Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

February 20, 2009

SUBJECT: FAP Route 642 (IL 78)
Project ACF-642 (48)
Section 11RS-3
Carroll County
Contract No. 64638
Item No. 23, March 6, 2009 Letting
Addendum B

NOTICE TO PROSPECTIVE BIDDERS:

Attached is an addendum to the plans or proposal. This addendum involves revised and/or added material.

1. Revised page ii of the Table of Contents to the Special Provisions.
2. Added pages 46 - 65 to the Special Provisions.

Prime contractors must utilize the enclosed material when preparing their bid and must include any Schedule of Prices changes in their bidding proposal.

Bidders using computer-generated bids are cautioned to reflect any and all Schedule of Prices changes, if involved, into their computer programs.

Very truly yours,

Charles J. Ingersoll, Chief
Bureau of Design and Environment

By: Ted B. Walschleger, P. E.
Engineer of Project Management

cc: George F. Ryan, Region 2, District 2; Bill Frey; Estimates

TBW:DB:jc

Revised 02/20/2009

HOT-MIX ASPHALT PAY FOR PERFORMANCE USING PERCENT WITHIN LIMITS

Effective: April 4, 2008 Revised: February 3, 2009

Description: This special provision describes the procedures used for production, placement and payment for hot-mix asphalt (HMA). This special provision applies to all HMA surface mixtures that individually have a minimum quantity of approximately 8,000 tons (7,260 metric tons) and are placed at a minimum nominal thickness equal to or greater than 3 times the nominal maximum aggregate size. This work shall be according to the Standard Specifications for Road and Bridge Construction except as specified herein.

Delete Articles:

406.06(b), 2nd Paragraph	(Temperature requirements)
406.06 (e) 3rd Paragraph	(Pavers speed requirements)
406.07	(Compaction)
1030.05(a) (4, 5, 7, 8, 9, & 10)	(QC/QA Documents)
1030.05(d) (2) a.	(Plant Tests)
1030.05(d) (2) b.	(Dust-to-Asphalt and Moisture Content)
1030.05(d) (2) d.	(Small Tonnage)
1030.05(d) (2) f.	(HMA Sampling)
1030.05(d) (3)	(Required Field Tests)
1030.05(d) (4)	(Control Limits)
1030.05(d) (5)	(Control Charts)
1030.05(d) (6)	(Corrective Action for Required Plant Tests)
1030.05(d) (7)	(Corrective Action for Field Tests (Density))
1030.05(e)	(Quality Assurance by the Engineer)
1030.05(f)	(Acceptance by the Engineer)

1030.06(a) (3, 7, 8, & 9):

- 3 (Before start-up…)
- 7 (After an acceptable…)
- 8 (If a mixture…)
- 9 (A nuclear/core…)

The following documents have been added or modified to replace the equivalent documents in the current Manual of Test Procedures for Materials.

Existing	Replacement (attached)
ERS - HMA QC/QA Initial Daily Plant & Random Samples; Appendix E2	PFP Hot-Mix Asphalt Random Plant Samples
ERS - Determination of Random Density Test Site Locations; Appendix E3	PFP Random Density Procedure
ERS - Quality Level Analysis; Appendix E1	PFP Quality Level Analysis

Definitions:

A. Quality Control (QC): All production and construction activities by the Contractor required to achieve the required level of quality.

B. Quality Assurance (QA): All monitoring and testing activities by the Engineer required to assess product quality, level of payment, and acceptability of the product.

Added 02/20/2009

C. Percent Within Limits (PWL): The percentage of material within the quality limits for a given quality characteristic.

D. Quality Characteristic: The characteristics that are evaluated by the Department for payment using PWL. The quality characteristics for this project are field VMA, voids, and density. Field VMA will be calculated using the combined G_{sb} from the mix design

E. Quality Level Analysis (QLA): QLA is a statistical procedure for estimating the amount of product within specification limits.

F. Sublot: The sublot for field VMA and voids will be 1000 tons. The sublot for density will be 1 mile. If a mixture sublot consists of less than 200 tons or a density sublot consists of less than 200 feet, it shall be combined with the previous sublot.

