COMPARING COOLING OF WARM MIX TO HOT MIX ASPHALTS

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Title

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Warm mix asphalt (WMA) is increasingly being tried in highway paving in the United States. Apart from environmental benefits, WMA is being considered useful in projects involving long haul distances and late season paving operations due to its material characteristics and the rate of cooling during field compaction. This thesis investigates whether WMA cools at a slower rate than hot mix asphalt (HMA) to offer more compaction time. Following an indirect investigative approach, comparative analysis of field observations with software predicted values for two paving projects was carried out. The results indicated that some types of WMA cool at a slower rate than HMA and would allow a longer period of compaction time to achieve the same density as HMA. The findings presented here can be informative to the asphalt paving industry in considering WMA for use in long haul, nighttime, and late season paving.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my advisor Dr. Jongchul Song for the continuous support during my master's study, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my study.

Besides my advisor, I would like to thank the rest of my thesis committee members; Dr. Jerry Gao and Dr. Adnan Akyuz, and faculty and staff of Department of Construction Management and Engineering for their encouragement and guidance.

DEDICATION

I would like to dedicate this thesis to my beloved parents, teachers and friends, without their love, encouragement and guidance I would not be, what I am today.

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1. INTRODUCTION

The highways in the western parts of the state of North Dakota have faced an immense surge of heavy truck traffic since the discovery of oil fields in the region. Roads which were initially designed for farm-to-market travel are now being used by big trucks to access rigs and wells, destroying country's highway system (Holeywell, 2011). In aggressive efforts to improve the infrastructure, the NDDOT has invested approximately $940 million in state projects from 2008-2012 to preserve and improve transportation infrastructure and plan on investing an additional $1.16 billion in the 2013-2015 biennium (NDDOT Portal). The period of highway construction in North Dakota is limited to the months of May through October due to severe cold weather conditions as it affects the construction process. Even with all the resources and dedication, the state has a limited time of the year to develop the infrastructure and maintain its performance. One of the determinants of long-term performance of highway asphalt pavements is density or in-place air voids of asphalt mixes (Bell et al. 1984; Linden et al. 1989). Compacting asphalt mixes to a low air voids level helps to minimize fatigue cracking, thermal cracking, and moisture susceptibility. The ability to compact an asphalt mix to desirable density is influenced by many material-related factors, such as the grade and content of asphalt binder, and moisture content and proportion of aggregates. However, temperature of an asphalt mix during paving is also an important factor to achieving proper density (Chadbourn et al. 1998, Hughes 1989). If temperature falls below cessation temperature, desirable density may not be attained. Maintaining asphalt temperature during transit period and compacting it to attain required density before it reaches cessation temperature is difficult during winter's extreme cold weather North Dakota. It is a dire need to find materials or improve processes which facilitate the paving process and provide more time in a year for highway construction in the region.

The importance of mix temperature to available compaction time is recognized in the paving industry practices. For example, the break-down compactor strives to keep up with the pace of mix laydown while making a sufficient number of passes. Although the success of such efforts can only be determined (and rewarded) upon the density measurements of core samples, the sufficient number of roller passes depends on mix laydown temperature, mix characteristics (e.g., stiffness), and the environmental conditions during paving. These factors come down to the required time for compaction, i.e., how long it will take a mix to cool, under the given environmental conditions, to a temperature that may no longer permit compaction. The time asphalt mix takes to reach this cessation temperature is a required piece of information for planning efficient paving operations.

The time taken by an asphalt mix to cool to a certain temperature during paving can be predicted using several computational models, discussed later. In solving the governing heat equation, these models require the knowledge of thermal properties of a mix as well as environmental boundary conditions. Chadbourn et al. (1998) experimentally determined thermal diffusivity of hot mix asphalt (HMA) to range from $0.37 \times l0^{-6}$ to $1.44 \times l0^{-6}$ m^2/s. However, it is unknown whether or not relatively new, warm mix asphalt (WMA) has similar thermal properties as HMA and therefore cools at a similar rate as HMA under similar field conditions.

This thesis compares cooling of HMA and WMA as observed from two paving projects in North Dakota. Its primary focus is to determine whether WMA will cool more slowly than HMA to allow longer compaction time under similar field conditions. The findings can be useful for the asphalt paving industry in assessing the potential of WMA for use in long haul projects and late season or nighttime paving where slower cooling and longer compaction time of WMA can help to achieve desirable density.

2. BACKGROUND AND LITERATURE REVIEW

Long-term performance of asphalt pavement can decrease in five areas; rutting, fatigue cracking, thermal cracking, moisture susceptibility, and friction. Except for moisture susceptibility, no specific tests are available to predict long-term performance of SuperPave hot mix asphalt (HMA) over a wide range of materials, traffic and climatic conditions (Brown et al. 2004). Since fatigue cracking, thermal cracking, and moisture susceptibility can be minimized by compacting asphalt mixes to low air voids, density has been used for years as a quality characteristic of HMA to determine conformance with performance requirements (Von Quintus et al. 2009). Most agencies use core density for evaluation and acceptance of HMA layers because cores provide accurate results, but it can take several days to obtain results and the number of samples is limited due to the destructive nature of the method (Starry 2010).

