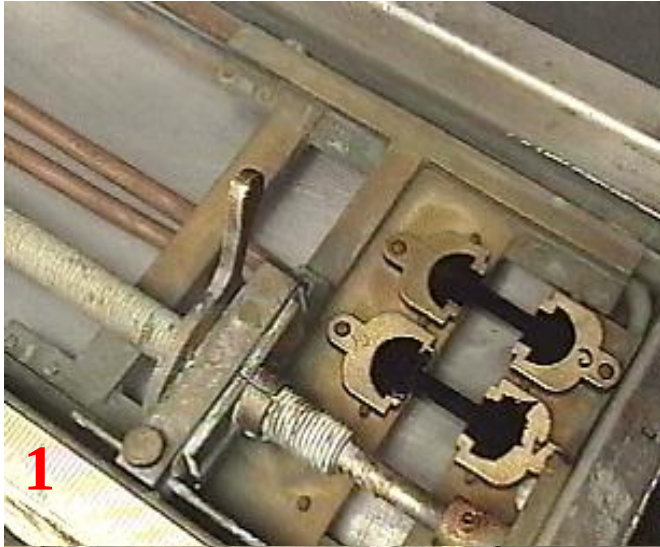
- The purpose of a “PG Plus” test is to ensure the presence of elastic modifiers and a minimum level of elastomeric behavior
- Typical PG Plus tests:
 - Elastic Recovery—ASTM 6084
 - Phase Angle
 - Ductility / Toughness and Tenacity



State DOTs Specifying PG-Plus to Ensure Presence of Polymer



Elastic Recovery Test Method



*Neat doesn't
recover*

*Modified
recovers*

Material Considerations in P-401 G

- Item P-401 Plant Mix Bituminous Pavement
- Item P-403 Hot-Mix Asphalt (HMA) Pavements (Base, Leveling or Surface Course)
 - In both specifications, the use of the Gyratory Compactor for design of HMA is a “tailoring option” that is available to all engineers on all projects. The AC contains no limitations to the use of Gyratory mixes on airport projects.

Material Considerations in P-401 G

This specification contains options for both Marshall and Gyratory Mix Design Methods. The Engineer shall select the options for the selected mix design method.



Choose Mix Design Method

401-3.2 Job mix formula (JMF). No hot-mixed asphalt (HMA) for payment shall be produced until a JMF has been approved in writing by the Engineer. The asphalt mix-design and JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.4. The HMA shall be designed using procedures contained in [___].

Marshall

Asphalt Institute MS-2 Mix Design Manual, 7th Edition. ASTM D6926 shall be used for preparation of specimens using the manually held and operated hammer for the mix design procedure. ASTM D6927 shall be used for testing for Marshall stability and flow.

If material variability exceeds the standard deviations indicated, the JMF and subsequent production targets shall be based on a stability greater than shown in Table 1 and the flow shall be targeted close to the mid-range of the criteria in order to meet the acceptance requirements.

Gyratory

Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared at various asphalt contents and compacted using the gyratory compactor in accordance with ASTM D6925.



