

**QCP Pay Calculation
Appendix E.6**

Effective: January 1, 2012

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This document explains the procedure used to determine the pay adjustment for a hot-mix asphalt (HMA) mixture for Quality Control for Performance (QCP) projects.

The following steps are used to determine the pay deduction for each QCP mixture:

1. Determine subplot deviation from target for each pay parameter.
2. Determine the subplot pay factor for each subplot using the Table 1 and the deviation from target.
3. Determine the average subplot Pay Factor for each pay parameter.
4. Calculate a Combined Pay Factor using the average subplot Pay Factors and Equation 1.
5. Determine the QCP pay deduction for the mixture using Equation 2.
6. The Combined Pay Factor shall not exceed 100%.
7. The 105% column only applies when the district conducts testing of all the sublots within a given lot and all of the tests for an individual pay parameter are within the Acceptable Limits. The 105% column also applies to density sublots where no individual density test is less than 90.0% or greater than 98.0% density. The average subplot Pay Factor for each pay parameter shall be capped at 100.0% prior to calculating the Combined Pay Factor.

Table 1

Parameter	Pay Factor			
	105%	100%	95%	90%
Voids ^{1/ 3/}	± 0.5%	± 1.2%	± 1.6%	± 2.0%
VMA ^{3/}	0% to +1.0% above minimum specified	-0.5% to +2.0%	-0.7% to +2.5%	-1.0% to +3.0%
Density ^{2/4/}	93.5% to 94.5%	92.5% to 96.5%	91.5% to 97.0%	90.0% to 98.0%
SMA	94.0% to 95.0%	93.5% to 96.5%	92.5% to 97.0%	92.0% to 98.0%

1/ Ranges based on deviation from the specified design percent Voids.

2/ If no density requirement applies the Contractor will receive 100% for the density pay factor in Equation 1.

3/ If mixture testing is waived for small tonnage, the Contractor will receive 100% for the Voids and VMA pay factors in Equation 1.

4/ A density test where the core thickness is less than 0.75 inch will not be used in the density pay factor calculation.

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Equation 1: $CPF = 0.30(PF_{\text{Voids}}) + 0.30(PF_{\text{VMA}}) + 0.40(PF_{\text{Density}})$

Where:

CPF = Combined Pay Factor

PF_{Voids} , PF_{VMA} , and PF_{Density} = Average subplot pay factors for the pay parameters

The QCP deduction for a given mixture is calculated by multiplying the Mixture Unit Price by the Quantity and the CPF according to Equation 2 below.

Equation 2: $QCP \text{ Deduction} = (\text{Mixture Unit Price} \times \text{Mixture Quantity} \times CPF/100) - (\text{Mixture Unit Price} \times \text{Mixture Quantity})$

Example:

Determine the QCP pay deduction for the given N70 HMA IL-9.5 surface mixture being placed at 1.5 inches thick as an overlay. The project consists of 6,900 tons placed over a distance of 12 lane miles.

Note that mix sample lots and density lots are independent of one another.

In this example the first mix lot represents 4,000 tons while the second lot represents 2,900 tons. There are 12 density sublots representing 12 lane miles (N=12, representing 12 miles x 5 cores/mile = 60 cores).

Mix sample: Each subplot represents 1000 tons except for lot 2, subplot 3 which represents 900 ton.

Lot	Sublot	Contractor	District	Contractor	District
1	1	4.1	3.2	14.9	14.6
	2	3.9		14.5	
	3	2.5		14.0	
	4	3.0		14.8	
2	1	2.3	2.5	14.3	14.5
	2	2.1	2.2	14.0	14.1
	3	3.8	3.6	14.7	14.6

Note: Bolded and italicized test results denote the subplot split that was randomly selected by the District for testing.

Density: Since this pavement is < 3 inches thick, cores are taken randomly every 0.2 mile which is 5 cores per mile. Each density subplot represents 1 mile. Therefore with cores taken every 0.2 mile, the density subplot will represent the average of 5 density cores.