There are many factors affecting compaction of asphalt pavement, including material properties such as binder grade and content, and type and proportion of aggregates. Nevertheless, temperature of an asphalt mix during paving is considered the most important factor in achieving proper density (Chadbourn et al. 1998, Hughes 1989, Schmitt et al. 2009). For a given compactive effort, the lower the temperature of the mix at the time of compaction, the lower the density obtained (McLeod 1967). Willoughby et al. (2001) indicated that when an asphalt mat varies in temperature by 25°F (14°C) or greater, the relatively cold area may not be compacted to the same density level as the surrounding area. When the mix temperature falls below what is referred to as cessation temperature, compaction may no longer be able to increase density (Dickson and Corlew 1970, Foster 1970). Often cited as cessation temperature is "an average layer temperature of 175°F (80°C)," below which additional compaction is uneconomical or injurious to the pavement (Tegeler and Dempsey 1973). This value of cessation temperature was

observed by Parker (1960) in the field for achieving desirable pavement density for then available and used hot mix asphalt. Although the value has been used by various researchers, it is unclear if the value was also verified through lab experiment and mathematical calculation. Therefore the value is merely used as a guideline rather than a set criterion.

The limited compaction time associated with mix temperature can pose a challenge during asphalt pavement construction in adverse field conditions. Although mix temperature can be adjusted at the asphalt mix plant, excessively high mix temperature can damage asphalt binder and cause the mix to be tender when rolled (APEC 2000). Despite the limited ability to adjust mix temperature and the difficulty with density control in the field, asphalt paving contractors have been achieving specified density through the use of best practices. For example, keeping the rollers directly behind the paver helps to maximize the use of available compaction time (Foster 1970, Scherocman 2006).

There have been many research efforts to predict available compaction time, i.e., the time that an asphalt mix takes upon laydown to cool to the cessation temperature (Chadbourn et al. 1998; Chang et al. 2009; Corlew and Dickson 1968; Hunter and McGuire 1986; Jordan and Thomas 1976; and Tegeler and Dempsey 1973). Except for Chang et al. (2009), available compaction time had been estimated by solving the equation of transient heat diffusion within an asphalt mat rather than using a steady state heat diffusion equation. Whereas steady state flow considers temperature within a material to vary only in space, transient heat flow involves temperature varying in both space and time.

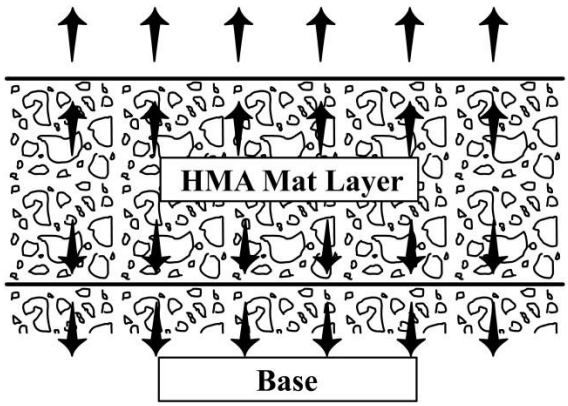


Figure 1. Idealized one-dimensional heat flow of asphalt mat during paving

Figure 1 illustrates the flow of heat (thermal energy) in one dimension from an asphalt mat during construction. One-dimensional transient flow of heat in a finite-thickness asphalt pavement slab is one of the basic problems. The rate of flow of heat from upper and lower physical boundaries of the pavement at any particular time is dependent on environmental conditions at the respective boundaries as well as thermal properties and temperature distribution of the mix and the base (Corlew and Dickson 1968). The time rate of temperature change at a point within the pavement slab, i.e., cooling rate, is proportional to the net heat flow through that point. This proportionality is represented by a material property called thermal diffusivity (α), which indicates how quickly the material carries heat away and is defined in terms of thermal conductivity, specific heat, and density.

$$\frac{\partial u}{\partial t}(x,t) = \alpha \frac{\partial^2 u}{\partial x^2} \quad \text{(Eq. 1)}$$

Above is the heat diffusion equation within a solid, represented by a second order partial differential equation that relates the time rate of temperature change at any point within the material to the net heat flow through that point (Powers 2006), i.e., the equation shows the relationship of temperature, u, with time, t, and position coordinate, x, while thermal diffusivity, α, being the proportionality constant. For a given asphalt mix, thermal diffusivity is

often assumed constant with respect to space and independent of temperature, as is the case with most existing models of asphalt cooling, although an asphalt mix may not actually be uniform in composition and its specific heat may vary with temperature.

The heat diffusion equation in Eq.1 by itself yields only general solutions, and to find the unique solution to a given problem, the equation needs to be solved together with other equations that describe the initial and boundary conditions appropriate for the problem at hand. In many real-world problems including asphalt pavement cooling, the differential equation can be solved by numerical methods, which change the differential equation to a system of finite difference equations. Then the solution, i.e., temperature at a point within the mat at each time instance, can be plotted over a time period as shown in Figure 2, giving a cooling curve from which the time to cool to the cessation temperature can be read. The slope of the cooling curve indicates the cooling rate. By the cooling rate, we mean the first derivative of temperature with respect to time, which in transient heat flow differs from the amount of temperature decrease over a given time span – there is an analogous distinction between instantaneous velocity and average velocity.