Marshall Criteria, P-401 Table 1

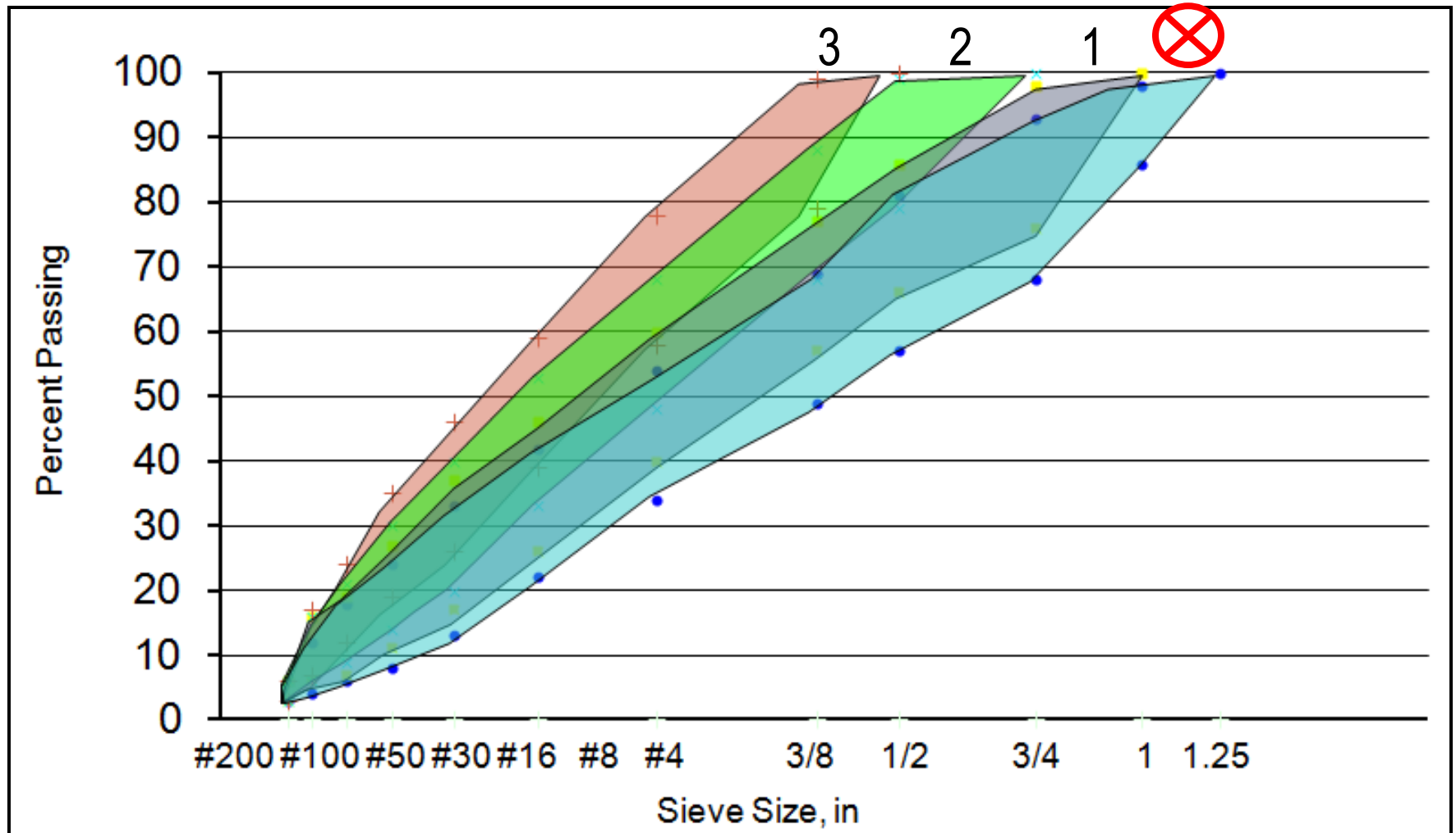
Test Property	Gross Wt $\geq$ 60 kips or Tire Pressures $\geq$ 100 psi	Gross Wt $<$ 60 kips or Tire Pressures $<$ 100 psi
No. of Blows	75	50
Stability, lbs (min)	2150	1350
Flow, 0.01 in	10 - 16	10 - 18
Target Air Voids, %	3.5	3.5



Mixture Criteria, P-401 Table 2

Maximum Particle Size	Minimum VMA
Gradation 3	16 %
Gradation 2	15 %
Gradation 1	14 %

P-401(G) Gradation Bands



Gyratory Criteria, P-401 Table 1

Test Property	Gross Wt $\geq$ 60 kips or Tire Pressures $\geq$ 100 psi	Gross Wt $<$ 60 kips or Tire Pressures $<$ 100 psi
No. of Gyrations	75	50
Target Air Voids, %	3.5	3.5

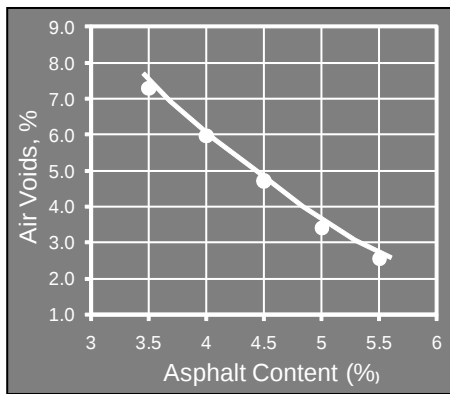
Mixture Criteria, P-401 Table 2

Maximum Particle Size	Minimum VMA
Gradation 3	16 %
Gradation 2	15 %
Gradation 1	14 %

