Airport Asphalt Pavement Technology Program

# Guidance for Selection of Proper Asphalt Binder Grade

## Final Report

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The Airport Asphalt Pavement Technology Program (AAPTP) is a cooperative agreement effort between the **National Asphalt Pavement Association** (NAPA) and the **Federal Aviation Administration** (FAA) to advance asphalt pavements and pavement materials. The AAPTP advances solutions for asphalt pavement design, construction, and materials deemed important to airfield reliability, efficiency, and safety. The program leverages NAPA's unique technology implementation capabilities with assistance from the FAA and industry to advance deployment and adoption of innovative asphalt material technologies.

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## Table of Contents


Introduction ..... 1

Chapter 1. Standard Asphalt Binder Grades Database Development ..... 2

Chapter 2. Asphalt Binder Grade Adjustments for Airfield Flexible Pavements ..... 10

- FAA P-401 Asphalt Mix Pavement (surface) ..... 10
- FAA P-403 Asphalt Mix Pavement (base, leveling) ..... 15
- FAA P-404 Fuel-Resistant Asphalt Mix Pavement ..... 19
- UFGS Section 32 12 15.13 Asphalt Paving for Airfields (11/20 CHG 1: 05/22) ..... 21
- UFGS Section 32 12 15.16 Stone Matrix Asphalt for Airfield Paving (02/19) ..... 24
- UFGS Section 332 12 17.19 Fuel Resistant Asphalt Paving for Airfields – Surface Course (11/20) ..... 27

Chapter 3. Using the Airfield Asphalt Binder Selection Tool ..... 30

- User Data ..... 30
- Using the Tool ..... 30

# List of Figures

Figure 1. P-401, Step 1: Initial Asphalt Binder PG Selection ..... 12
Figure 2. P-401, Step 2: Performing High-Temperature PG-Grade Bumping ..... 13
Figure 3. P-401, Step 3: Verifying Asphalt Binder UTI ..... 14
Figure 4. P-401, Step 4: Verifying the Asphalt Binder is State-Specified ..... 14
Figure 5. P-403, Step 1: Initial Asphalt Binder PG Selection ..... 16
Figure 6. P-403, Step 2: Performing High-Temperature PG Bumping ..... 17
Figure 7. P-403, Step 3: Verifying Asphalt Binder UTI ..... 18
Figure 8. P-403, Step 4: Verifying Asphalt Binder is State-Specified ..... 18
Figure 9. P-404, Step 1: Selecting the Asphalt Binder PG ..... 20
Figure 10. P-404, Step 4: Verifying the Asphalt Binder is State-Specified ..... 20
Figure 11. UFGS Section 32 12 15.13, Step 1: Selecting the Initial Asphalt Binder PG ..... 22
Figure 12. UFGS Section 32 12 15.13, Step 2: Adjusting the Low-Temperature PG ..... 22
Figure 13. UFGS Section 32 12 15.13, Step 3: Performing High-Temperature PG-Grade Bumping ..... 23
Figure 14. UFGS Section 32 12 15.13, Step 4: Verifying the Asphalt Binder is State-Specified ..... 24
Figure 15. UFGS Section 32 12 15.16, Step 1: Selecting the Asphalt Binder PG ..... 25
Figure 16. UFGS Section 32 12 15.16, Step 2: Performing High-Temperature PG-Grade Bumping. ..... 26
Figure 17. UFGS Section 32 12 15.16, Step 3: Verifying the Asphalt Binder is State-Specified ..... 26
Figure 18. UFGS Section 332 12 17.19, Step 1: Selecting the Asphalt Binder PG ..... 28
Figure 19. UFGS Section 332 12 17.19, Step 2: Adjusting the Low-Temperature PG ..... 29
Figure 20. UFGS Section 332 12 17.19, Step 3: Verifying Asphalt Binder is Specified in the State ..... 29
Figure 21. Initial Web Page View ..... 30
Figure 22. Available Scenario Types ..... 31
Figure 23. Base Binder Grade Selection ..... 32
Figure 24. Software Output ..... 33
Figure 25. Airfield Asphalt Binder Selection Tool Report ..... 34

# List of Tables

Table 1. Asphalt Binder Grades Approved or Specified for Use in U.S. SHAs ..... 3
Table 2. Asphalt Binder Grades Approved or Specified for Use in Canadian Provinces ..... 7
Table 3. Standard Asphalt Binder Grades for Use in U.S. SHAs ..... 8
Table 4. FAA P-401 Required Grade Bumping (i.e., adjustment of 6°C increments)..... 11
Table 5. PG 64-22 Climate Grade Requirements Example..... 12

# List of Symbols and Acronyms

| | |
|---|---|
| AAPTP | Airport Asphalt Pavement Technology Program |
| AASHTO | American Association of State Highway and Transportation Officials |
| AC | Advisory circular |
| AGW | Aircraft gross weight |
| AMAP | Association of Modified Asphalt Producers |
| ASTM | ASTM International |
| DOD | Department of Defense |
| ESAL | Equivalent single axle load |
| FAA | Federal Aviation Administration |
| PG | Performance grade |
| PMA | Polymer-modified asphalt |
| PSI | Pounds per square inch |
| RAP | Reclaimed asphalt pavement |
| RTFO | Rolling thin-film oven |
| SHA | State highway agency |
| UFGS | Unified Facilities Guide Specifications |
| UTI | Useful temperature interval |

# Introduction

This report documents findings from the Airport Asphalt Pavement Technology Program (AAPTP) Guidance for Selection of Proper Asphalt Binder Grade project. The project developed recommendations for selecting the appropriate asphalt binder grade for airfield flexible pavement designs. Specifically, the project goals were as follows:

- Develop guidance, such as a decision tree, that aids specifiers in selecting an asphalt binder grade for airfields in the United States, its territories, and Canada based on climate, aircraft loading, speed, and pavement layer.
- Develop a web-based tool that specifiers can use to select an appropriate binder grade for asphalt mixtures in a pavement structure.
- Deliver draft language for Federal Aviation Administration (FAA) and Department of Defense (DOD) specifications used for airfield projects that need clarification.

Chapter 1 describes the standard asphalt binder grades database. Chapter 2 presents a detailed review of asphalt binder-related FAA specifications and Unified Facilities Guide Specifications (UFGS) for airfield projects, detailing conditions and requirements that could result in an asphalt binder grade adjustment when considering airfield flexible pavement designs. Chapter 2 also includes flowcharts displaying possible outcomes from design engineer decisions based on FAA specifications and UFGS. Chapter 3 describes a new web-based decision support tool design engineers can use to determine the appropriate binder grade for asphalt mixtures.

# Chapter 1.
# Standard Asphalt Binder Grades Database Development

The research team developed an asphalt binder-related database of standard asphalt binder grades that are approved and specified for use in each U.S. State and Canadian Province. The database also lists the asphalt binder grades currently in use in each State and Province.

The research team surveyed U.S. State and Canadian Provincial highway agencies to determine which binder grades are typically used and available per project area. The team then used their network of State highway agency (SHA) asphalt engineers to follow up on missing details. Fifty-one SHAs, including all 50 States and Puerto Rico, and four Canadian Provinces (Alberta, British Columbia, New Brunswick, and Ontario) provided information. The survey consisted of three questions:

1. What asphalt binder grades are currently included in your specifications? Of those binders, which ones (if any) are not typically available?
2. Does your agency require performance grade (PG) "Plus" testing on modified binders? If so, what additional tests are required, and what are the minimum requirements?
3. What binder specifications does your agency use to test and accept modified binders (i.e., AASHTO M 320, AASHTO M 332, ASTM D6084, etc.)?

After a project panel meeting on December 2, 2022, researchers decided to only include survey question 1 data in developing the web-based decision support tool. This information is summarized in Table 1 and Table 2, along with information from the Asphalt Institute U.S. State Binder Specifications Database. The Asphalt Institute database was used as a resource for information related to survey questions 2 and 3.

**Table 1. Asphalt Binder Grades Approved or Specified for Use in U.S. SHAs**

| SHA | Asphalt Binders Included in the Specifications | |
|---|---|---|
| | Survey Response | Asphalt Institute Binder Specification Database |
| Alabama | PG 58-22, PG 64-22, PG 67-22, PG 76-22 *Included in the specifications but not typically available:* PG 58-22 and PG 64-22 | PG 58-22, PG 64-22, PG 67-22, PG 76-22 *Included in the specifications but not typically available:* PG 58-22 and PG 64-22 |
| Alaska | PG 52-28, PG 52-40, PG 58-28, PG 58-34, PG 64-40 | PG 52-28, PG 52-40, PG 58-28, PG 58-34, PG 64-40 |
| Arizona | PG 64-28, PG 70-22, PG 76-16, PG 76-22, PG 70-28, PG 64-28 GTR* | PG 58-22, PG 64-16, PG 64-22, PG 70-10, PG 76-16, PG 64-16 GTR*, PG 58-22 GTR*, PG 58-28 GTR* |
| Arkansas | PG 64-22, PG 67-22, PG 70-22, PG 76-22 | PG 64-22, PG 67-22, PG 70-22, PG 76-22 |
| California | PG 58-22, PG 64-10, PG 64-16, PG 64-28, PG 70-10, PG 58-34 M*, PG 64-28 M*, PG 76-22 M* | PG 58-22, PG 64-10, PG 64-16, PG 64-28, PG 70-10, PG 58-34 M*, PG 64-28 M*, PG 76-22 M* |
| Colorado | PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 70-28, PG 76-28 | PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 70-28, PG 76-28 |
| Connecticut | PG 64S-22, PG 64E-22 | PG 58S-28, PG 64S-22, PG 64S-28, PG 64E-22 |
| Delaware | N/A | PG 58-28, PG 64-22, PG 76-22, PG 58S-28, PG 64S-22, PG 64E-22 |
| Florida | PG 52-28, PG 58-22, PG 67-22, PG 76-22 (PMA or ARB)*, High Polymer | PG 52-28, PG 58-22, PG 67-22, PG 76-22 (PMA or ARB)*, High Polymer |
| Georgia | PG 58-22, PG 64-22, PG 67-22, PG 76-22 PMA, PG 76E-22 (HiMA)*, PG 76-22 TBPRH*, and PG 76-22 ARB* | PG 58-22, PG 64-22, PG 67-22, PG 76-22 |
| Hawaii | PG 64-16, PG 64E-22 | PG 64-16, PG 64E-22 |
| Idaho | PG 58-34, PG 58-28, PG 64-34, PG 64-28, PG 70-28, PG 76-28 | PG 58-34, PG 58-28, PG 64-34, PG 64-28, PG 70-28, PG 76-28 |
| Illinois | PG 46-34, PG 46-28, PG 52-28, PG 52-34, PG 58-28, PG 58-22, PG 64-28, PG 64-22, PG 70-22, PG 64-28 SBS*, PG 64-34 SBS*, PG 70-22 SBS*, PG 70-28 SBS*, PG 76-22 SBS*, PG 76-28 SBS* | PG 46-34, PG 46-28, PG 52-28, PG 52-34, PG 58-28, PG 58-22, PG 64-28, PG 64-22, PG 70-22, PG 64-28 SB/SBS*, PG 70-22 SB/SBS*, PG 70-28 SB/SBS*, PG 76-22 SB/SBS*, PG 76-28 SB/SBS*, PG 64-28 SBR*, PG 70-22 SBR*, PG 70-28 SBR*, PG 76-22 SBR*, PG 76-28 SBR* |
| Indiana | PG 58-28, PG 64-28, PG 64-22, PG 70-28, PG 70-22, PG 76-22 | PG 58-28, PG 64-28, PG 64-22, PG 70-28, PG 70-22, PG 76-22 |
| Iowa | PG 52S-34S, PG 52H-34, PG 52V-34, PG 52E-34, PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34, PG 58E-34, PG 64S-22, PG 64H-22, PG 64V-22, PG 64E-22, PG 64E-34, PG 64E-34 | PG 52S-34S, PG 52H-34, PG 52V-34, PG 52E-34, PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34, PG 58E-34, PG 64S-22, PG 64H-22, PG 64V-22, PG 64E-22, PG 64E-34, PG 64E-34 |