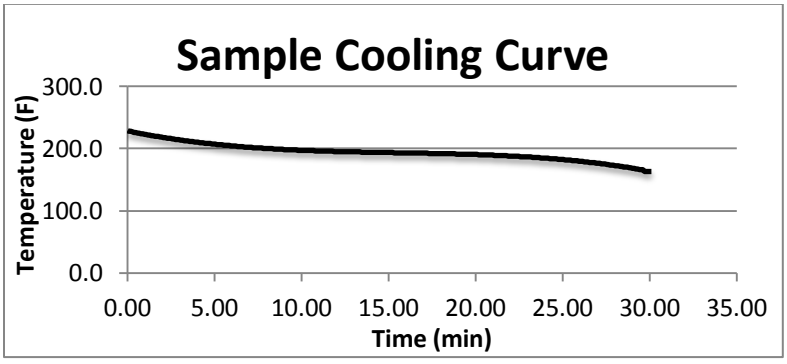


Figure 2. Sample cooling curve

It should be noted however that numerical methods do not yield the cooling rate of the material as an explicit function of time and space variables, and thermal diffusivity. Rather,

thermal diffusivity is a required input parameter for solving Eq. 1 shown above. Based on experimental determination of conductivity of HMA, Chadbourn et al. (1998) estimated its thermal diffusivity to range from 0.37 x $l0^{-6}$ to 1.44 x $l0^{-6}$ m^2/s. This estimated range of thermal diffusivity values was used by Tim et al. (2001) in developing MultiCool, a PC-based software tool to implement a finite difference method. However, thermal diffusivity of other types of asphalt mixes such as WMA has not been explicitly determined so far. If the thermal diffusivity of WMA is assumed to be the same as for HMA, then that assumption would lead to prediction of the same cooling time as HMA under the same environmental conditions. While HMA is currently the major paving material used in the United States, WMA is increasingly being used in highway paving. WMA is typically produced in the range of 220 to 275°F (104 to 135°C), which is as much as 100°F (56°C) lower than HMA production temperatures. With a chemical additive, wax or water introduced into the production process, WMA can achieve low viscosity relative to the production temperature. The relatively low viscosity of WMA has the positive effect of reducing temperature dependency of compaction and towards attaining required density. In fact, most WMA trial sections constructed showed no significant difference in density from HMA control sections (e.g., Diefenderfer et al. 2007). However, the potential use of WMA in adverse field conditions has not been tested as extensively, and it remains uncertain whether or not WMA will cool at such a slow rate to significantly influence available compaction time.

In summary, available compaction time is important for asphalt pavement construction in achieving density for desirable long-term performance. Despite the increasing use of WMA, its potential for use under adverse field conditions has not been sufficiently rigorously investigated. Existing numerical methods are useful in predicting available compaction time for HMA, but extending their application to WMA requires determination of thermal properties of WMA,

which may differ from those of HMA. With the knowledge of thermal diffusivity of WMA, its cooling rate could be estimated using an existing numerical method to solve the heat diffusion equation in Eq. 1 given the initial conditions (temperature distribution) of the material and its boundary conditions. Without the knowledge of actual thermal diffusivity values of WMA, this thesis compares cooling of WMA and HMA by an indirect means. The focus of this thesis is on determining whether or not WMA differ significantly from HMA in thermal properties to affect available compaction time. The knowledge from the research can provide a basis towards putting efforts to determine thermal diffusivity values of all types of asphalt mixes being used in the industry and develop accurate mathematical model for temperature prediction of different asphalt types considering their thermal properties.

3. METHODOLOGY

In this thesis cooling of WMA and HMA is compared by an indirect means. The steps followed in the research have been summarized in the flow chart shown in Figure 3. The research was initialized with review of the literature related to asphalt paving, cooling of asphalt mix and existing methods of calculating cooling rate. The problem identified for the research was to determine whether or not new types of asphalt mix, WMA has similar cooling rate as of HMA. Projects from previous research performed by Song and Gao (2012) were selected for the study and results from prior analysis by the authors were reviewed to formulate a hypothesis for testing. Hypothesis was formulated according to which it was assumed that WMA and HMA have similar cooling rate. Indirect investigative approach was used to test the hypothesis by collecting the environmental data and using it in software MultiCool to predict asphalt temperatures. The predicted temperatures were compared with actual asphalt temperatures observed and recorded in the field by Song and Gao (2012). The decision of accepting or rejecting the hypothesis was made based on the results of the comparison.

While we impose the actual initial and boundary conditions on the transient cooling problem, we solve it under the hypothesis that WMA and HMA have similar cooling rates implying that WMA is not significantly different from HMA in thermal diffusivity. The transient heat flow equation is solved using MultiCool (Tim et al. 2001). Figure 4 shows graphical user interface of MultiCool software with input variables entered and the cooling curve predicted on one of the samples obtained during ND 3 highway paving.