G. Lot: A lot consists of 10 sublots. If seven or less sublots remain at the end of production of a mixture, the test results for these sublots will be combined with the previous lot for evaluation of percent within limits and pay factors.

H. Density Test: A density test consists of a core taken at a random longitudinal and transverse offset.

<u>Pre-production Meeting:</u>

The Engineer will schedule a pre-production meeting a minimum of seven calendar days prior to the start of production. The HMA QC Plan, test frequencies, random test locations, and responsibilities of all parties involved in testing and determining the PWL will be addressed.

Personnel attending the meetings will include the following:

- Resident Engineer
- District Mixture Control Representative
- QC Manager
- Contractor Paving Superintendent
- Any consultant involved in any part of the HMA sampling or testing on this project

<u>Quality Control (QC) by the Contractor</u>:

The Contractor’s quality control plan shall include the schedule of testing for both quality characteristics and non-quality characteristics required to control the product such as asphalt binder and gradation. The schedule shall include sample location. The minimum test frequency shall not be less than outlined in the Minimum Quality Control Sampling and Testing Requirements table below.

Added 02/20/2009

Minimum Quality Control Sampling and Testing Requirements

Quality Characteristic	Minimum Test Frequency	Sampling Location
Mixture Gradation	1/day	per QC Plan
Binder Content	1/day	per QC Plan
G_{mm}	1/day	per QC Plan
G_{mb}	1/day	per QC Plan
Density	per QC plan	per QC Plan

Revise Article 1030.05(d) (4) to read:

"(4) The QC Manager shall notify the Engineer when corrective action limits are exceeded and describe corrective action.

Quality Control Limits

Characteristic	Corrective Action Limit
Gradation	Moving Average of 4
½ inch	± 6 %
No. 4	± 5 %
No. 8	± 5 %
No. 30	± 4 %
No. 200	± 1.5 %
Voids	± 1.2 %
Field VMA	- 0.7 % or + 2.0 % from Spec Limit
Dust/AC Ratio	Min. 0.6 - Max 1.2
HMA Moisture Content	Max 0.3%"

Initial Production Testing: Three way splits will occur on the first two sublots of a given mixture. The Contractor and Engineer's laboratory shall each run a split and the third portion will be retained for potential dispute resolution. The Contractor and Engineer's laboratory shall complete all tests and report all results to the Engineer within two working days of sampling. If a test strip is utilized, the comparison evaluation may be utilized on the test strip samples.

The Contractor and Engineer's test results will be evaluated for acceptable precision limits listed in the following table.

Acceptable Limits of Precision

Test Parameter	Limits of Precision
½ in. (12.5 mm)	5.0 %
No. 4 (4.75 mm)	5.0 %
No. 8 (2.36 mm)	3.0 %
No. 30 (600 µm)	2.0 %
No. 200 (75 µm)	2.2 %
Binder Content	0.3%
G_{mm}	± 0.026
G_{mb}	± 0.030
Core Density	1.0%

Added 02/20/2009

Upon approval of the initial production testing, production of sublot 1 shall begin. If the initial production testing test results do not meet the acceptable limits of precision, the Contractor and Engineer will jointly review the results, check equipment and review the test procedures for all testing laboratories to determine if there is an identifiable cause for the discrepancy. If the Department results are acceptable, production of sublot 1 shall then begin.

Quality Assurance (QA) by the Engineer:

The Engineer will test each sublot for field VMA, voids, dust/ac ratio and density to determine payment for each lot. A sublot shall begin once an acceptable test-strip has been completed and the AJMF has been determined. If the test strip is waived, a sublot shall begin with the start of production.

Voids, field VMA, and Dust/AC ratio: The mixture sublot size is 1000 tons. The Engineer will determine the random tonnage and the Contractor shall be responsible for obtaining the sample according to the "PFP Hot-Mix Asphalt Random Plant Samples" procedure.

Density: The sublot size for density is one mile. The Engineer will identify three locations within each sublot and the Contractor shall be responsible for obtaining the cores according to the "PFP Random Density Procedure". The locations will be identified after final rolling and cores shall be obtained under the supervision of the Engineer.

