QA\QC for Airfield Asphalt Paving Projects High Risk

INTRODUCTION & BACKGROUND

- **Mark D. McGuire, P.E., Sr. Vice President for Campbell & Paris Engineers, a small business Civil Engineering firm focusing on planning, design, and construction management for aviation related projects.**

- **P. Kerr Chase, P.E., Construction Phase Service Manager**

- **Personal focus on FAA / State / Local funded aviation projects since 1998. Funding agency grant assurances typically require use of FAA specifications, quality control and quality assurance procedures. Adherence to the Brooks Act and Design – Bid – Build process with contracts between contractor / owner and engineer / owner.**

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GOVERNING DOCUMENTS

- **Federal Aviation Administration Advisory Circulars (ACs) – mandatory when Airport Improvement Funds or Passenger Facility Charges are used for project. Federal Aviation Regulations (FAR) 150 Series (Airports) 5370-10 (F) Current – Standards for Specifying Construction of Airports**

- **Part 5 – Flexible Surfaces Courses**
  - **Item P-401 Plant Mix Bituminous Pavements**
  - **Item P-402 Porous Friction Course (Central Plant Hot Mix)**
  - **Item P-403 Plant Mix Bituminous Pavements (Base, Leveling or Surface Course)**

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P-401 Plant Mix Bituminous Pavements

Description, Materials, Composition, Construction Methods, Material Acceptance, Contractor Quality Control, Method of Measurement, Basis of Payment, Testing Requirements, Material Requirements

What is old is new! Marshall Mix Design is only approved method for FAA projects. Superpave can be approved through Regional Office for aircraft weights < 100K lbs and through HQ for weights over 100K lbs with a Modifications to Standards.

Engineering Brief 59A (May 2006) provides guidance on using Superpave mixtures. FAA William J. Hughes Technical Center, Atlantic City International Airport, NJ – work in progress.

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P-401 Plant Mix Bituminous Pavements

Major Issues with Adopting Superpave (stolen from Roy D. McQueen)

- **Required number of gyrations for mix design**
- **Volumetric – appropriate level of VMA and VTM**
- **Gradation Requirements**
- **Field compaction Standard**

Mix Designs

- **Superpave AASHTO T 312 Gyratory Compactor vs Marshall Apparatus ASTM D 6926**
- **Quality of Asphalt Cement – common to see polymer modified PG 70-22 required for airfield projects. Informal FAA guidance is to always use polymer modified unless directed otherwise.**

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Mix Designs (continued)

- **a. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the job mix formula.**
- **b. Percent of asphalt cement.**
- **c. Asphalt performance, viscosity or penetration grade, and type of modifier if used.**
- **d. Number of blows of hammer compaction per side of molded specimen.**
- **e. Mixing temperature.**
- **f. Compaction temperature.**
- **g. Temperature of mix when discharged from the mixer.**
- **h. Temperature-viscosity relationship of the asphalt cement.**

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Mix Designs (continued)

- **i. Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.**
- **j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content.**
- **k. Percent natural sand.**
- **l. Percent fractured faces.**
- **m. Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).**
- **n. Tensile Strength Ratio (TSR).**
- **o. Anti-strip agent (if required).**
- **p. Date the job mix formula was developed.**

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Mix Designs (continued)

- **The Marshall Design Criteria applicable to the project shall be specified by the Engineer from the information shown below:**

Test Property	Pavements Designed for Aircraft Gross Weights of 60,000 Lb or More or Tire Pressures of 100 PSI or More	Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lb or Tire Pressures Less Than 100 PSI
Number of Blows	75	50
Stability, pounds (Newtons)	2150 (9564)	1350 (6005)
Flow, 0.01 in. (0.25 mm)	10-14	10-18
Air Voids (percent)	2.8-4.2	2.8-4.2
Percent Voids in Mineral Aggregate (minimum)	See Table 2.	See Table 2

Maximum Particle Size		Minimum Voids in Mineral Aggregate
½ in	12.5 mm	16%
¾ in	19.0 mm	15%
1 in	25.0 mm	14%
1 ½ in	37.5 mm	13%

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Mix Designs (continued)

- **Reclaimed Asphalt Pavement (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 percent, 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.**
- **We typically note: RAP shall not be permitted in this contract…**

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Test Section

- **Test Section / Test Strip – varies from project to project but typically consists of a 300‘ X 20’ area placed in two lanes, with a longitudinal cold joint, and shall be constructed at the same depth specified for the construction of the course which it represents.**
- **The test section shall be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 401-5.1 and 401-6.3. The test section shall be divided into equal sublots. As a minimum the test section shall consist of 3 sublots.**
- **Test strip acceptance criteria exceeds production acceptance criteria!**

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Test Section (continued)

- **The test section shall be considered acceptable if; 1) stability, flow, mat density, air voids, and joint density are 90 percent or more within limits, 2) gradation and asphalt content are within the action limits specified in paragraphs 401-6.5a and 5b, and 3) the voids in the mineral aggregate are within the limits of Table 2.**
- **THE RISK!** **If the initial test section should prove to be unacceptable, the necessary adjustments to the job mix formula, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that are not acceptable shall be removed at the Contractor's expense. Full production shall not begin until an acceptable section has been constructed and accepted in writing by the Engineer. Once an acceptable test section has been placed, payment for the initial test section and the section that meets specification requirements shall be made in accordance with paragraph 401-8.1**

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Testing Facilities

- **The Contractor shall provide laboratory facilities at the plant for the use of the Engineer's acceptance testing and the Contractor's quality control testing. The Engineer will always have priority in the use of the laboratory. The lab shall have sufficient space and equipment so that both testing representatives (Engineer's and Contractor's) can operate efficiently. The lab shall also meet the requirements of ASTM D 3666.**

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Testing Facilities (continued)

- **Equipment requirements A – V:**
- **n. Marshall testing equipment meeting ASTM D 6926, ASTM D 6927, automatic compaction equipment capable of compacting three specimens at once and other apparatus as specified in ASTM C 127, D 2172, D 2726, and D 2041**
- **s. Equipment for Theoretical Specific Gravity testing including a 4,000 cc pycnometer, vacuum pump capable of maintaining 30 ml mercury pressure and a balance, 16-20 km with accuracy of 0.5 grams**
- **t. Extraction equipment, centrifuge and reflux types and Rotoflex equipment**

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401-5.1 ACCEPTANCE SAMPLING AND TESTING. (How to get Paid!)