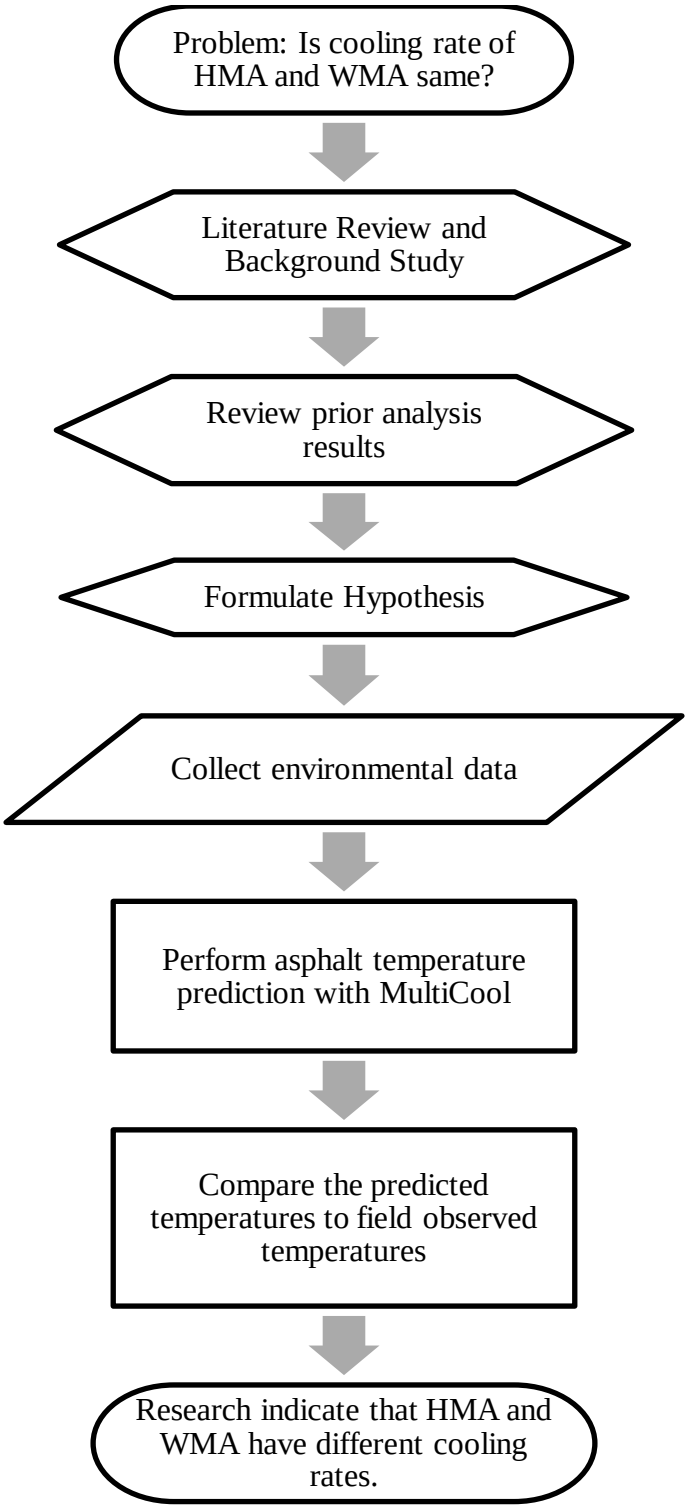


Figure 3. Flow chart summarizing the steps of the research

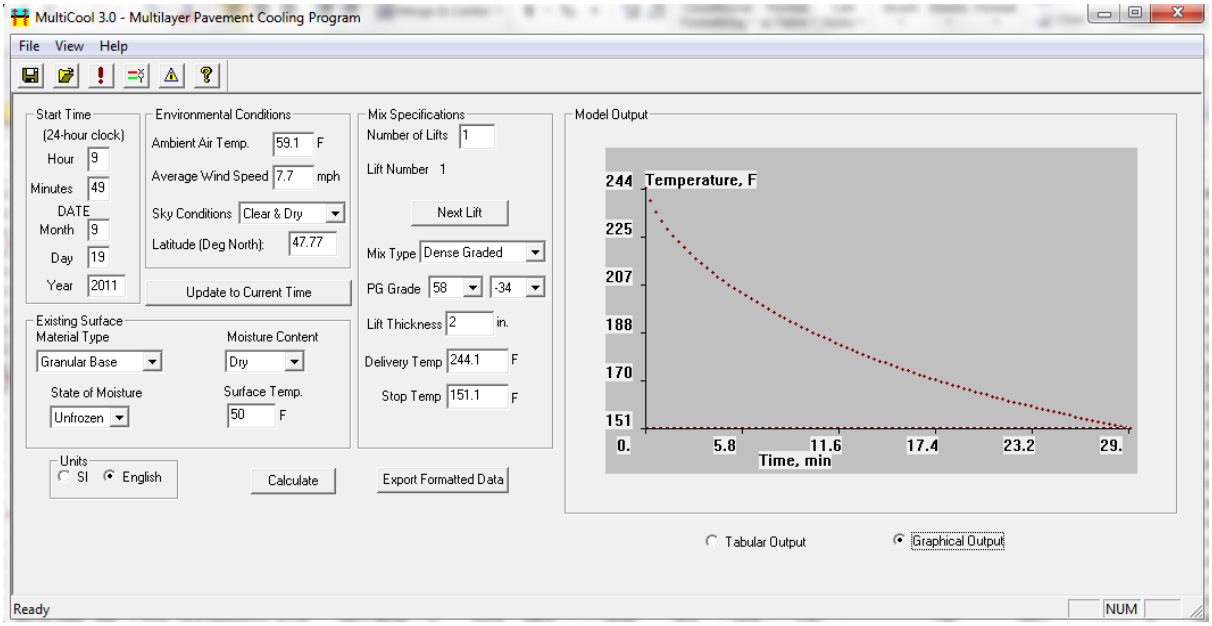


Figure 4. MutliCool interface showing example calculation for a sample of ND3 HMA

Actual laydown temperatures are input into MultiCool as well as other collected data that represent actual field conditions, except for mix type. In fact, MultiCool, developed prior to the advent of WMA, does not have WMA as a possible input choice for mix type. Treating actual WMA as if it were one type of HMA has an effect of MultiCool taking as the thermal diffusivity value of WMA, one that had been set for HMA. Finally, the difference thus found in cooling time of WMA between the MultiCool-predicted and the field-observed is evaluated to test the hypothesis that the unknown thermal diffusivity value of WMA does not differ from the presumed value, one of HMA. The difference between the predicted and observed cooling time of WMA is then compared: (1) to the difference between the predicted and observed cooling time of HMA; and (2) in relation to the overall paving cycle time of WMA. The purpose of the comparison is to find the extent to which behavior of the types of asphalt mixes varies. This variation in the behavior of the asphalt mix in terms of cooling time is translated into the available time for paving which is very important for field operations especially for projects with

long haul distance, during severe weather or night time. From the review of Song and Gao (2012), comparison of time taken for complete paving cycle by different asphalt types at a project among each other was observed to determine if paving cycle time for a certain type of asphalt was more variable then the others. Also, the results of core density test were reviewed for meeting specified density requirement and compared for consistency in results to assess the validity of expected performance of each type of asphalt mix.