Test Results: The Department test results for the first sublot of every lot will be available to the Contractor five working days from the time the sublot has been delivered to a Department's Testing Facility or a location designated by the Engineer. Test results for the completed lot will be available to the Contractor 14 working days from the time the last sublot has been delivered to a Department testing facility or a location designated by the Engineer.

All Department testing will be performed in a qualified laboratory by personnel who have successfully completed the Department HMA Level I training.

The Engineer will maintain a complete record of all Department test results. Copies will be furnished upon request. The records will contain, as a minimum, the originals of all Department test results and raw data, random numbers used and resulting calculations for sampling locations, and quality level analysis calculations.

Dispute Resolution:

If dispute resolution is necessary, the Contractor shall submit a request in writing within four working days of receipt of the results of the quality index analysis for the lot. The request for dispute resolution must include the Contractor's quality control and, if available, split sample test results for the lot. The Engineer will document receipt of the request. The Department central laboratory will be used for dispute resolution testing.

For density disputes, the Engineer will locate and mark the dispute resolution core locations by adding 1.0 ft longitudinally to the location of the original cores tested using the same transverse offset. The Engineer will witness the coring process and take possession of the cores and submit them to the Department central laboratory for testing. The G_{mm} from the original QA test results will be used to calculate the new density values. If, in addition to density, either voids or field VMA are in dispute for the same lot, the new G_{mm} value will be used only to calculate the new density values for the disputed tests.

All dispute resolution results will replace original quality assurance test results. The overall lot pay factor and the lot pay adjustment for the lot under dispute resolution will be recalculated.

If the recalculated overall lot pay factor is less than or equal to the original overall lot pay factor, all costs associated with completing the dispute resolution sample testing will be borne by the Contractor.

If the recalculated overall lot pay factor is greater than the original pay factor, all costs associated with completing the dispute resolution sample testing will be borne by the Department.

Department central laboratory test costs are as follows:

Test	Cost
Mix Testing	$600.00 / sublot
Core Density	$150.00 / sublot

<u>Acceptance by the Engineer and Basis of Payment</u>:

The Engineer may cease production and reject material produced under the following circumstances:

- If the Contractor is not following the approved quality control plan
- If PWL for any quality characteristic is below 50% for any lot
- If visible pavement distress occurs such as segregation or flushing
- If any sublot test exceeds the acceptable limits listed below:

Acceptable Limits

Parameter	Acceptable Range
Field VMA	-1.0 -+3.0%
Voids	2.0 – 6.0 1/
Density:	
IL-9.5, IL-12.5	89.0 – 98.0%
IL-4.75, IL-19.0, IL-25.0	90.0 – 98.0%
SMA	92.0 – 98.0%
Dust / AC Ratio	0.4 – 1.5

1/ The acceptable range for SMA mixtures shall be 2.0% - 5.0%

Added 02/20/2009

Payment will be based on the calculation of the quantity within specification limits for each quality characteristic according to the "PFP Quality Level Analysis" document.

For this contract only the contractor minimum pay will be limited to 92% even if the calculated final pay is less than 92%. However the contractor will still have the possibility of receiving the maximum 103% if the calculated final pay so indicates. This special provision shall only apply to the surface course mixtures.

Dust / AC Ratio

In addition to the PWL on VMA, voids, and density, a monetary deduction will be made using the pay adjustment table below for dust/AC ratios that deviate from the 0.6 to 1.2 range.

Dust / AC Pay Adjustment Table

Range	Deduct / sublot
$0.6 \le X \le 1.2$	$0
$0.5 \le X < 0.6$ or $1.2 < X \le 1.4$	$1000
$0.4 \le X < 0.5$ or $1.4 < X \le 1.6$	$3000
$X < 0.4$ or $X > 1.6$	Shall be removed and replaced

PFP Hot-Mix Asphalt Random Plant Samples

Effective: May 1, 2008

Samples shall be obtained at the frequency specified in the Hot Mix Asphalt Pay for Performance Using Percent within Limits special provision.