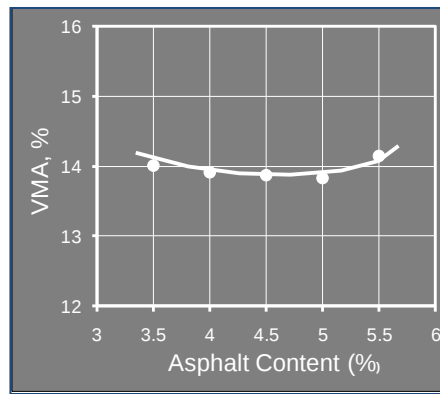
Interpretation of Gyratory Test Data

Plot averages vs. asphalt content

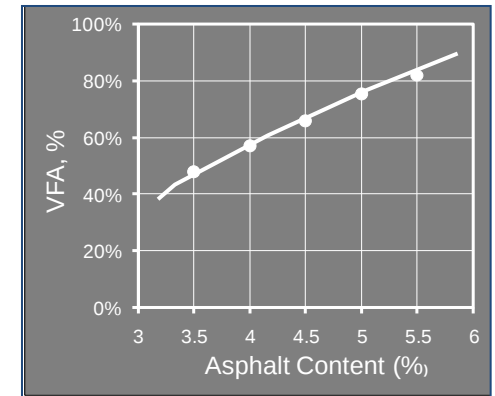
V_a



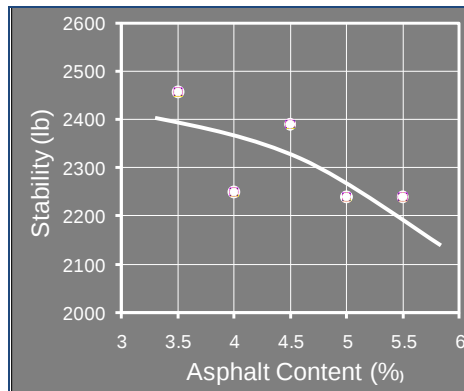
VMA



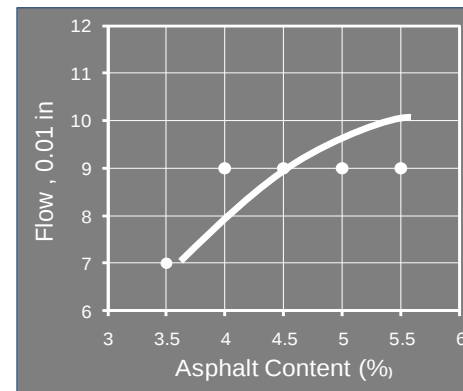
VFA



Stability



Flow



Moisture Sensitivity

- ASTM D 4867
 - 6 specimens compacted to 6 - 8% air voids
 - 3 conditioned and 3 unconditioned
 - Conditioned specimens
 - 55 to 80 percent saturation
 - Freeze-thaw cycle
 - 24 hour soak in 60°C water bath
 - Cooled to 25°C and broken on IDT Tester
 - Unconditioned specimens
 - Left undisturbed until broken on IDT Tester
- $TSR \geq 75\%$
 - If less, try adding LAS, hydrated lime or changing aggregate/binder combination



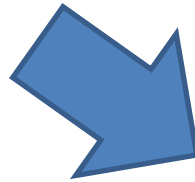
Reclaimed Asphalt Pavement

Engineer will determine if RAP is/is not allowed and make appropriate selection.

RAP should not be used for surface mixes, except on shoulders. It can be used very effectively in lower layers or for shoulders. Engineer to specify the maximum percentage of reclaimed asphalt allowed in the mix. The amount of RAP shall be limited to 30%, as long as the resulting recycled mix meets all requirements that are specified for virgin mixtures. The Contractor may obtain the RAP from the job site or an existing source.



2014



20XX?



Asphalt Materials for Airfield Pavements



Photo Courtesy Steve Muench

Thank You!

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PAVEMENT SERVICES, INC.