As an example of cooling time calculation and comparison, for a sample of HMA at ND 3 paving actual temperatures at laydown and end of paving process were observed to be 241.7^{o}F and 136.0^{o}F respectively with a total duration of 26.22 minutes for complete paving process. Using these values along with other field observed data, cooling curve was plotted using the software MultiCool to find software predicted cooling time and temperatures. Actual time elapsed (t_a) for the same sample at the end of breakdown rolling was 14.42 minutes when surface temperature (U_a) of the asphalt mat was observed to be 164.2^{o}F. Software predicted breakdown rolling end time (t_p) to be 21 minutes when average layer temperature (U_p) is predicted to be 175.3^{o}F. Since the predicted temperature is the average layer temperature of the asphalt mat, it is expected to be higher than the actual observed surface temperature. Similarly time duration for the asphalt mat to cool down to average layer temperature is also expected to be longer than the actual time duration observed for the surface temperature. In the above mentioned example, difference between actual and predicted time ($t_a - t_p$) is -6.58 minutes and difference between actual and predicted temperature ($U_a - U_p$) is -11.10^{o}F. The negative signs show that the results of the comparisons are in conformance with how the asphalt mat is expected to cool down naturally. In case the comparison yields positive difference, the result will be in contradiction with the natural cooling behavior and defy the hypothesis.

4. ANALYSIS

4.1. Description of Data

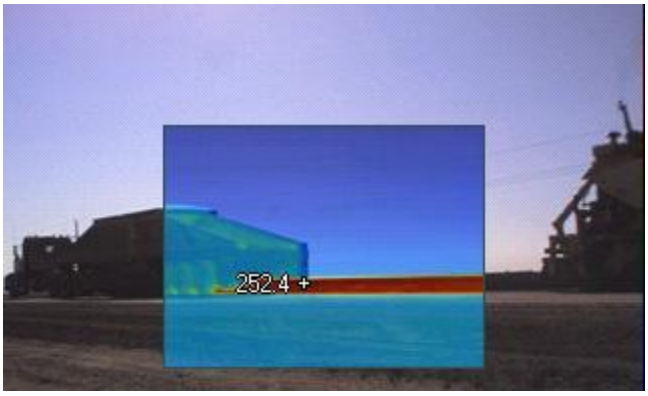
Data needed include climatic data and asphalt mix temperatures. Climatic data were obtained from local weather reports, including air temperature, wind speed, and cloud cover. Collected climatic data can be found in Appendix A.

Asphalt mix temperatures during paving had been recorded by Song and Gao (2012), using an infrared camera from two projects in North Dakota (Table 1). These projects were among the first five WMA pilot projects of the state and were completed by two different paving contractors in September 2011 and June 2012, respectively. Overall three different types of WMA were used in the two projects, namely Advera, Evotherm, and foamed asphalt, which are among the most tried WMA additives and processes by the twenty northern states (Saboori et al. 2012). The project scope included blade patching on the existing HMA pavement, overlaying the undivided two-lane rural highways with HMA and WMA, and compacting the overlays to two inches. Both projects used a windrow elevator (Figure 5) attached to a paver and the same type of rollers in breakdown rolling and finish rolling, i.e., double steel drum rollers in vibratory and static modes, respectively. For intermediate rolling, a pneumatic tire roller was used for ND 15 paving, and a double steel drum, vibratory roller for ND 3 paving.

Table 1. Paving Projects to be Tested (Song and Gao, 2012)

Project No.	Overall Length[1]	HMA Control Section[2]	WMA Trial Section[2]	Grade of Asphalt Concrete	Aggregate	Compacted Thickness
ND 15	21 miles	3.5 miles	3 miles (Evotherm); 4.5 miles (foamed)	PG 58-28	Class 29 (HMA); FAA[3] 43 (WMA)	2 inches
ND 3	18 miles	3 miles	2.5 miles (Advera)	PG 58-28	FAA[3] 43	2 inches

[1]Based on mile points; multiply 2 for equivalent lane-miles.
[2]Based on mile points between which temperature recording was performed.
[3]Fine aggregate angularity.



(a) in front of windrow elevator

(b) behind windrow elevator

Figure 5. Window elevator used in the project (Courtesy by Song, J.)

Song and Gao (2012) performed temperature recording at every location at the following intervals: (1) out of the haul truck (unloading), (2) immediately behind the paver (laydown), (3) immediately before the start of breakdown rolling, intermediate rolling, and finish rolling, and (4) at conclusion of each rolling. The total number of temperature recording locations for each mix type varied from 12 locations for the ND 3 HMA section to 17 locations for the ND 15 Evotherm section. One of the thermal pictures is shown in Figure 6. All thermal pictures that are included for analysis in this thesis, presented later, can be found in Song and Gao (2012).