A. The random plant samples shall be taken at the randomly selected tonnage within a sublot. The random tonnage will be determined by the Engineer using the "Random Numbers" table as specified herein or an approved software program. The tonnage shall be calculated according to the following:

   1. Unless otherwise known, determine the random locations for a tonnage in excess of five percent over plan quantity by multiplying the plan quantity tonnage by 1.05 to determine an over-projected final quantity. If the over-projected final quantity is not achieved, disregard the additional random values.

   2. Determine the maximum number of sublots needed for the given mixture by dividing the over-projected tonnage calculated above by the sublot size in tons (metric tons). This will determine the maximum number of sublots for the given mixture.

   3. Multiply the sublot tonnage by a three-digit random number, expressed as a decimal. The number obtained (rounded to a whole number) shall be the random sampling tonnage within the given sublot.

Added 02/20/2009

4. The individual sublot random tonnages shall then be converted to the cumulative random tonnages. This is accomplished by using the following equation for each sublot.

$$CT_n = [(ST) * (n - 1)] + RT_n$$

Where: n = the sublot number
CT = Cumulative tonnage
RT = Random tonnage as determined in #3 above
ST = Sublot tonnage (typically 1000 tons)

B. If the paving is completed for a particular mixture before the specified sampling tonnage for the last sublot is achieved, the partial sublot shall be omitted.

C. Plant truck samples shall be taken of the mixture for testing. Two sampling platforms (one on each side of the truck) shall be provided for sampling of the mix. In order to obtain a representative sample of the entire truck, an equal amount of material shall be taken from each quarter point around the circumference of each pile in the truck to obtain a composite sample weighing approximately 200lbs. (95 kg). All truck samples shall be obtained by using a "D"-handled, square-ended shovel with built-up sides and back (1 to 1-1/2 in. [25 to 38 mm]). The sample shall be taken out of the truck containing the random tonnage as determined by the Engineer following the procedure described herein. The sample tonnage will be disclosed no more than 30 minutes prior to sampling. Sampling shall be performed by the Contractor under the supervision of the Engineer.

D. The truck sample shall be divided into three approximately equal size (split) samples by the use of an approved mechanical sample splitter. The Engineer will witness all splitting. Two split samples for Department testing shall be placed in Department-approved sample containers provided by the Contractor and identified as per the Engineer's direction. The Engineer will gain immediate possession of both Department split samples. The Contractor may store, discard, or test the remaining split as described in Section 1030 of the Standard Specifications. However, the Contractor must test and provide the sample results in order to initiate the dispute resolution process as described in the Hot Mix Asphalt Pay for Performance Special Provision.

<u>Example:</u>

Given: - Plan quantity = 10,000 tons for a given mixture. - Sublot = 1000 tons (725 metric tons).

1. Determine the over-projected final tonnage.

10,000 tons * 1.05 = 10,500 tons (Note: Always round up)

Added 02/20/2009

2. Determine the maximum number of sublots needed for the project based on the over-projected tonnage.

10,500 tons/1000 tons = 10.5 (Note: Always round up)

Therefore, 11 maximum sublots

3. Obtain random numbers from the table and apply a different random number to each sublot.

1000 * 0.546 = 546

1000 * 0.123 = 123

Repeat for **each** sublot.

4. Convert **individual** tonnage to cumulative job tonnage.

[1000*(1-1)] + 546 = 546

[1000*(2-1)] + 123 = 1123

Repeat for **each** sublot.

The following contains a completed table for the eleven plant random samples:

Lot Number	Sublot Number	Random Number	Tonnage within Sublot		Cumulative Job Tonnage	
1	1	0.546	1000 * 0.546 =	546	[1000 * (1-1)] + 546 =	546
	2	0.123	1000 * 0.123 =	123	[1000 * (2-1)] + 123 =	1123
	3	0.789	1000 * 0.789 =	789	[1000 * (3-1)] + 789 =	2789
	4	0.372	1000 * 0.372 =	372	[1000 * (4-1)] + 372 =	3372
	5	0.865	1000 * 0.865 =	865	[1000 * (5-1)] + 865 =	4865
	6	0.921	1000 * 0.921 =	921	[1000 * (6-1)] + 921 =	5921
	7	0.037	1000 * 0.037 =	37	[1000 * (7-1)] + 37 =	6037
	8	0.405	1000 * 0.405 =	405	[1000 * (8-1)] + 405 =	7405
	9	0.214	1000 * 0.214 =	214	[1000 * (9-1)] + 214 =	8214
	10	0.698	1000 * 0.698 =	698	[1000 * (10-1)] + 698 =	9698
	11	0.711	1000 * 0.711 =	711	[1000 * (11-1)] + 711 =	10711

Added 02/20/2009

RANDOM NUMBERS

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.301	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.146
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.281	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Note: Always select a new set of numbers in a systematic manner, either horizontally or vertically. Once used, the set should be crossed out.