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Density Sublot	Density Intervals (cores)				
	1	2	3	4	5
1	90.4	90.8	91.6	92.4	92.1
2	93.8	94.1	92.3	92.1	92.6
3	91.8	93.5	93.9	92.8	92.5
4	93.7	94.2	93.5	93.3	92.8
5	92.1	94.1	92.6	93.8	92.3
6	94.1	94.3	93.2	94.5	93.9
7	93.6	93.3	92.5	91.9	92.7
8	92.8	93.3	94.2	93.5	93.7
9	91.5	91.2	91.9	91.8	90.9
⋮	⋮	⋮	⋮	⋮	⋮
12	91.5	93.5	92.7	93.8	92.1

Determine the average subplot pay factor for each parameter:

Voids:

Since the District randomly selected and tested the split from subplot 2 in Lot 1, and the void results were 1) within the 100% pay factor tolerance **and** 2) within Precision Limits of the Contractor's results, the District does not need to test the remaining sublots in Lot 1 and the entire Lot receives a Pay Factor of 100%.

For the second Lot the District randomly selected and tested the split from subplot 1. Since the District void results were not within the 100% pay factor tolerance, the District had to test all of the remaining Sublot splits. (see completed table below):

Calculate the void deviation from target for each of the District subplot split results.

Lot 1:

Sublot 2: Deviation = 3.2% - 4.0% = -0.8%

Lot 2:

Sublot 1: Deviation = 2.5% - 4.0% = -1.5%

Sublot 2: Deviation = 2.2% - 4.0% = -1.8%

Sublot 3: Deviation = 3.6% - 4.0% = -0.4%

Using Table 1 and the deviation from Target, determine the corresponding Void subplot Pay Factor for each District test result.

Lot 1:

Sublot 2: Pay Factor associated with -0.8% in Table 1 is 100%

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Lot 2:

- Sublot 1: Pay Factor associated with -1.5% in Table 1 is 95%
- Sublot 2: Pay Factor associated with -1.8% in Table 1 is 90%
- Sublot 3: Pay Factor associated with -0.4% in Table 1 is 105%

Lot	Sublot	Contractor	District	Deviation	Sublot PF
1	1	4.1	3.2	-0.8	100.0
	2	3.9			
	3	2.8			
	4	3.0			
2	1	2.3	2.5	-1.5	95
	2	2.1	2.2	-1.8	90
	3	3.8	3.6	-0.4	105

Note: Bolded and italicized test results denote the subplot split that was randomly selected by the District for testing.

Calculate the average subplot Pay Factor for Voids. (Note: The 100% in Lot 1 represents four sublots and therefore is multiplied by four)

$$\text{Ave Sublot Pay Factor (PF}_{\text{Voids}}) = ((100\% \times 4) + 95\% + 90\% + 105\%) / 7 \text{ sublots} = \mathbf{98.6\%}$$

VMA:

Since the District randomly selected and tested the split from Sublot 2 in Lot 1, and the VMA results were 1) within the 100% pay factor tolerance **and** 2) within Precision Limits of the Contractor's results, the District does not need to test the remaining sublots in Lot 1 and the entire Lot receives a Pay Factor of 100%.

For the second Lot the District randomly selected and tested the split from Sublot 1. Since the District results were not within the 100% pay factor tolerance **for Voids**, the District had to test all of the remaining subplot splits. (see completed table below):

Calculate the VMA deviation from target for each of the District subplot split results.

Lot 1:

Sublot 2: Deviation = 14.6% - 15.0% = -0.4%

Lot 2:

- Sublot 1: Deviation = 14.5% - 15.0% = -0.5%
- Sublot 2: Deviation = 14.1% - 15.0% = -0.9%
- Sublot 3: Deviation = 14.6% - 15.0% = -0.4%

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Using Table 1 and the deviation from Target, determine the corresponding VMA subplot pay factor for each District test result.

Lot 1:

Sublot 2: Pay Factor associated with -0.4% in Table 1 is 100%

Lot 2:

Sublot 1: Pay Factor associated with -0.5% in Table 1 is 100%

Sublot 2: Pay Factor associated with -0.9% in Table 1 is 90%

Sublot 3: Pay Factor associated with -0.4% in Table 1 is 100%

Minimum VMA = 15.0%					
Lot	Sublot	Contractor	District	Deviation	Sublot PF
1	1	14.9	14.6	-0.4	100
	2	14.5			
	3	14.4			
	4	14.8			
2	1	14.3	14.5	-0.5	100
	2	14.0	14.1	-0.9	90
	3	14.7	14.6	-0.4	100

Note: Bolded and italicized test results denote the subplot split that was randomly selected by the District for testing.