- **Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor except that coring [and profilograph testing] as required in this section shall be completed and paid for by the Contractor.**

401-6.3 QUALITY CONTROL TESTING.

- **The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.**

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QUALITY CONTROL TESTING (continued)

- **a. Asphalt Content: two tests performed per lot**
- **b. Gradation: minimum of twice per lot**
- **c. Moisture Content of Aggregate: once per lot**
- **d. Moisture Content of Mixture: once per lot**
- **e. Temperatures: four times per lot**
- **f. In-Place Density Monitoring: nuclear gauge testing as necessary**

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QUALITY ASSURANCE TESTING

- **Plant-Produced Material. Plant-produced material shall be tested for stability, flow, and air voids on a lot basis. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. Samples shall be taken in accordance with ASTM D 979. A lot will consist of:**

  One day or shift's production not to exceed 2,000 tons (1,814 t), or half day or shift's production where a day's production is expected to consist of between 2,000 and 4,000 tons (1, 814 t and 3,628 t), or Similar subdivisions for tonnages over 4,000 tons (3,628, t).

Where more than one plant is simultaneously producing material for the job, the lot sizes shall apply separately for each plant.

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QUALITY ASSURANCE TESTING (continued)

Acceptance Criteria: General. Acceptance will be based on the following characteristics of the bituminous mixture and completed pavement as well as the implementation of the Contractor Quality Control Program and test results:

(1) Stability
(2) Flow
(3) Air voids
(4) Mat density
(5) Joint density
(6) Thickness
(7) Smoothness
(8) Grade

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QUALITY ASSURANCE TESTING (continued)

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QUALITY ASSURANCE TESTING (continued)
b. Acceptance Criteria.
(1)Mat Density and Air Voids. Acceptance of each lot of plant produced material for mat density and air voids shall be based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable.

(2) Stability and Flow. PWL >= 90%, <90% corrective action, <80% stop production

(3) Joint Density. PWL same as Stability and Flow. If the PWL is less than 71 percent, the pay factor for the lot used to complete the joint shall be reduced by 5 percentage points.

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QUALITY ASSURANCE TESTING (continued)
b. Acceptance Criteria.
(4) Thickness. Thickness of each lift of surface course shall be evaluated by the Engineer for compliance to the requirements shown on the plans. Measurements of thickness shall be made by the Engineer using the cores extracted for each sublot for density measurement. The maximum allowable deficiency at any point shall not be more than ¼ in less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, shall not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or sublot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the Engineer to circumscribe the deficient area.

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QUALITY ASSURANCE TESTING (continued)
b. Acceptance Criteria.
(5) Smoothness. The final surface shall be free from roller marks. The finished surfaces of each course… shall not vary more than ⅜ in when evaluated with a 16 ft straightedge. The finished surface of the final course of pavement shall not vary more than ¼ in when evaluated with a 16 ft straightedge. The lot size shall be 2,000 square yards (typical). Smoothness measurements shall be made at 50 ft intervals… When more than 15 % of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. A Profilograph may be used for smoothness acceptance.

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QUALITY ASSURANCE TESTING (continued)
b. Acceptance Criteria.
(6) Grade. The finished surface of the pavement shall not vary… by more than ½ in (12.70 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15.2 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet) to determine the elevation of the completed pavement… The lot size shall be 2,000 square yards. When more than 15 percent of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates ¾ in or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course of pavement and replace with new material. Skin patching shall not be permitted…

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QUALITY ASSURANCE TESTING (continued)
b. Acceptance Criteria.

Table 5 Marshall Acceptance Limits For Stability, Flow, Air Voids, Density

TEST PROPERTY	Pavements Designed for Aircraft Gross Weights of 60,000 Lb or More or Tire Pressures of 100 PSI or More		Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lb or Tire Pressures Less Than 100 PSI	
Number of Blows	75 blows		50 blows	
	Specification Tolerance Limits		Specification Tolerance Limits	
	L	U	L	U
Stability, minimum (pounds)	1800	--	1000	--
Flow, 0.01-inch	8	16	8	20
Air Voids Total Mix (%)	2	5	2	5
Surface Course Mat Density (%)	96.3	[101.3]	96.3	[101.3]
Base Course Mat Density (%)	95.5	[101.3]	95.5	[101.3]
Joint density (%)	93.3	--	93.3	--

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BASIS OF PAYMENT

a. Basis of Adjusted Payment. The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100 percent or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100 percent or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100 percent.

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject [2]

[1] Although it is theoretically possible to achieve a pay factor of 106 percent for each lot, actual payment above 100 percent shall be subject to the total project payment limitation specified in paragraph 401-8.1.

[2] The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

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BASIS OF PAYMENT

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 401-8.1. Payment in excess of 100 percent for accepted lots of bituminous concrete pavement shall be used to offset payment for accepted lots of bituminous concrete pavement that achieve a lot pay factor less than 100 percent.

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QUESTIONS & ANSWERS!