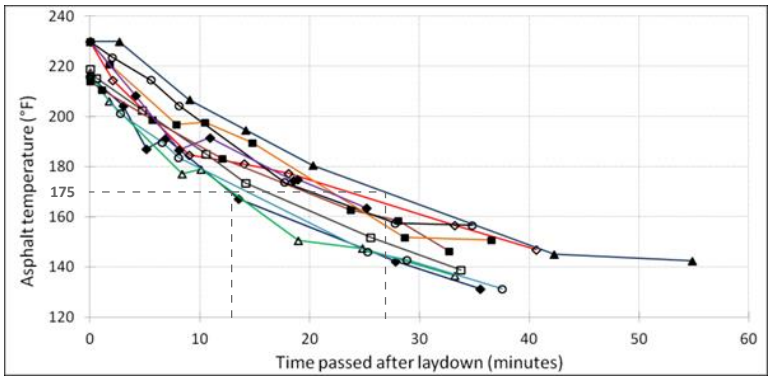
Figure 6. Sample picture of asphalt mat temperatures (Song and Gao, 2012)

4.2. Overview of Data Analysis

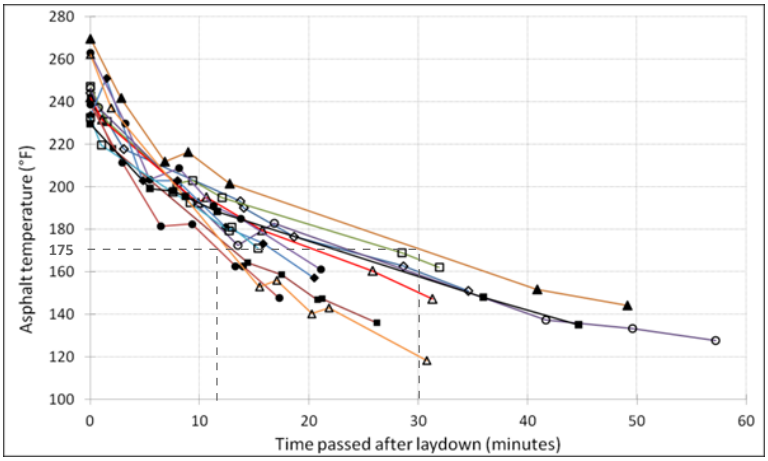
Data analysis was performed in several steps. As a first step, the field temperatures of WMA and HMA were plotted against time, and the plots were visually inspected to discern any differences between cooling of WMA and HMA, described later. Secondly, MultiCool was used to predict the temperature of WMA during paving (with its thermal diffusivity assumed as one type of HMA). We then checked the solution (predicted asphalt temperature) against the actual temperature measured in the field and evaluated whether or not the hypothesis stated earlier would be true. The paving cycle time used in this thesis was the time from laydown till the end of finish rolling as per Song and Gao (2012). Results from their previous analysis for paving cycle time were reviewed to determine if paving cycle time for a certain type of asphalt was more variable then the others. This variation of paving cycle time could be translated into the available time for breakdown rolling and intermediate rolling during which 90% of the pavement density is achieved. Review of pavement density test results from Song and Gao (2012) was presented to validate the applicability of WMA as equally acceptable for performance as HMA.

4.3. Asphalt Mat Temperature

Figure 7 shows the change of mat temperature with time during ND 3 paving (Song and Gao, 2012). Temperatures shown are the average surface temperature of a freshly laid asphalt mat over the 12 feet (3.7 m) lane width, excluding the tapered edge. The time shown in Figure 7 is the time that elapsed after the asphalt mix was laid down by the paver. A series of plotted points in Figure 7 correspond to discrete time points during paving operations at which thermal pictures were taken.



(a)



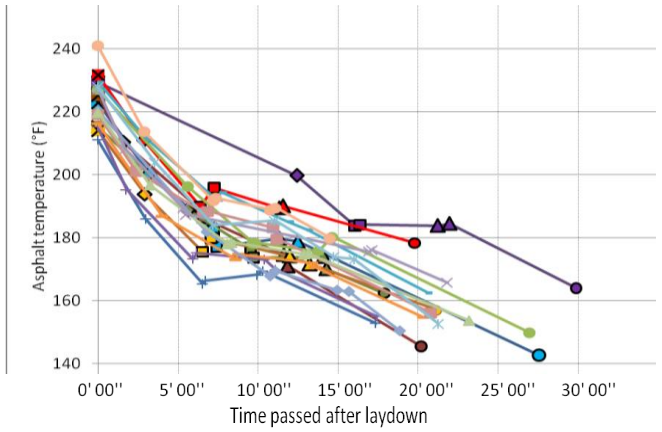
(b)

Figure 7. ND 3 project – asphalt mix temperatures: (a) WMA (Advera) and (b) HMA (Song and Gao, 2012)

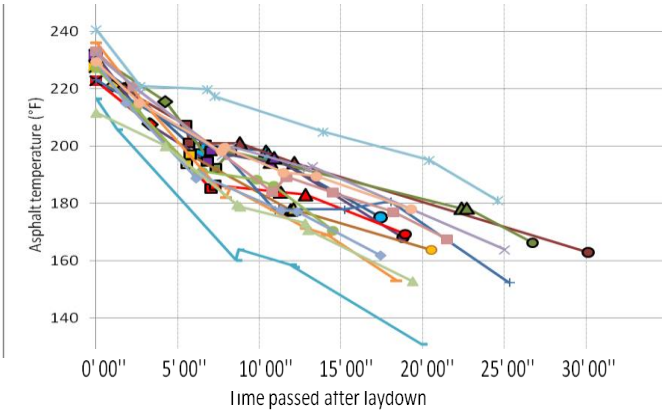
Reviewing the comparison of WMA and HMA temperatures during ND 3 paving (Figure 7), the following observations are made:

- At laydown (behind the paver), WMA was lower in temperature: on average 223°F (106°C), compared to 250°F (121°C) for HMA.
- At the end of breakdown rolling, WMA was higher in temperature: on average 195°F (91°C), compared to 189°F (87°C) for HMA. Breakdown rolling on the WMA section was completed 2 minutes earlier.
- WMA temperatures were more consistent from location to location.
- WMA temperatures decreased by a lesser amount: 79°F (44°C) drop from laydown to finish rolling compared to 99°F (55°C) decrease for HMA.
- The overall temperature decrease during WMA paving was more consistent from location to location: with standard deviation of 7°F (4°C), compared to 22°F (12°C) for HMA.