| SHA | Asphalt Binders Included in the Specifications | |
|---|---|---|
| | Survey Response | Asphalt Institute Binder Specification Database |
| Kansas | PG 52-34, PG 58-34, PG 64-28, PG 58-28, PG 64-22, PG 64-34, PG 70-34, PG 70-28, PG 70-22, PG 76-28, PG 76-22 | PG 52-34, PG 58-34, PG 64-28, PG 58-28, PG 64-22, PG 64-34, PG 70-34, PG 70-28, PG 70-22, PG 76-28, PG 76-22 |
| Kentucky | PG 58-28 (PG 58S-28), PG 64-22 (PG 64S-22), PG 76-22 (PG 64E-22) | PG 58-28 (PG 58S-28), PG 64-22 (PG 64S-22), PG 76-22 (PG 64E-22) |
| Louisiana | PG 58-28, PG 67-22, PG 70-22 M*, PG 76-22 M*, PG 76-22 RM* | PG 58-28, PG 67-22, PG 70-22 M*, PG 76-22 M*, PG 76-22 RM* |
| Maine | PG 64-28, PG 58-28, PG 64E-28, PG 70E-28, PG 76E-28 (HiMA)* | PG 52-34, PG 58-34, PG 64-28, PG 64E-28, PG 70E-28 |
| Maryland | PG 58-22, PG 64S-22, PG 64E-22 | PG 58S-22, PG 58S-28, PG 64S-22, PG 64S-28, PG 64H-22, PG 64E-22 |
| Massachusetts | PG 64-28, PG 64E-28, PG 73E-34 | PG 52-34, PG 58-28, PG 64-28, PG 64E-28 |
| Michigan | PG 46-34, P 52-22, PG 52-28, PG 52-34, PG 58-34, PG 58-28, PG 58-22, PG 64-22, PG 64-28, PG 64-34, PG 64-28 P*, PG 64-34 P*, PG 70-22, PG 70-22 P*, PG 70-28 P*, PG 76-22 P*, PG 76-28 P* | PG 46-34, PG 46-40, PG 46-46, PG 52-10, PG 52-16, PG 52-22, PG 52-28, PG 52-34, PG 52-40, PG 52-46, PG 58-16, PG 58-22, PG 58-28, PG 58-34, PG 58-40, PG 64-10, PG 64-16, PG 64-22, PG 64-28, PG 64-34, PG 64-40, PG 70-10, PG 70-16, PG 70-22, PG 70-28, PG 70-34, PG 70-40, PG 76-10, PG 76-16, PG 76-22, PG 76-28, PG 76-34, PG 82-10, PG 82-16, PG 82-22, PG 82-28, PG 82-34 |
| Minnesota | PG 52S-34, PG 58S-28, PG 58H-34, PG 58H-28, PG 58V-34, PG 58V-28, PG 58E-34, PG 64S-22, PG 49S-34 | PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34, PG 46S-34, PG 52S-34, PG 64S-22 |
| Mississippi | PG 67-22, PG 76-22 | PG 58-28, PG 67-22, PG 76-22, PG 82-22 |
| Missouri | PG 64-22, PG 70-22, PG 76-22, PG 64S-22, PG 64H-22, PG 64V-22 | PG 64-22, PG 70-22, PG 76-22, PG 64S-22, PG 64H-22, PG 64V-22 |
| Montana | PG 58-28, PG 64-28, PG 70-28 | PG 58-28, PG 64-22, PG 64-28, PG 70-28 |
| Nebraska | PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34 | PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34 |
| Nevada | PG 58-28, PG 64-22, PG 70-16, PG 64-16, PG 64-28 NV*, PG 76-22 NV*, PG 70-34 NV*, PG 64-28 NVTR*, PG 76-22 NVTR* | PG 58-28, PG 64-22, PG 70-16, PG 64-28 NV*, PG 76-22 NV*, PG 64-28 NVTR*, PG 76-22 NVTR* |
| New Hampshire | PG 58-28, PG 58-34, PG 64-28, PG 70-34, PG 78-28 | PG 52-34, PG 58-28, PG 58-34, PG 64-28, PG 76-28 |
| New Jersey | PG 64-22, PG 64E-22 | PG 64-22, PG 64E-22 |
| New Mexico | PG 58-28, PG 64-22, PG 64-28, PG 70-22, PG 70-28, PG 76-28, PG 70-28 R*, PG 76-28 R* | PG 58-28, PG 64-22, PG 64-28, PG 70-22, PG 70-28, PG 76-28, PG 70-28 R*, PG 76-28 R* |

| SHA | Asphalt Binders Included in the Specifications | |
|---|---|---|
| | Survey Response | Asphalt Institute Binder Specification Database |
| New York | PG 58E-34, PG 64S-22, PG 64V-22, PG 64H-22, PG 64E-22, PG 76E-28, PG 83-22<br>*Included in the specifications but not typically available:* PG 58E-34, PG 64H-22, PG 76E-28, PG 83-22 | PG 58E-34, PG 64S-22, PG 64V-22, PG 64H-22, PG 64E-22 |
| North Carolina | PG 58-28, PG 64-22, PG 70-28, PG 76-22 | PG 58-28, PG 64-22, PG 70-28, PG 76-22 |
| North Dakota | PG 58S-28, PG 58H-28, PG 58S-34, PG 58H-34, PG 58V-34 | PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34 |
| Ohio | PG 58-28, PG 64-22, PG 64-28 M*, PG 70-22 M*, PG 76-22 M*, PG 88-22 M* | PG 58-28, PG 64-22, PG 64-28 M*, PG 70-22 M*, PG 76-22 M*, PG 88-22 M* |
| Oklahoma | PG 58-28, PG 64-22, PG 70-28, PG 76-28, PG 76E-28 | PG 64-22, PG 70-28, PG 76-28, PG 76E-28 |
| Oregon | PG 64-28, PG 64-22, PG 70-22 ER*, PG 70-28 ER*, PG 76-22 ER*<br>*Included in the specifications but not typically available:* PG 76-22 ER* | PG 64-28, PG 64-22, PG 70-22, PG 70-28, PG 76-22, PG 70-22 ER*, PG 70-28 ER*, AC-15-5 TR*, AC-15 P* |
| Pennsylvania | PG 58S-28, PG 64S-22, PG 64E-22<br>*Included in the specifications but not typically available:* PG 46S-40, PG 52S-28, PG58V-28, PG 64V-22, and PG 64H-22 | PG 46S-40, PG 52S-28, PG 58S-28, PG 58E-28, PG 64S-22, PG 64S-28, PG 64H-22, PG 64E-22, PG 64E-28 |
| Puerto Rico | PG 64-22 | PG 64-22 |
| Rhode Island | PG 58S-28, PG 64S-22, PG 64S-28, PG 64E-28, PG 76E-34<br>*Included in the specifications but not typically available:* PG 76E-34 | PG 58S-28, PG 64S-22, PG 64S-28, PG 64E-28, PG 76E-34<br>*Included in the specifications but not typically available:* PG 76E-34 |
| South Carolina | PG 64-22, PG 76-22 | PG 64-22, PG 76-22 |
| South Dakota | PG 58-34, PG 64-34 | PG 58-28, PG 58-34, PG 64-34, PG 64-22, PG 64-28, PG 70-34, PG 70-28 |
| Tennessee | PG 64-22, PG 70-22, PG 76-22, PG 82-22 | PG 64-22, PG 70-22, PG 76-22, PG 82-22 |
| Texas | PG 58-22, PG 58-28, PG 58-34, PG 64-16, PG 64-22, PG 64-28, PG 64-34, PG 70-16, PG 70-22, PG 70-28, PG 70-34, PG 76-16, PG 76-22, PG 76-28, PG 76-34, PG 82-16, PG 82-22, PG 82-28 | PG 58-22, PG 58-28, PG 58-34, PG 64-16, PG 64-22, PG 64-28, PG 64-34, PG 70-16, PG 70-22, PG 70-28, PG 70-34, PG 76-16, PG 76-22, PG 76-28, PG 76-34, PG 82-16, PG 82-22, PG 82-28 |
| Utah | PG 58-28, PG 64-34, PG 70-28, PG 76-34 | PG 58-28, PG 58-34, PG 64-28, PG 64-34, PG 70-28, PG 76-34 |
| Vermont | PG 58-28, PG 70-28 | PG 70-28, PG 70-34 |
| Virginia | PG 64S-16, PG 64H-16, PG 64E-22 | PG 58S-22, PG 64S-22, PG 64H-22, PG 64E-22, PG 76E-28 HP* |
| Washington | PG 58H-22, PG 64H-28 | PG 52S-28, PG 58S-22, PG 58H-22, PG 58V-22, PG 58S-28, PG 64S-28, PG 64H-28, PG 64V-28 |

| SHA | Asphalt Binders Included in the Specifications | |
|---|---|---|
| | Survey Response | Asphalt Institute Binder Specification Database |
| West Virginia | PG 58S-28, PG 70-28 | PG 58S-28, PG 64S-22, PG 64H-22, PG 64E-22 |
| Wisconsin | PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34 | PG 58S-28, PG 58H-28, PG 58V-28, PG 58E-28, PG 58S-34, PG 58H-34, PG 58V-34, PG 58E-34 |
| Wyoming | PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 64-34, PG 70-28, PG 70-34, PG 76-28, PG 76-34 | PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 70-28, PG 76-28 |

*Notes
ARB, RB, R, TR: asphalt rubber modified
ER: AASHTO M320 PG graded asphalt binder with a plus specification for elastic recovery on rolling thin-film oven (RTFO) residue material
GTR: ground tire rubber modified
HiMA: highly modified asphalt
HP: high-polymer modified
M, P, PMA: polymer-modified asphalt
NV: polymer-modified asphalt for Nevada
NVTR: terminally blend rubber modified asphalt for Nevada
SB: styrene-butadiene modified
SBR: styrene-butadiene rubber modified
SBS: styrene-butadiene-styrene block copolymer modified
TBPRH: terminally blended polymer/rubber hybrid