Added 02/20/2009

PFP Random Density Procedure

Effective: May 1, 2008 Revised: January 1, 2009

Density tests (core samples) shall be obtained at the frequency specified in the Hot Mix Asphalt Pay for Performance Using Percent within Limits special provision. The random test locations shall be determined as follows:

A. The beginning station number shall be established daily and the estimated paving distance computed for the day's production. The total distance paved shall then be subdivided into sublots of one mile each.

B. Three core locations shall be determined for each sublot. Each core location within the sublot shall be determined with two random numbers. The first random number shall be used to determine the longitudinal distance into the one-mile sublot, and the second random number shall be used to determine the transverse offset from the left edge of the paving lane. The entire width of the pavement shall be used in calculating transverse offset when both edges are confined. Unconfined edges of pavement shall omit the outer 1.0 foot from the calculation. Areas outside the mainline pavement that are paved concurrently with the mainline pavement (e.g. three-foot wide left shoulders, driveways) are not considered part of the paved mainline mat.

This example illustrates the determination of the three core locations within a sublot:

The first mile of pavement consists of a 13.0-foot-wide mat with the left edge unconfined and the right edge confined. The random numbers for the longitudinal direction are 0.917, 0.289, and 0.654. The random numbers for the transverse direction are 0.890, 0.317, and 0.428. The core locations are determined by multiplying the longitudinal random numbers by 5280, and transverse random number by multiplying the width of the paved mat less the one, 1.0 foot edge for the left unconfined edge. In this case, the width of the paved mat available for coring is 12.0 feet. Therefore, these are the random cores locations, measured from the beginning of the sublot and the left edge of the paved mainline mat:

Core Number	Longitudinal location	Transverse location
1	5280 x 0.917 = 4841.8 feet	12.0 x 0.890 = 10.7 feet
2	5280 x 0.289 = 1525.9 feet	12.0 x 0.317 = 3.8 feet
3	5280 x 0.654 = 3453.1 feet	12.0 x 0.428 = 5.1 feet

C. This process shall be repeated for the subsequent sublots for the day's production, using a random number for each location.

D. A core shall be cut along each unconfined edge at a rate of 1 per sublot. A random number shall be used to determine the longitudinal distance into the one-mile sublot. This core shall be located a distance equal to the mat thickness from the unconfined edge. This core shall have a minimum density of 90.0%. Failing cores shall require corrective action on the following days paving.

Added 02/20/2009

RANDOM NUMBERS

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.301	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.146
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.281	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Note: Always select a new set of numbers in a systematic manner, either horizontally or vertically. Once used, the set should be crossed out.

Added 02/20/2009

PFP Quality Level Analysis

Effective: May 1, 2008

This stand-alone document explains the statistical procedure used to determine the pay factor for Hot-Mix Asphalt (HMA) mixture based on VMA, voids and in-place density.

Test results will be analyzed statistically by the Quality Level Analysis method using the procedures listed to determine the total estimated percent of the lot that is within specification limits (PWL). Quality Level Analysis is a statistical procedure for estimating the percent compliance to a specification and is affected in the arithmetic mean and the sample standard deviation. Two measures of quality are required to establish the contract unit price adjustment. The first measure is the Acceptable Quality Level (AQL) which is the PWL at which the lot will receive 100 percent pay. The second measure of quality is the Rejectable Quality Level (RQL) at which the Department has determined the material may not perform as desired and may be rejected.

The pay factor on full-depth projects shall be determined by combining pay factors for each mixture proportional to the quantity.