Similar observations were made reviewing the results of analysis performed by Song and Gao (2012) during ND 15 paving. Compared to the HMA section (Figure 8(c)), WMA sections (Evotherm: Figure 8(a) and foamed asphalt: Figure 8(b)) were laid down at lower temperatures. WMA was more consistent in temperature from location to location than HMA, and the overall temperature drop was smaller in WMA sections than in HMA section. Unlike ND 3 paving, ND 15 paving however experienced slightly more variable temperature decreases over the WMA sections.



(a)



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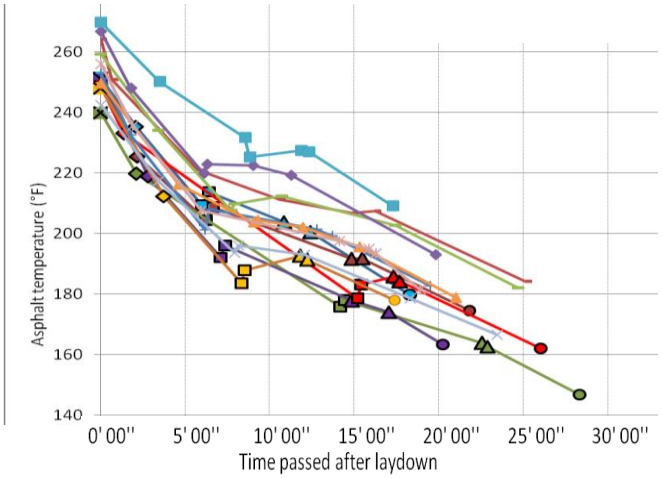


(c)

Figure 8. ND 15 project – asphalt mix temperatures: (a) Evotherm, (b) Foamed Asphalt and (c) HMA (Song and Gao, 2012)

4.4. Paving Cycle Time

The time taken by the laid asphalt mix to be compacted to the desirable pavement density is of significant importance since it is the parameter against which change in temperature of the asphalt mat is evaluated to determine the rate of cooling. Elapsed time after the asphalt mix had been laid down was recorded throughout the paving operation till finish rolling by Song and Gao (2012) and their observations of paving cycle time is given in Table 2. Following observations were made regarding paving duration:

- For ND 3 paving, WMA took a longer period of time to pave: 36.5 minutes for WMA, and 31.5 minutes for HMA. However, the overall cycle time from laydown to finish was more consistent during WMA paving (standard deviation 7.5 minutes) than during HMA paving (standard deviation 13.0 minutes).
- For ND 15 paving, WMA took about the same period of time as HMA to pave: 21.0 minutes for WMA, and 21.5 minutes for HMA. However, the overall cycle time was slightly more variable during WMA paving (standard deviation 4.0 minutes) than during HMA paving (standard deviation 3.5 minutes).

Table 2. Paving cycle time (minutes)

		Minimum	Average	Maximum
ND3 Paving	HMA	15.35	32.98	57.17
	Advera	25.15	36.47	54.85
ND15 Paving	HMA	17.23	21.53	28.30
	Evotherm	14.50	21.14	29.87
	Foamed	14.47	21.10	30.12

4.5. Testing the Hypothesis

Following the indirect approach described in Research Methodology, the asphalt mat temperatures and corresponding cooling times were compared in order to avoid possible inaccuracies incurred by many factors influencing cooling rates.

The comparative analysis of cooling time taken by the asphalt mats of different asphalt mixes was performed assuming that WMA is not significantly different from HMA in thermal diffusivity. Based on this proposition, a PC-based software MultiCool (Tim et. al, 2001) was used to predict expected time to cool from laydown temperature to the temperature at the end of breakdown rolling. This was done by defining the actual temperature range along with the initial and boundary conditions observed in the field. Table 3 shows a sample print of the MultiCool calculation that shows input variable values for one sample of Advera from ND 3 paving project. Appendix B includes MultiCool calculation outputs along with input variable for all samples of different types of asphalt mix.

Table 3. A Sample of the MultiCool Calculations with Input Variable Values

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:30:09 2013
Sample: ND3 Advera S04

PAVING START TIME

Hour:	13
Min.:	39
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	142.5

***ENVIRONMENTAL CONDITIONS

The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	69.7	9.1	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	114.4 F

Lift	Lift time, min
1	57

Total Time of Paving Operation:57.00 min

COOLING CURVES (Temp (F))

Actual Time Time, min	Lift 1	Time, min	Lift 1
0	230	30	160
1	220.88	31	159.07
2	215.07	32	158.18
3	210.53	33	157.31
4	206.63	34	156.47
5	203.14	35	155.66
6	199.96	36	154.87
7	197.01	37	154.1
8	194.28	38	153.36
9	191.72	39	152.63
10	189.33	40	151.93
11	187.07	41	151.25
12	184.95	42	150.58
13	182.94	43	149.94
14	181.04	44	149.31
15	179.23	45	148.69
16	177.52	46	148.09
17	175.88	47	147.51
18	174.33	48	146.94
19	172.84	49	146.38
20	171.42	50	145.84
21	170.06	51	145.31
22	168.76	52	144.79
23	167.51	53	144.28
24	166.31	54	143.78
25	165.16	55	143.3
26	164.05	56	142.82
27	162.98		
28	161.95		
29	160.96		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

For all samples of HMA and WMA taken from ND 3 paving, Table 4 shows the following:

i) Actual time elapsed at the end of breakdown rolling (t_a)

ii) Predicted breakdown rolling end time (t_p)

iii) Actual surface temperature (U_a) at t_a

iv) Predicted average layer temperature (U_p) at t_a.