**Table 2. Asphalt Binder Grades Approved or Specified for Use in Canadian Provinces**

| Province | Asphalt Binders Included in the Specifications | |
|---|---|---|
| | Survey Response | Asphalt Institute Binder Specification Database |
| Alberta | 80-100A (PG 64-25), 120-150A (PG 58-31), 200-300A (PG 52-34), 300-400A (PG 46-37), PG 46-34, PG 52-34, PG 58-28, PG 58-34, PG 58-37, PG 64-28, PG 64-34, PG 64-40, PG 64-37,PG 70-28, PG 76-28 | PG 46-34, PG 52-34, PG 58-28, PG 58-34, PG 58-37, PG 58-40, PG 64-28, PG 64-34, PG 64-37, PG 70-28, PG 76-28 |
| British Columbia | 80-100A (PG 64-22), 120-150A (PG 58-28), 150-200A (PG 58-28), 200-300A (PG 52-34) | 80-100A (PG 64-22), 120-150A (PG 58-28), 150-200A (PG 58-28), 200-300A (PG 52-34), PG 52-34, PG 58-28, PG 58-34, PG 58-37, PG 58-40, PG 64-22, PG 64-28, PG 64-34, PG 64-37, PG 70-28, PG 76-28 |
| New Brunswick | PG 52-34, PG 58-28, PG 58-34<br>*Included in the specifications but not typically available*: PG 58S-34, which is often substituted by PG 58H-34 | PG 52n-YY*, PG 58n-28*, PG 58n-YY*, PG 64n-28*, PG 70n-28* |
| Ontario | PG 52-34, PG 52-40, PG 58-28, PG 58-34, PG 58-40, PG 64-34, PG 64-28, PG 70-28, PG 70-34 | PG 52-34, PG 52-40, PG 58-28, PG 58-34, PG 58-40, PG 64-34, PG 64-28, PG 70-28, PG 70-34 |

*Notes
n: asphalt binder not modified with polymers

In addition to the survey, the research team compiled a county listing of standard asphalt binder grades, assuming that the binder would be used on low-traffic-volume projects (i.e., less than 10 million equivalent single axle loads [ESALs]) in a dense-graded mixture with no reclaimed asphalt pavement (RAP). This information was organized in an Excel file.

Table 3 summarizes the standard asphalt binder grades for the 51 SHAs. Some States follow ASTM D6373 Standard Specification for Performance-Graded Asphalt Binder,also known as AASHTO M 320, Standard Specification for Performance-Graded Asphalt Binder. In contrast, others follow ASTM D7405 Standard Test Method for Multiple Stress Creep and Recovery (MSCR) of Asphalt Binder Using a Dynamic Shear Rheometer, also known as AASHTO M 332, Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery Test. Thus, a suggested equivalent ASTM D6373 PG (AASHTO M 320) is presented for the States following ASTM D7405 (AASHTO M 332).

**Table 3. Standard Asphalt Binder Grades for Use in U.S. SHAs**

| SHA | Standard Asphalt Binder Grade(s) (for a low-traffic-volume project, < 10 million ESALs, in a dense-graded mixture with no RAP) |
|---|---|
| Alabama | PG 67-22 |
| Alaska | PG 52-28 |
| Arizona | PG 64-22 |
| Arkansas | PG 64-22 |
| California | PG 64-16, PG 64-10, PG 64-28, PG 70-10 |
| Colorado | PG 58-34, PG 58-28, PG 64-28, PG 64-22 |
| Connecticut | PG 64S-22<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 64-22 |
| Delaware | PG 64-22 |
| Florida | PG 67-22 |
| Georgia | PG 64-22, PG 67-22 |
| Hawaii | PG 64-22 |
| Idaho | PG 58-34, PG 58-28, PG 64-28 |
| Illinois | PG 64-28, PG 64-22 |
| Indiana | PG 64-22 |
| Iowa | PG 58-28 |
| Kansas | PG 64-28 |
| Kentucky | PG 64-22 |
| Louisiana | PG 67-22 |
| Maine | PG 64-28 |
| Maryland | PG 64S-22<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 64-22 |
| Massachusetts | PG 64-28 |
| Michigan | PG 58-34, PG 64-28, PG 64-22 |
| Minnesota | PG 58S-28<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 58-28 |
| Mississippi | PG 67-22 |
| Missouri | PG 64-22 |
| Montana | PG 64-28 |
| Nebraska | PG 64-28 |
| Nevada | PG 64-28 |
| New Hampshire | PG 58-28, PG 64-28 |
| New Jersey | PG 64-22 |
| New Mexico | PG 58-28, PG 64-28, PG 64-22, PG 70-22 |
| New York | PG 64S-22 (Upstate), PG 64H-22 (Downstate)<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 64-22 and PG 70-22, respectively |
| North Carolina | PG 64-22 |
| North Dakota | PG 58S-28<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 58-28 |
| Ohio | PG 64-22 |
| Oklahoma | PG 64-22 |
| Oregon | PG 64-28, PG 64-22 |
| Pennsylvania | PG 58S-28 and PG 64S-22<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 58-28 and PG 64-22, respectively |
| Puerto Rico | PG 64-22 |

| SHA | Standard Asphalt Binder Grade(s) (for a low-traffic-volume project, < 10 million ESALs, in a dense-graded mixture with no RAP) |
|---|---|
| Rhode Island | PG 64-28 |
| South Carolina | PG 64-22 |
| South Dakota | PG 64-34 |
| Tennessee | PG 64-22 |
| Texas | PG 64-22 |
| Utah | PG 64-34, PG 70-28 (for St. George) |
| Vermont | PG 58-28 |
| Virginia | PG 64S-22<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 64-22 |
| Washington | PG 64-22 (Western Washington) and PG 64-28 ER (Eastern Washington) |
| West Virginia | PG 64S-22<br>*Suggested equivalent ASTM D6373 PG (AASHTO M 320)*: PG 64-22 |
| Wisconsin | PG 58-34, PG 58-28 |
| Wyoming | PG 52-34, PG 52-28, PG 58-28, PG 58-34, PG 64-34 |

*Notes

ER: AASHTO M320 PG graded asphalt binder with a plus specification for elastic recovery on RTFO residue material

NV: polymer-modified asphalt for Nevada

# Chapter 2.
# Asphalt Binder Grade Adjustments for Airfield Flexible Pavements

The research team reviewed specifications and Engineer Notes related to materials and methods used for airfield flexible pavement projects. The review included advisory circular (AC) 150/5370-10H, *Standards for Specifying Construction of Airports*, dated Dec. 21, 2018, for items P-401, P-403, and P-404 for the Federal Aviation Administration (FAA) specifications. Division 32–Exterior Improvements was reviewed for sections 32 12 15.13, 32 12 15.16, and 32 12 17.19 for the Unified Facilities Guide Specifications (UFGS). The team gave specific attention to requirements, conditions, or guidance that impact the selection of an asphalt binder grade and the environmental project location. They also addressed specific conditions requiring "PG Plus" testing. Additionally, the project's advisory committee assisted the research team in identifying other challenges related to the asphalt binder selection process that contractors, designers, and material suppliers typically face when working on an airfield project.

FAA specification reviews focused on the specification item selected (i.e., P-401, P-403, P-404), location in the pavement layer (e.g., base, leveling, surface), pavement location (e.g., runway, shoulder, taxiway, apron), allowable RAP content, aircraft gross weight, and loading duration (i.e., slow or stationary, moving). When considering UFGS specifications, researchers reviewed maximum low-temperature grade restrictions, rutting concerns or concerns with aircraft "stacking" before takeoff, tire pressures, and specific military service projects.

The research team synthesized the information and used it to develop flowcharts that illustrate how decisions made by design engineers following FAA and UFGS specifications affect the outcomes. They then used the flowcharts to develop the web-based decision support tool presented in Chapter 3. The critical information gathered from the FAA and UFGS specifications and Engineer Notes is listed below.

## FAA P-401 Asphalt Mix Pavement (surface)

- This specification is intended for surface courses for flexible airfield pavements subject to aircraft loadings of gross weights greater than 30,000 pounds.
- The specification may also be used for a stabilized base course.
- The dimensions and depth of the surface course are defined by the design engineer's pavement design per (AC) 150/5320-6, *Airport Pavement Design and Evaluation*, and the FAA Rigid and Flexible Iterative Elastic Layer Design (FAARFIELD) software program.

- The design engineer will determine if RAP is allowed and make the 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.
- Binder grades when using RAP:
    - For 0- to 20-percent RAP, there is no change in binder grade.
    - For RAP percentages greater than 20 to 30 percent, binder grade should be one grade softer (for example, adjust PG 64-22 to PG 58-28).
- The initial asphalt binder PG should be consistent with the recommendations of the applicable SHA requirements for the environmental conditions.
- Aircraft gross weight and movement govern binder grade adjustments. Then, high-temperature PG-grade bumping (i.e., adjustment of 6°C increments) should be performed per Table 4. The low-temperature grade remains the same as the environmental-base grade.

**Table 4. FAA P-401 Required Grade Bumping (i.e., adjustment of 6°C increments)**

| Aircraft Gross Weight | High-Temperature Adjustment to Asphalt Binder Grade | |
|---|---|---|
| | All Pavement Types | Pavement Area with Slow or Stationary Aircraft |
| ≤12,500 lbs. | - | 1 grade |
| <100,000 lbs. | 1 grade | 2 grades |
| ≥100,000 lbs. | 2 grades | 3 grades |

- The asphalt binder should conform to ASTM D6373 Standard Specification for Performance-Graded Asphalt Binder and meet a minimum 75-percent elastic recovery per ASTM D6084 Elastic Recovery of Asphalt Materials by Ductilometer.
- If the useful temperature interval (UTI) "PG spread" of the binder is less than 92°C (e.g., a PG 64-22 would have a UTI of 86°C since 64 – (−22) = 86°C), delete the requirement for ASTM D6084. Otherwise, use a minimum 75-percent elastic recovery per ASTM D6084 on RTFO-aged binder or the "PG Plus" test found in the Asphalt Institute's State Binder Specifications Database.
- The asphalt industry is in a state of change regarding binder designations. Some States follow ASTM D6373 or AASHTO M 320, while others follow ASTM D7405 or AASHTO M 332. Ensure the asphalt binder meets the minimum requirements of ASTM D6373 or AASHTO M 320.
- An example of grade requirements for a PG 64-22 climate is presented in Table 5.