QUALITY LEVEL ANALYSIS

Note: Table 1: Pay Attributes and Price Adjustment Factors contain the UL, LL, and pay factor “f” weights.

The following procedure will be repeated for each pay factor parameter.

(1) Determine the arithmetic mean ($\bar{x}$) of the test results:

$$\bar{x} = \frac{\sum x}{n}$$

Where:

$\sum$ = summation of

x = individual test value

n = total number of test values

(2) Calculate the sample standard deviation(s):

$$S = \sqrt{\frac{n \cdot \Sigma\,(x)^2 - (\Sigma\,x)^2}{n(n-1)}}$$

Where:

$\sum(x^2)$ = summation of the squares of individual test values

Added 02/20/2009

$(\sum x)^2$ = summation of the individual test values squared

(3) Calculate the upper quality index (Q_U):

$$Q_U = \frac{UL - \bar{x}}{s}$$

Where:
UL = upper specification limit or target value (TV) plus allowable deviation

(4) Calculate the lower quality index (Q_L):

$$Q_L = \frac{\bar{x} - LL}{s}$$

Where:
LL = lower specification limit or target value (TV) minus allowable deviation

(5) Determine P_U (percent within the upper specification limit which corresponds to a given Q_U) from Table 2. (Note: Round up to nearest Q_U in table 2.)

Note: If a UL is not specified, P_U will be 100.

(6) Determine P_L (percent within the lower specification limit which corresponds to a give Q_L) from Table 2. (Note: Round up to nearest Q_L in table 2.)

Note: If a LL is not specified, P_L will be 100.

(7) Determine the Quality Level or PWL (the total percent within specification limits).

$$PWL = (P_U + P_L) – 100$$

(8) To determine the pay factor for each individual parameter lot:

Pay Factor (PF) = 53 + 0.5 (PWL)

Determine the Composite Pay Factor (CPF) for each lot. The CPF shall be rounded to 3 decimal places.

$$CPF = \left[f_{VMA}\left(PF_{VMA}\right) + f_{voids}\left(PF_{voids}\right) + f_{density}\left(PF_{density}\right)\right] / 100$$

Substituting from Table 1:

$$CPF = \left[0.3\left(PF_{VMA}\right) + 0.3\left(PF_{voids}\right) + 0.4\left(PF_{density}\right)\right] / 100$$

Added 02/20/2009

Where:
F_{VMA}, f_{voids}, and $f_{density}$ = Price Adjustment Factor listed in Table 1

PF_{VMA}, PF_{voids}, and $PF_{density}$ = Pay Factor for the designated measured attribute

Determine the final pay for a given mixture.

Final Pay = Mixture Unit Price * Quantity * CPF

Table 1: Pay Attributes and Price Adjustment Factors

Measured Attribute	Weight Factor "f"	UL	LL
VMA	.3	MDR[/1] + 3.0	MDR[/1] – 0.7
Plant Voids	.3	AJMF + 1.35	AJMF – 1.35
In-Place Density:	.4	97.0%[2]	91.5%[2]
IL 4.75	.4	97.0%	92.5%
IL-19.0 & 25.0	.4	97.0%	92.2%
SMA	.4	98.0%	93.0%

1. MDR = Minimum Design Requirement
2. Applies to all HMA mixes other than IL-4.75, IL-19.0, IL25.0 and SMA

Example:

The average and standard deviation of a N90 HMA binder have been calculated using the given results:

NOTE: Sublot Number 1 for plant samples may not include the same material as Sublot Number 1 for density.

Added 02/20/2009

Lot #	Sublot #	Voids TV = 4.0	VMA AJMF = 13.0	Density
1	1	4.2	13.0	91.5
	2	4.5	12.5	93.0
	3	3.3	13.0	92.9
	4	5.0	13.3	93.5
	5	5.4	12.9	93.0
	6	2.5	12.4	94.0
	7	3.8	13.4	92.8
	8	4.1	13.0	93.5
	9	4.3	12.6	91.0
	10	4.5	12.8	92.7
	Average:	4.16	12.89	92.79
	Standard Deviation:	0.825	0.325	0.910

Determine the pay factor for each parameter.