Calculate the average subplot pay factor for VMA. (Note: The 100% in Lot 1 represents four sublots and therefore is multiplied by four)

Ave Sublot Pay Factor (PF_{VMA}) = $((100\% \times 4) + 100\% + 90\% + 100\%) / 7$ sublots = **98.6%**

Density:

Determine the average density for each subplot.

Determine the subplot pay factor using the average subplot density and Table 1 (see completed table below).

Determine the Density pay factor by averaging the subplot pay factors.

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Density Sublot	Density Intervals (cores)					Sublot Ave	Sublot PF
	1	2	3	4	5		
1	90.4	90.8	91.6	92.4	92.1	91.5	95
2	93.8	94.1	92.3	92.1	92.6	93.0	100
3	91.8	93.5	93.9	92.8	92.5	92.9	100
4	93.7	94.2	93.5	93.3	92.8	93.5	105
5	92.1	94.1	92.6	93.8	92.3	93.0	100
6	94.1	94.3	93.2	94.5	93.9	94.0	105
7	93.6	93.3	92.5	91.9	92.7	92.8	100
8	92.8	93.3	94.2	93.5	93.7	93.5	105
9	91.5	91.2	91.9	91.8	90.9	91.5	95
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
12	91.5	93.5	92.7	93.8	92.1	92.7	100
Average Density Sublot PF =						100.5	

Combined Pay Factor:

Determine the Combined Pay Factor using Equation 1.

$$\begin{aligned} \text{CPF} &= 0.30(\text{PF}_{\text{Voids}}) + 0.30(\text{PF}_{\text{VMA}}) + 0.40(\text{PF}_{\text{Density}}) \\ &= 0.30(98.6) + 0.30(98.6) + 0.4(100.0) \\ \text{CPF} &= 99.2\% \end{aligned}$$

QCP Deduction:

Determine the QCP deduction pay for the given mixture using Equation 2.

$$\text{QCP Deduction} = (\text{Mixture Unit Price} \times \text{Mixture Quantity} \times \text{CPF}/100) - (\text{Mixture Unit Price} \times \text{Mixture Quantity})$$

Where: Mixture Unit Price = \$65.00

Mixture Quantity = 6,900 tons placed.

$$\begin{aligned} \text{QCP Deduction} &= (\$65.00/\text{ton} \times 6,900 \text{ tons} \times 99.2 / 100) - (\$65.00/\text{ton} \times 6,900 \text{ tons}) \\ &= - \$3588 \end{aligned}$$

In this case a \$3588 disincentive would be paid as per Construction Memorandum 10-4.

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Full Depth Examples:

Given a full-depth project with two mixtures whose combined pay factors were determined to be 100.0% and 98.2%. The full-depth pay factor shall be calculated as follows:

$$100.0(1/2) + 98.2(1/2) = 99.1\%$$

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

Given that the bid price per square yard = \$25.00 and 1400 yd² were placed.

$$\text{Plan Unit Pay} = \$25.00/\text{yd}^2 * 1400 \text{ yd}^2 = \$35,000$$

$$\text{Adjusted Pay} = \$25.00/\text{yd}^2 * 1400 \text{ yd}^2 * 0.991 = \$34,685$$

$$\text{Difference} = \$34,685 - \$35,000 = - \$315$$

Given a full-depth project with three mixtures whose pay factors were determined to be 98.9%, 100.0% and 99.2%. The full depth pay factor shall be calculated as follows:

$$98.9(1/3) + 100.0(1/3) + 99.2(1/3) = 99.4\%$$

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

Given that the bid price per square yard = \$25.00 and 1400 yd² were placed.

$$\text{Plan Unit Pay} = \$25.00/\text{yd}^2 * 1400 \text{ yd}^2 = \$35,000$$

$$\text{Adjusted Pay} = \$25.00/\text{yd}^2 * 1400 \text{ yd}^2 * 0.994 = \$34,790$$

$$\text{Difference} = \$34,790 - \$35,000 = - \$210$$

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