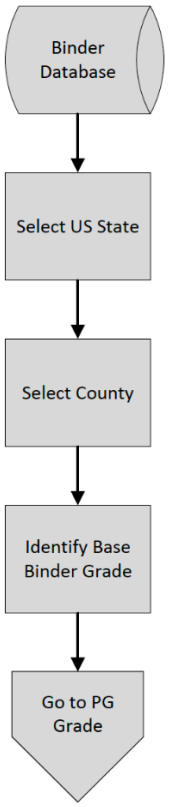
**Table 5. PG 64-22 Climate Grade Requirements Example**

| Aircraft Gross Weight | High-Temperature Adjustment to Asphalt Binder Grade | |
|---|---|---|
| | All Pavement Types | Pavement Area with Slow or Stationary Aircraft |
| ≤12,500 lbs. | PG 64 | PG 70 |
| <100,000 lbs. | PG 70 | PG 76* |
| ≥100,000 lbs. | PG 76* | PG 82** |

*lightly modified asphalt binder (~2 to 3% polymer)

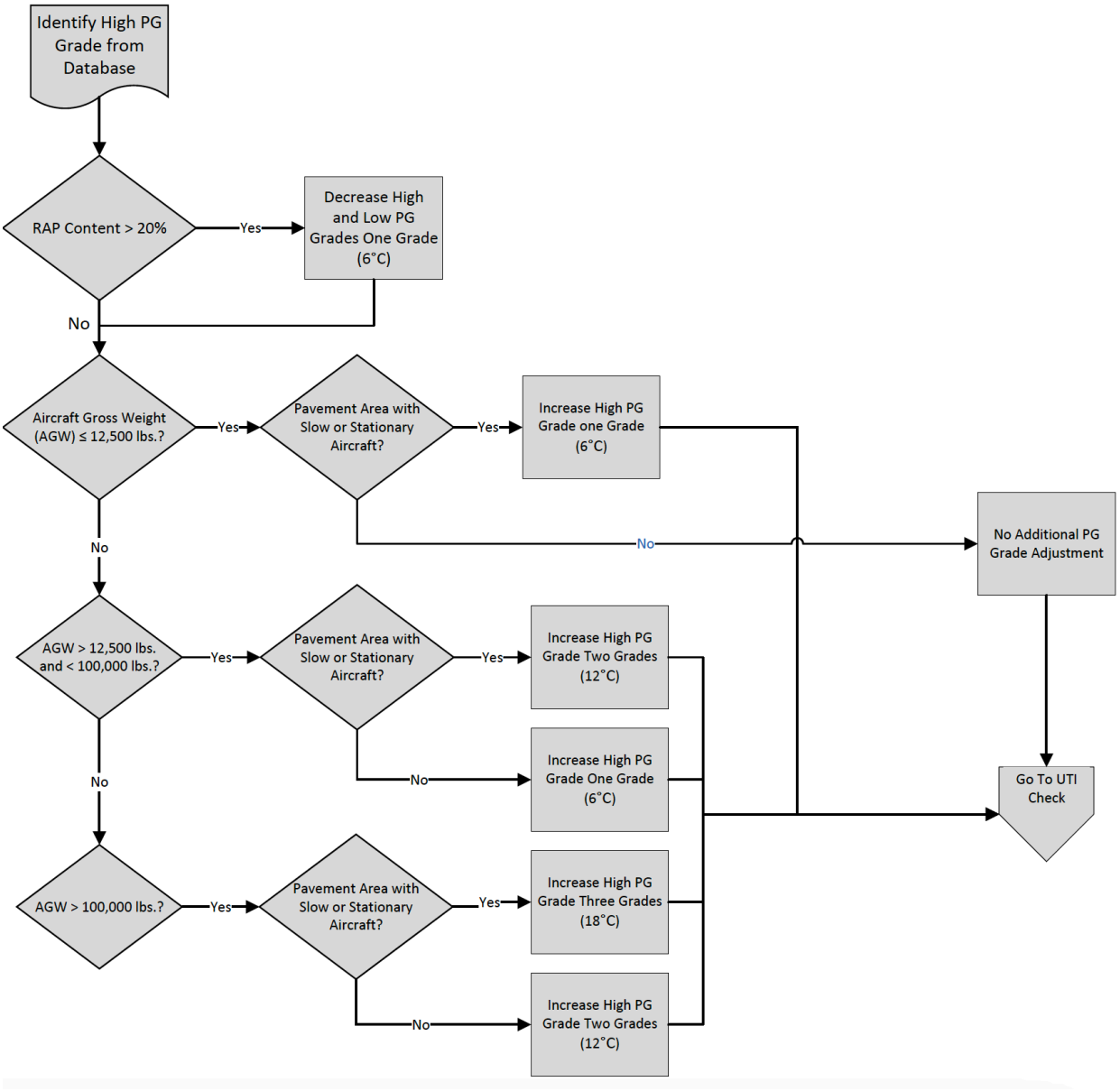
**medium modified asphalt binder (~4 to 5% polymer)

Figure 1, Figure 2, and Figure 3 present the three key FAA P-401 binder selection steps and summarize the conditions, guidance, and requirements that could impact the asphalt binder grade selection. Figure 4 presents the fourth step in the web-based decision support tool, where the design engineer verifies whether the selected asphalt binder is routinely specified in that State.