Voids:

Lot: Average = 4.16
Standard Deviation = 0.825

$$Q_U = \frac{(4.0 + 1.35) - 4.16}{0.825} = 1.44$$

$$Q_L = \frac{4.16 - (4.0 - 1.35)}{0.825} = 1.83$$

N = 10 sublots (from table)

P_U = 94

P_L = 98

PWL = (94 + 98) - 100

PWL = 92

PF = 53 + 0.5 (92)

PF = 99.0

Added 02/20/2009

Determine the pay factor for Voids.

PF_{Voids} = 99.0

VMA:

Lot: Average = 12.89
Standard Deviation = 0.325

$$Q_U = \frac{(13.0 + 3.0) - 12.89}{0.325} = 9.57$$

$$Q_L = \frac{12.89 - (13.0 - 0.7)}{0.325} = 1.82$$

N = 10 sublots (from table)

P_U = 100

P_L = 98

PWL = (100 + 98) - 100

PWL = 98

PF = 53 + 0.5 (98)

PF = 102.0

Determine the pay factor for VMA.

PF_{VMA} = 102.0

Density:

Lot: Average = 92.79
Standard Deviation = 0.910

$$Q_U = \frac{97.0 - 92.79}{0.910} = 4.63$$

$$Q_L = \frac{92.79 - 91.5}{0.910} = 1.42$$

Added 02/20/2009

N = 10 Density measurements (from table)

P_U = 100

P_L = 93

PWL = (100 + 93) - 100

PWL = 93

PF = 53 + 0.5 (93)

PF = 99.5

Determine the pay factor for Density.

$PF_{Density}$ = 99.5

Determine the pay factor for the given mixture using the above pay factors for each parameter.

CPF = [0.3(99.0) + 0.3(102.0) + 0.4(99.5)] / 100

CPF = 1.001

Determine the price paid for the given mixture.

Given that the mixture bid price per ton = $35.00 and 10,000 tons were placed.

Final Pay = $35.00/ ton * 10,000 tons * 1.001 = $350,350

Final Pay = $350,350

Full Depth Examples:

Given a full-depth project with two mixtures whose pay factors were determined to be 101.5% and 99.2%. The full-depth pay factor shall be calculated as follows:

101.5(1/2) + 99.2(1/2) = 100.4%

Determine the adjusted pay for the full-depth pay factor.

Given that the bid price per square yard = $25.00 and 1400 yd^2 were placed.

Final Pay = $25.00/ yd^2 * 1400 yd^2 * 1.004 = $35,140

Final Pay = $35,140

Added 02/20/2009

Given a full-depth project with three mixtures whose pay factors were determined to be 98.9%, 101.5% and 99.2%. The full depth pay factor shall be calculated as follows:

98.9(1/3) + 101.5(1/3) + 99.2(1/3) = 99.9%

Determine the adjusted pay for the full-depth pay factor.

Given that the bid price per square yard = $25.00 and 1400 yd^2 were placed.

Final Pay = $25.00/ yd^2 * 1400 yd^2 * 0.999 = $34,965

Final Pay = $34,965

Added 02/20/2009

TABLE 2: QUALITY LEVELS
QUALITY LEVEL ANALYSIS BY STANDARD DEVIATION METHOD

P_U OR P_L PERCENT WITHIN LIMITS FOR POSITIVE VALUES OF Q_U OR Q_L	UPPER QUALITY INDEX Q_U OR LOWER QUALITY INDEX Q_L														
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=200	n=201 to infinity
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.53

Added 02/20/2009

TABLE 2 (continued): QUALITY LEVELS
QUALITY LEVEL ANALYSIS BY STANDARD DEVIATION METHOD

P_U OR P_L PERCENT WITHIN LIMITS FOR POSITIVE VALUES OF Q_U OR Q_L	UPPER QUALITY INDEX Q_U OR LOWER QUALITY INDEX Q_L														
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=200	n=201 to infinity
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: For negative values of Q_U or Q_L, P_U or P_L is equal to 100 minus the table P_U or P_L. If the value of Q_U or Q_L does not correspond exactly to a figure in the table, use the next higher value.

Added 02/20/2009