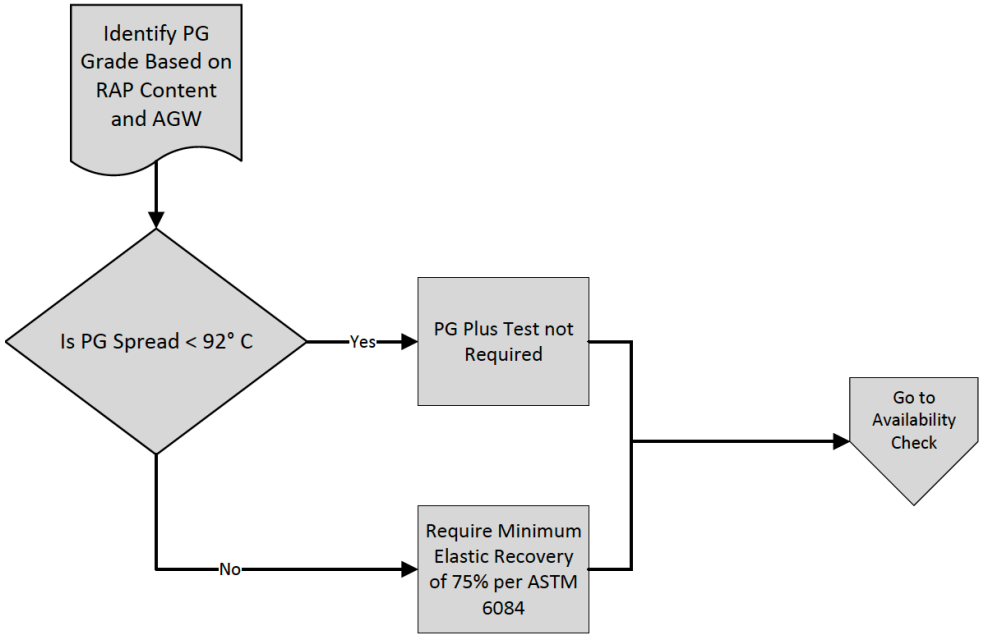

*Source: AAPTP*

**Figure 1. P-401, Step 1: Initial Asphalt Binder PG Selection**



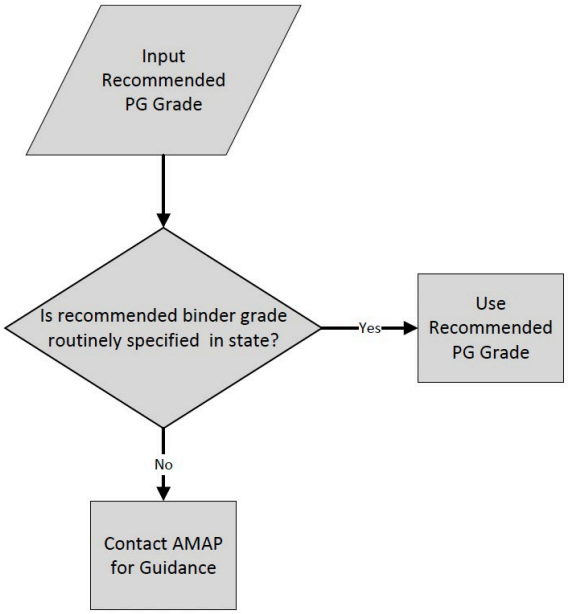

*Source: AAPTP*

**Figure 2. P-401, Step 2: Performing High-Temperature PG-Grade Bumping**




*Source: AAPTP*

**Figure 3. P-401, Step 3: Verifying Asphalt Binder UTI**



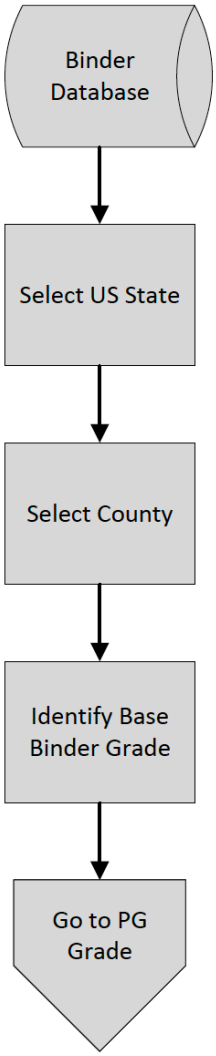

*Source: AAPTP*

**Figure 4. P-401, Step 4: Verifying the Asphalt Binder is State-Specified**

## FAA P-403 Asphalt Mix Pavement (base, leveling)

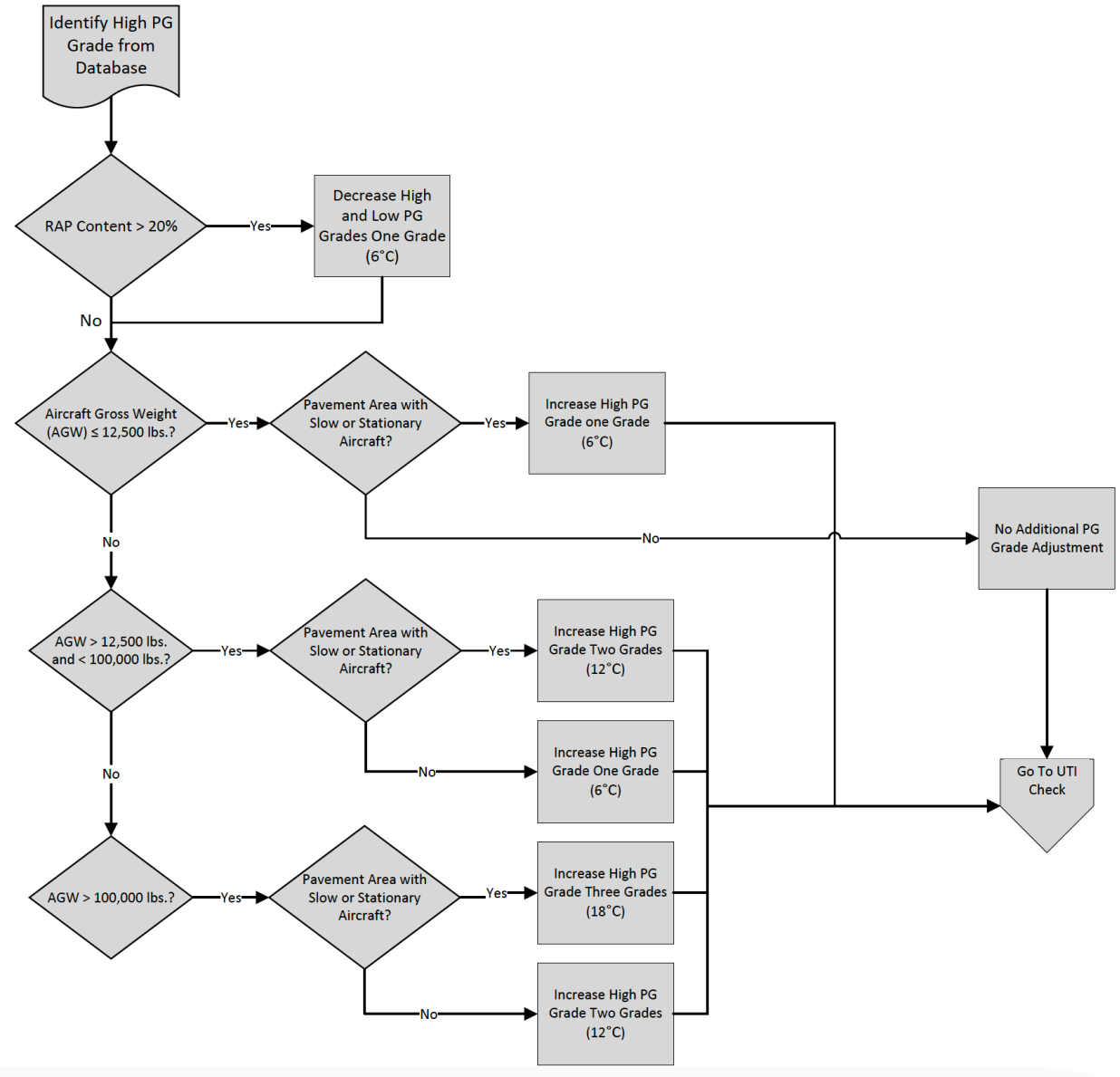
- This specification is intended for base and leveling courses.
- Surface course may be specified for pavements designed for aircraft with gross weights more than 30,000 pounds.
- The design engineer will determine whether RAP is allowed and make the appropriate selection.
    - RAP should not be used for surface mixes except on shoulders. It can be used very effectively in lower layers or for shoulders.
- Binder grades when using RAP:
    - For 0- to 20-percent RAP, there is no change in binder grade.
    - For RAP percentages greater than 20 to 30 percent, binder grade should be one grade softer. For example, adjust PG 64-22 to PG 58-28.
- The asphalt binder should conform to ASTM D6373 and meet a minimum 75-percent elastic recovery per ASTM D6084.
- The initial asphalt binder PG should be consistent with applicable SHA requirements for environmental conditions.
- AGW and movement govern binder grade adjustments. Then, perform high-temperature PG-grade bumping per Table 4. The low-temperature grade remains the same as the environmental-base grade, as shown in the example in Table 5.
- If the binder UTI, or "PG spread" is less than 92°C, delete the requirement for ASTM D6084. For example, a PG 64-22 would have a UTI of 86°C since 64 − (−22) = 86. Otherwise, use a minimum 75-percent elastic recovery per ASTM D6084 on RTFO-aged binder or the "PG Plus" test found in the Asphalt Institute's State Binder Specifications Database.
- The asphalt industry is in a state of change regarding binder designations. Some States follow ASTM D6373 (AASHTO M 320), while others follow ASTM D7405 (AASHTO M 332). Ensure the asphalt binder meets ASTM D6373 (AASHTO M 320).

Figure 5, Figure 6, and Figure 7 present three FAA P-403 key binder selection steps and summarize the conditions, guidance, and requirements that could impact asphalt binder grade selection. Figure 8 presents the fourth step in the web-based decision support tool, in which the design engineer verifies that the selected asphalt binder is State-specified.



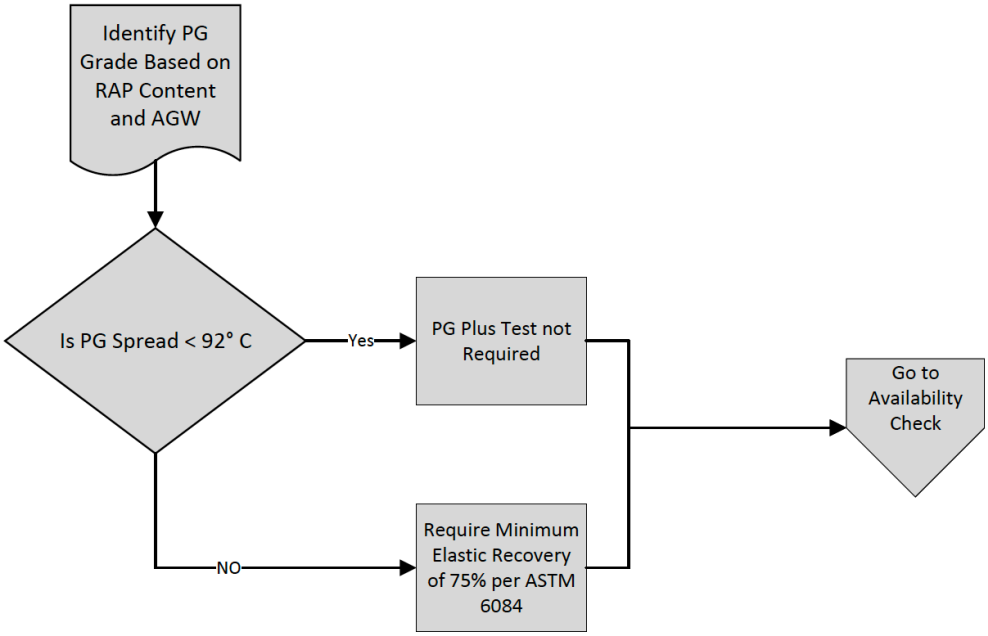

*Source: AAPTP*

**Figure 5. P-403, Step 1: Initial Asphalt Binder PG Selection**



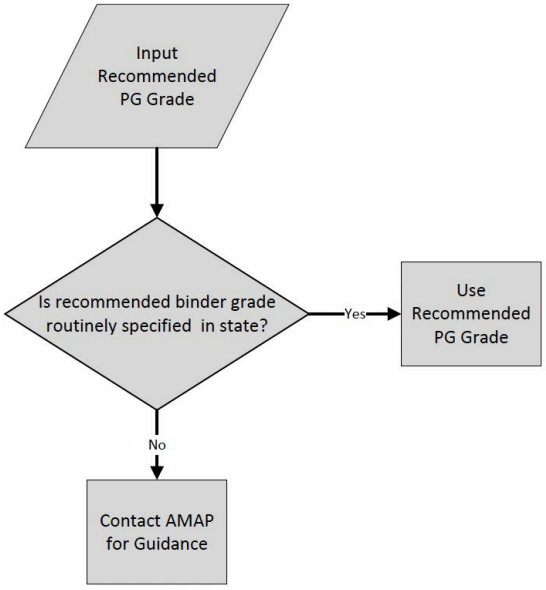

*Source: AAPTP*

**Figure 6. P-403, Step 2: Performing High-Temperature PG Bumping**




*Source: AAPTP*

**Figure 7. P-403, Step 3: Verifying Asphalt Binder UTI**



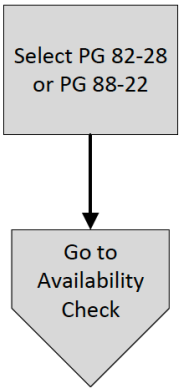

*Source: AAPTP*

**Figure 8. P-403, Step 4: Verifying Asphalt Binder is State-Specified**

## FAA P-404 Fuel-Resistant Asphalt Mix Pavement

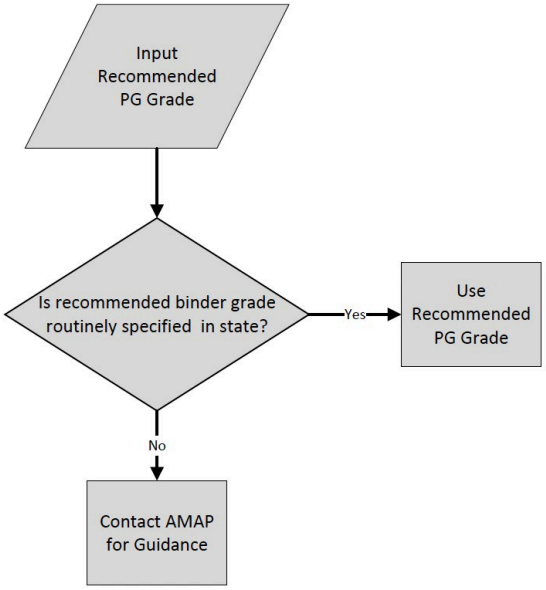
- This specification only applies to the surface course for specified locations subject to fuel spills. It requires a PG 82-28 or PG 88-22 asphalt binder with the following changes:
    - Minimum 85-percent elastic recovery per ASTM D6084 using procedure A on RTFO-aged binder.
    - Maximum 4°C difference in top and bottom softening point after ASTM D7173 Standard Practice for Determining the Separation Tendency of Polymer from Polymer-Modified Asphalt.
    - Must also meet the fuel resistance requirement with a maximum weight loss of 1.5 percent by fuel immersion using the following procedure:
        a) Prepare three test specimens in accordance with the mix design requirements at optimum asphalt binder content and 2.5 ± 0.7-percent air voids.
        b) Determine the percent air voids in each specimen. If any do not meet these requirements, discard and replace them. Dry the specimens under a fan at room temperature between 20°C (68°F) and 27°C (80°F) for a minimum of 24 hours.
        c) Immerse the sample in kerosene meeting ASTM D3699 Standard Specification for Kerosine at room temperature between 20°C (68°F) and 27°C (80°F) for 2 minutes ± 30 seconds.
        d) After submerging for 2 minutes ± 30 seconds, remove the sample and immediately surface dry it with a clean paper towel. Then determine the weight in the air to the nearest 0.1 grams. Report this as weight “A” (weight before immersion).
        e) Resubmerge the sample in kerosene for 24 hours.
        f) After 24 hours ± 10 minutes, carefully remove the sample from the kerosene and suspension container and place it on an absorbent cloth or paper towel. Dry the specimen under a fan at room temperature between 20°C (68°F) and 27°C (80°F) for 24 hours.
        g) After drying for 24 hours ± 10 minutes, weigh the sample in air to the nearest 0.1 grams. Report this as weight “B” (weight after immersion).
        h) Calculations:
            - Percent of weight loss by fuel immersion = (A − B/A) × 100 where: A = weight before and B = weight after.

Figure 9 summarizes FAA P-404 asphalt binder requirements. Figure 10 is an additional step in the web-based decision support tool that shows the design engineer how to verify the selected asphalt binder is routinely specified by a State.




*Source: AAPTP*

**Figure 9. P-404, Step 1: Selecting the Asphalt Binder PG**



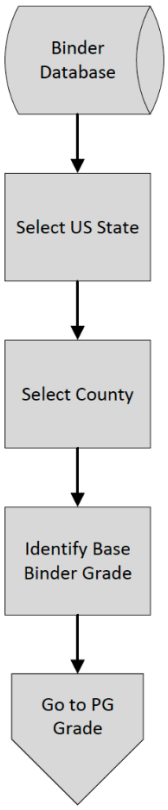

*Source: AAPTP*

**Figure 10. P-404, Step 4: Verifying the Asphalt Binder is State-Specified**

## UFGS Section 32 12 15.13 Asphalt Paving for Airfields (11/20 CHG 1: 05/22)

- Specify a PG asphalt binder that conforms to ASTM D6373; otherwise, provide an asphalt binder that conforms to ASTM D946/D946M Standard Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction or to ASTM D3381/D3381M Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction.
- Consider using the same SHA PG binder as the base grade for the project. For example, the PG binder typically specified in that specific location for dense-graded mixes on highways with a design of less than 10 million ESALs.
- Do not use a low-temperature grade higher than -22 (i.e., PG XX-16, PG XX-10).
- If there has been rutting on the project, or it is anticipated that stacking may accrue during the project's design life, apply a 6°C increment grade bump for the top 5 inches of pavement at the end of runways and taxiway areas.
- Increase the high temperature one grade for aircraft tire pressures between 100 and 200 pounds per square inch (PSI).
    - Increase the high temperature two grades for aircraft tire pressure greater than 200 PSI.
    - Increase the high-temperature two grades for Navy projects.
    - The low-temperature grade should remain the same. However, the design engineer may lower the low-temperature grade to comply with Federal Highway Administration LTPPBind software if considered appropriate.
- Perform "PG Plus" testing as required in ASTM D6084 procedure B on RFTO-aged binder for polymer-modified asphalt binders. Designers should use a minimum elastic recovery value of 75 percent for acceptance.

Figure 11, Figure 12, and Figure 13 present three UFGS Section 32 12 15.13 key binder selection steps and summarize the conditions, guidance, and requirements that could result in an asphalt binder grade adjustment. Figure 14 presents the fourth step in the web-based decision support tool, in which the design engineer verifies whether the selected asphalt binder is State-specified.




*Source: AAPTP*

**Figure 11. UFGS Section 32 12 15.13, Step 1: Selecting the Initial Asphalt Binder PG**

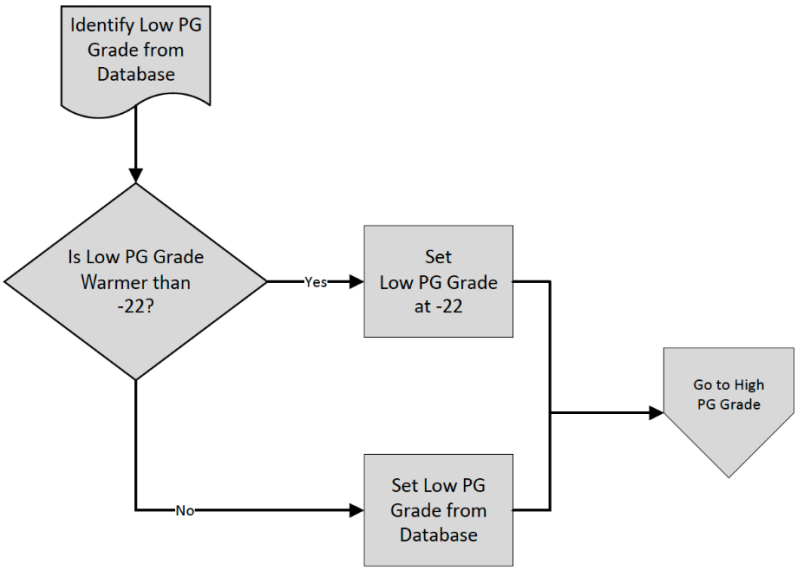



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**Figure 12. UFGS Section 32 12 15.13, Step 2: Adjusting the Low-Temperature PG**

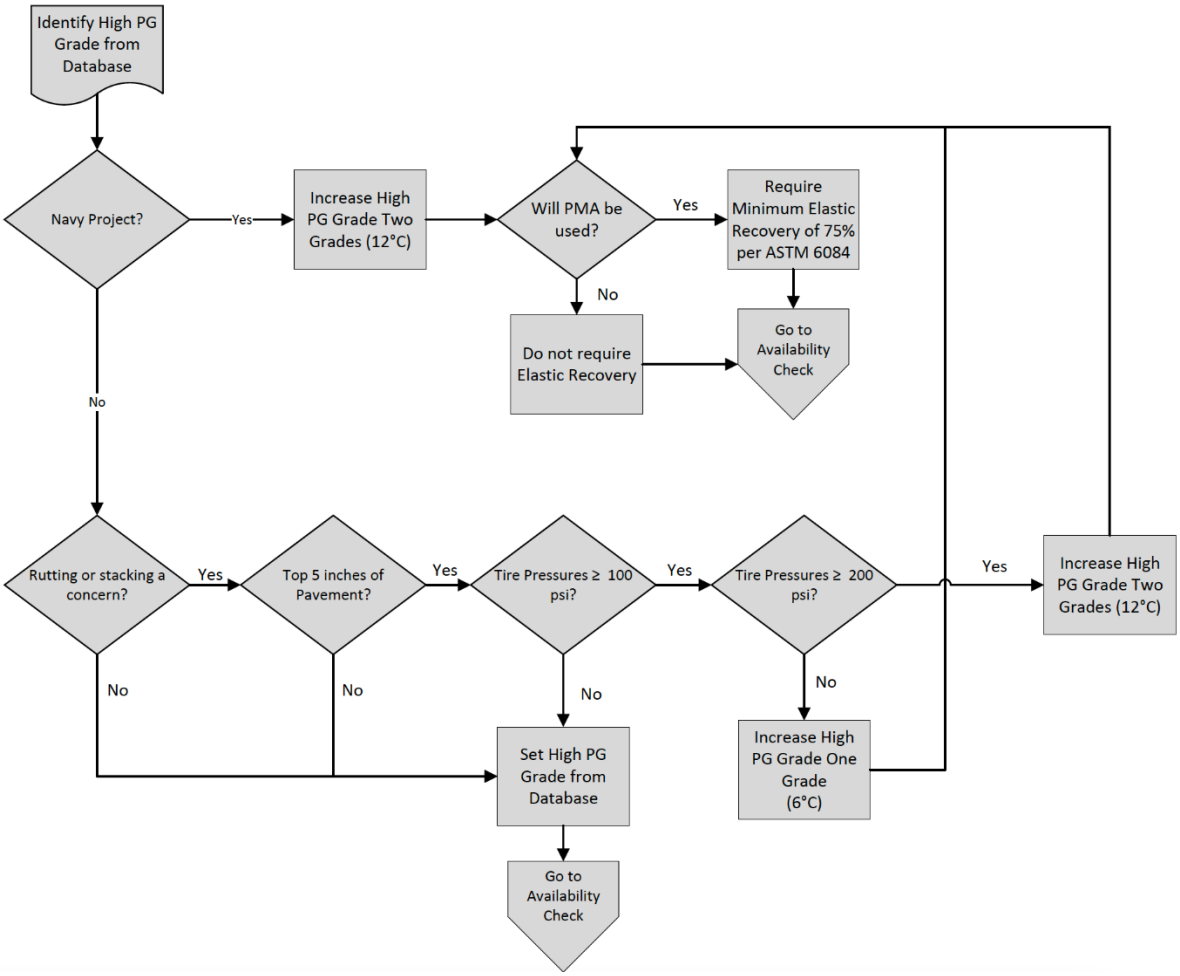


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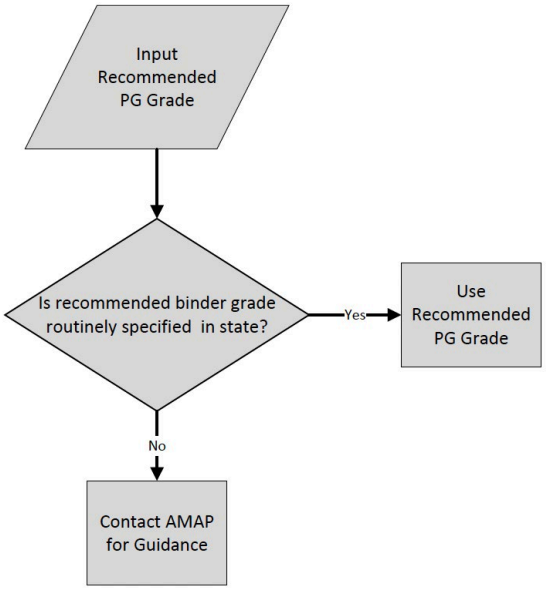
**Figure 13. UFGS Section 32 12 15.13, Step 3: Performing High-Temperature PG-Grade Bumping**



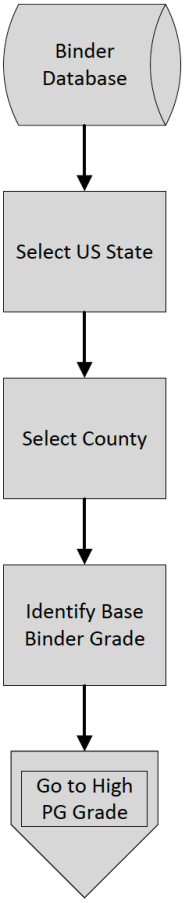

*Source: AAPTP*

**Figure 14. UFGS Section 32 12 15.13, Step 4: Verifying the Asphalt Binder is State-Specified**

## UFGS Section 32 12 15.16 Stone Matrix Asphalt for Airfield Paving (02/19)

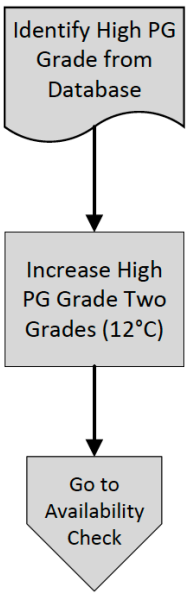
- Specify a PG asphalt binder that conforms to ASTM D6373; otherwise, provide an asphalt binder that conforms to ASTM D946/D946M Standard Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction.
- Use a bumped grade of asphalt binder. In most areas of the United States this is a PG 76-22, but it will vary in colder climates to match the lower PG requirements used by the SHA.

Figure 15 and Figure 16 summarize the asphalt binder requirements in UFGS Section 32 12 15.16. Figure 17 is an additional step in the web-based decision support tool, guiding the design engineer to verify the selected asphalt binder is State-specified.



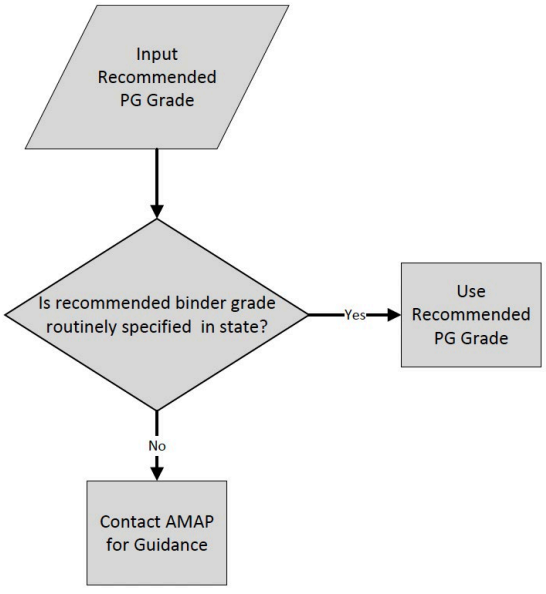

*Source: AAPTP*

**Figure 15. UFGS Section 32 12 15.16, Step 1: Selecting the Asphalt Binder PG**




*Source: AAPTP*

**Figure 16. UFGS Section 32 12 15.16, Step 2: Performing High-Temperature PG-Grade Bumping.**




*Source: AAPTP*

**Figure 17. UFGS Section 32 12 15.16, Step 3: Verifying the Asphalt Binder is State-Specified**

## UFGS Section 332 12 17.19 Fuel Resistant Asphalt Paving for Airfields – Surface Course (11/20)

- Select binder grade based on the low-temperature PG in accordance with the environmental project location.
- Provide an asphalt binder that conforms to ASTM D6373 for PG 82-28 or PG 88-22 and meets the following requirements:
    - Test the original, unaged binder according to ASTM D6084 procedure A at 25°C (77°F) with a minimum recovery of 85 percent.
    - Test the original binder according to ASTM D7173 and meet the maximum top and bottom temperature difference of 4.0°C when using the ASTM D36 Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus).
- Prepare fuel-resistant asphalt pavement specimens with the appropriate asphalt binder using a maximum weight loss of 1.5 percent by fuel immersion. Use the following procedure:
    - Prepare three test specimens by the mix design requirements at optimum asphalt binder content and 2.5 ± 0.7-percent air voids. Short-term age the mix before compaction per AASHTO R 30, Standard Practice for Mixture Conditioning of Hot Mix Asphalt.
    - Determine the percent air voids in each specimen. If any do not meet the requirements, discard and replace them. Dry the samples under a fan at room temperature between 20°C (68°F) and 27°C (80°F) for a minimum of 24 hours.
    - Immerse the sample in kerosene following ASTM D3699 at a room temperature between 20°C (68°F) and 27°C (80°F).
- After submerging for 2 minutes ± 30 seconds, remove the sample and immediately surface dry it with a clean paper towel. Determine the weight in the air to the nearest 0.1 grams. Report this as weight “A” (weight before immersion).
- Resubmerge the sample in kerosene for 24 hours.
- After 24 hours ± 10 minutes, carefully remove the sample from the kerosene and suspension container and place it on an absorbent cloth or paper towel. Dry the specimen under a fan at a room temperature between 20°C (68°F) and 27°C (80°F) for 24 hours.
- After drying for 24 hours ± 10 minutes, weigh the sample in the air to the nearest 0.1 grams. Report this as weight “B” (weight after immersion).
- Calculations:
    - Percent of weight loss by fuel immersion = (A − B/A) × 100
      where: A = weight before and B = weight after.

After passing these requirements, grade the asphalt binder as PG 82-28FR or PG 88-22FR.

Figure 18 and Figure 19 summarize UFGS Section 332 12 17.19 asphalt binder requirements. Figure 20 is an additional step in the web-based decision support tool, guiding the design engineer to verify the selected asphalt binder is State-specified.

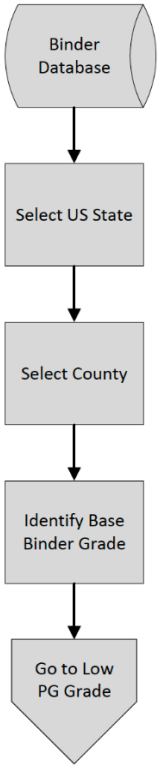



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**Figure 18. UFGS Section 332 12 17.19, Step 1: Selecting the Asphalt Binder PG**

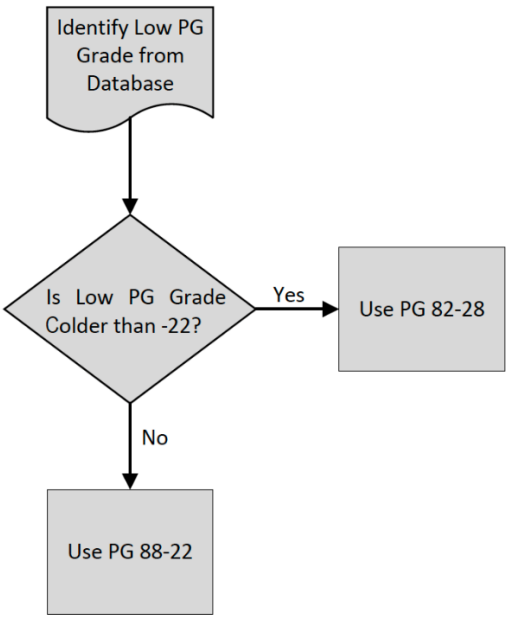


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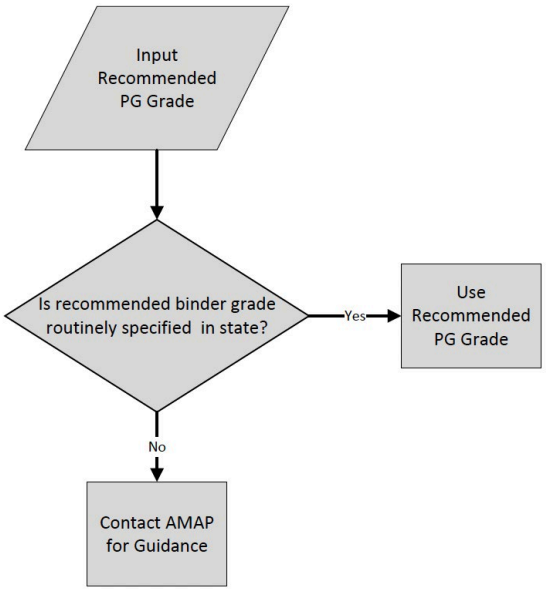
**Figure 19. UFGS Section 332 12 17.19, Step 2: Adjusting the Low-Temperature PG**




*Source: AAPTP*

**Figure 20. UFGS Section 332 12 17.19, Step 3: Verifying Asphalt Binder is Specified in the State**

# Chapter 3.
# Using the Airfield Asphalt Binder Selection Tool

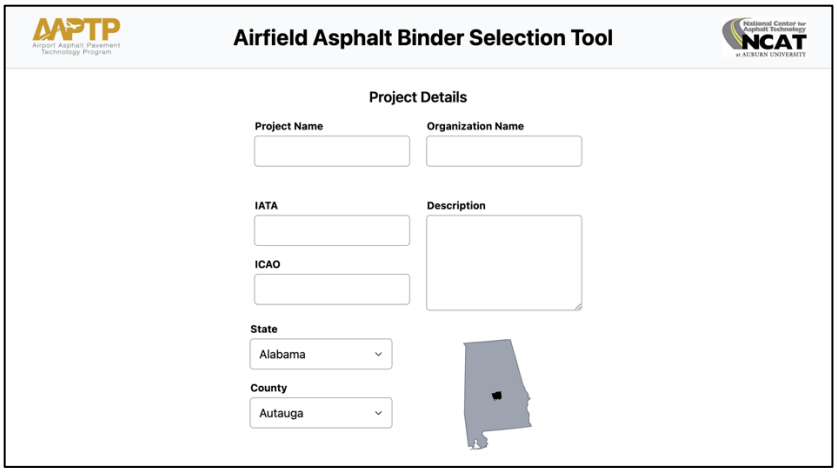
The Airfield Asphalt Binder Selection Tool implements the guidelines and workflows compiled from the FAA specifications and UFGS detailed in Chapter 2. The tool is driven by the asphalt binder availability database, incorporating State- and county-level information as described in Chapter 1. The tool provides a method for identifying specified asphalt binder grades for civilian and military airfield asphalt projects in the United States and Canada to determine whether additional testing or binder modification is required.

## User Data

The tool stores no user data. All user-provided data remains exclusively on the user's personal device.

## Using the Tool

The tool is free and requires no login. Users can navigate to the webpage, enter project details, select a scenario type, answer scenario-specific questions, and receive a printable report. Users are presented with a simple form (shown in Figure 21) with inputs for a project name, organization name, International Air Transport Association code, International Civil Aviation Organization code, project description, State, and county. This information is used to drive the asphalt binder selection algorithm.

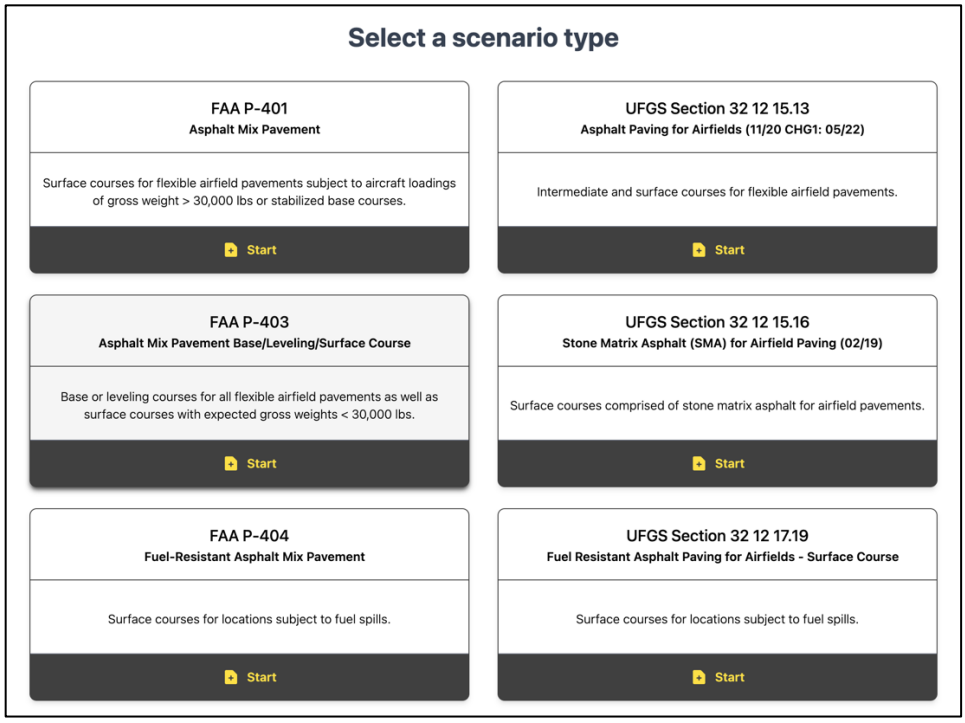



*Source: AAPTP*

**Figure 21. Initial Web Page View**

The second half of the page allows the user to select one of six scenario types: three scenarios are FAA binder selection standards and three are UFGS, as shown in Figure 22. Each scenario has a custom algorithm for establishing appropriate final binder grades. For

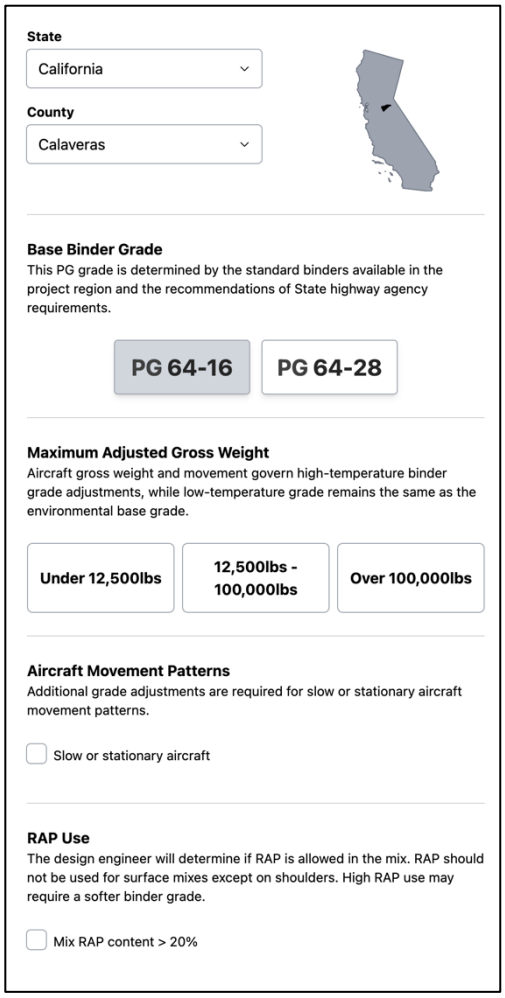
the purposes of this document, FAA P-401 is used as an example, but all scenario types use the same basic workflow.




*Source: AAPTP*

**Figure 22. Available Scenario Types**

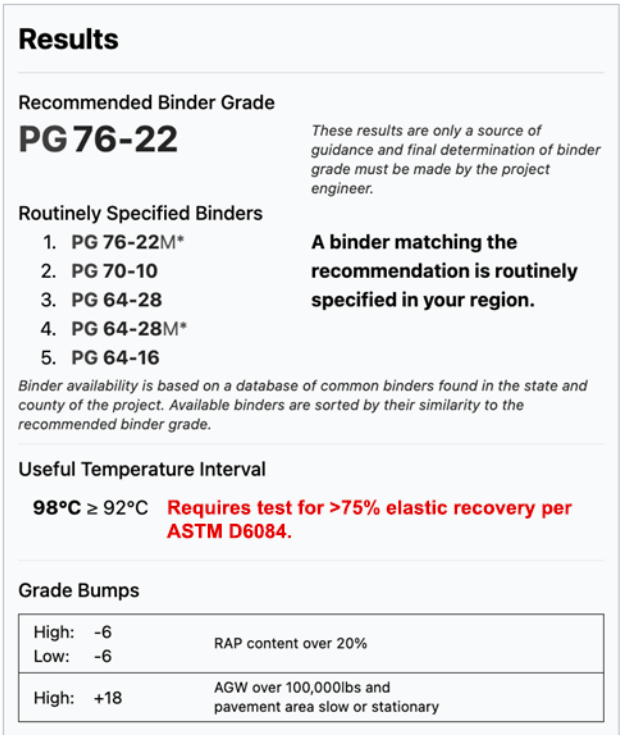
Upon navigating the scenario, the user is presented with a data entry form and results. In all scenario types, the foundation of the selection process is establishing the base binder grade. This base grade is determined by the standard binder grades used in the project's home State and county. It is obtained after collecting the information about what the SHA considers to be a standard asphalt binder grade, assuming that the binder would be used on a project with less than 10 million ESALs in a dense-graded mixture with no RAP. The user has a menu of available base binder grades for selection. In this view, users can select different States and counties to cross-compare base binder recommendations across county or State lines, see Figure 23.




*Source: AAPTP*

**Figure 23. Base Binder Grade Selection**

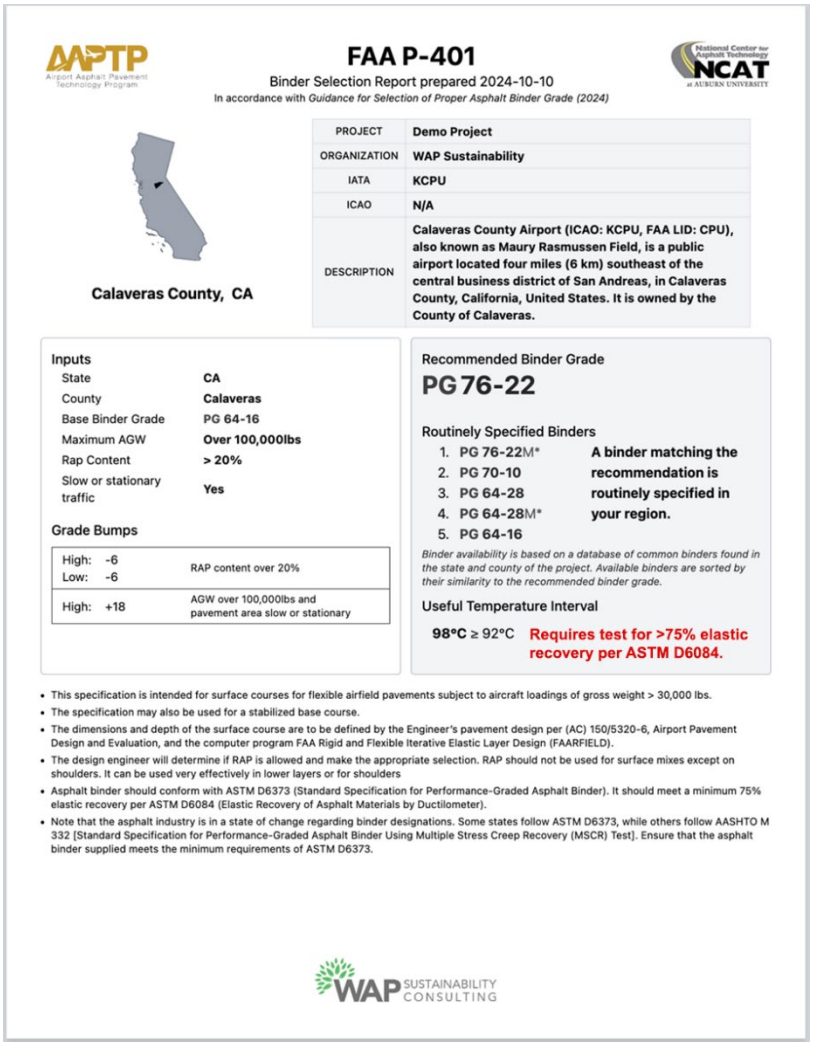
A series of scenario-specific questions follow the selection of the base asphalt binder. For example, the P-401 specification includes the aircraft's maximum adjusted gross weight, aircraft movement patterns on the airfield section under evaluation, and whether a high-RAP mix will be used. While answering these questions, the system displays the results of applying the scenario-specific grade bumping algorithm in the side panel. These include the recommended post-grade-bumping binder grade, the most similar binders specified in the region, and additional guidance on required testing if applicable, see Figure 24. The system reports the reason for each grade bump and the grade bump values applied to the base binder grade. If no binders specified by the State satisfy the recommended binder grade, the user should contact the Association of Modified Asphalt Producers for assistance finding a suitable product.




*Source: AAPTP*

**Figure 24. Software Output**

Once users complete all inputs, they can click the "show report" button. Clicking the "print" button allows users to print the document or export it to a portable document format (PDF). This is the recommended way to archive results. The report includes additional information, such as the date and notes relevant to the scenario type, as shown in the example in Figure 25.



FAA P-401

Binder Selection Report prepared 2024-10-10

In accordance with *Guidance for Selection of Proper Asphalt Binder Grade (2024)*

Calaveras County, CA

| | |
|---|---|
| PROJECT | Demo Project |
| ORGANIZATION | WAP Sustainability |
| IATA | KCPU |
| ICAO | N/A |
| DESCRIPTION | Calaveras County Airport (ICAO: KCPU, FAA LID: CPU), also known as Maury Rasmussen Field, is a public airport located four miles (6 km) southeast of the central business district of San Andreas, in Calaveras County, California, United States. It is owned by the County of Calaveras. |

Inputs

| | |
|---|---|
| State | CA |
| County | Calaveras |
| Base Binder Grade | PG 64-16 |
| Maximum AGW | Over 100,000lbs |
| Rap Content | > 20% |
| Slow or stationary traffic | Yes |

Grade Bumps

| | |
|---|---|
| High: -6<br>Low: -6 | RAP content over 20% |
| High: +18 | AGW over 100,000lbs and pavement area slow or stationary |

Recommended Binder Grade

**PG 76-22**

Routinely Specified Binders

1. PG 76-22M*
2. PG 70-10
3. PG 64-28
4. PG 64-28M*
5. PG 64-16

**A binder matching the recommendation is routinely specified in your region.**

*Binder availability is based on a database of common binders found in the state and county of the project. Available binders are sorted by their similarity to the recommended binder grade.*

Useful Temperature Interval

**98°C** ≥ 92°C **Requires test for >75% elastic recovery per ASTM D6084.**

- This specification is intended for surface courses for flexible airfield pavements subject to aircraft loadings of gross weight > 30,000 lbs.
- The specification may also be used for a stabilized base course.
- The dimensions and depth of the surface course are to be defined by the Engineer's pavement design per (AC) 150/5320-6, Airport Pavement Design and Evaluation, and the computer program FAA Rigid and Flexible Iterative Elastic Layer Design (FAARFIELD).
- The design engineer will determine if RAP is allowed and make the 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
- Asphalt binder should conform with ASTM D6373 (Standard Specification for Performance-Graded Asphalt Binder). It should meet a minimum 75% elastic recovery per ASTM D6084 (Elastic Recovery of Asphalt Materials by Ductilometer).
- Note that the asphalt industry is in a state of change regarding binder designations. Some states follow ASTM D6373, while others follow AASHTO M 332 [Standard Specification for Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test]. Ensure that the asphalt binder supplied meets the minimum requirements of ASTM D6373.

*Source: AAPTP*

**Figure 25. Airfield Asphalt Binder Selection Tool Report**