Table 4. Observed and Predicted Times and Temperatures for ND 3 Paving

HMA Sample	$\mathbf{U_a - U_p}$	$\mathbf{t_a - t_p}$	Advera Sample	$\mathbf{U_a - U_p}$	$\mathbf{t_a - t_p}$
1	11.10	3.73	1	0.60	0.03
2	-11.10	-6.58	2	0.10	0.12
3	-1.00	-1.07	3	2.10	0.38
4	-13.60	-7.50	4	13.60	2.77
5	-1.60	-1.15	5	9.70	2.55
6	-9.20	-3.17	6	13.70	3.67
7	7.80	0.80	7	14.60	3.52
8	-8.60	-2.55	8	5.80	1.85
9	-6.00	-2.20	9	15.70	5.05
10	-8.60	-2.57	10	-5.30	-1.90
11	12.50	2.53			
12	-26.00	-13.53			
13	14.90	2.62			

From Table 4, it can be observed that

- Actual surface temperature for HMA is <u>less</u> than predicted average layer temperature for 10 out of 13 samples whereas actual surface temperature for WMA Advera is <u>more</u> than predicted average layer temperature for 9 out of 10 samples.
- Actual time duration for HMA is <u>less</u> than predicted time duration for 10 out of 13 samples whereas actual time duration for WMA Advera is <u>more</u> than predicted time duration for 9 out of 10 samples.

Table 5. Observed and Predicted Times and Temperatures for ND 15 Paving

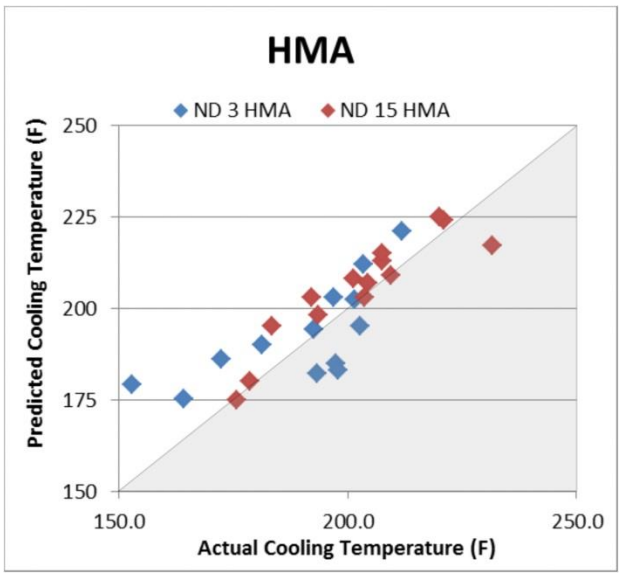
HMA Sample	$U_a - U_p$	$t_a - t_p$	Evotherm Sample	$U_a - U_p$	$t_a - t_p$	Foamed Asphalt Sample	$U_a - U_p$	$t_a - t_p$
1	0.40	0.00	1	0.20	0.20	1	2.20	0.33
2	-2.50	-0.78	2	1.70	0.20	2	8.10	2.52
3	0.90	0.15	3	3.40	1.52	3	-6.80	-2.67
4	-10.90	-2.92	4	16.80	6.03	4	-7.40	-3.20
5	-1.30	-0.82	5	-5.10	-1.62	5	-6.90	-2.95
6	-11.40	-3.67	6	-4.50	-1.50	6	-6.30	-2.45
7	-6.70	-1.83	7	-10.60	-3.48	7	-4.50	-3.03
8	-2.90	-0.25	8	1.30	0.68	8	-6.10	-2.77
9	-5.40	-2.30	9	-8.80	-3.07	9	-13.80	-6.43
10	-5.00	-0.90	10	10.00	2.45	10	-7.90	-3.07
11	14.70	3.52	11	4.10	0.58	11	-4.20	-1.87
12	0.80	0.03	12	-0.20	-0.25	12	-3.00	-1.20
13	-4.30	-1.10	13	7.80	1.60	13	-0.60	-0.35
14	-7.40	-2.07	14	3.00	1.12	14	-0.20	-0.27
			15	-2.60	-0.68	15	11.80	3.80
			16	-2.00	-0.82	16	0.20	-0.35
			17	-3.30	-0.78			

Similar observations were made in ND 15 paving where actual time duration and surface temperature for HMA were less than predicted time duration and average layer temperature respectively in 11 and 10 out of total 14 cases. Also actual time duration and surface temperature for Evotherm were more than predicted time duration and average layer temperature in 9 out of 17 cases. However the behavior of Foamed asphalt was dissimilar to the other two WMA with actual time duration and surface temperature slightly less than predicted time duration and average layer temperature respectively in 3 and 4 out of total 16 cases.

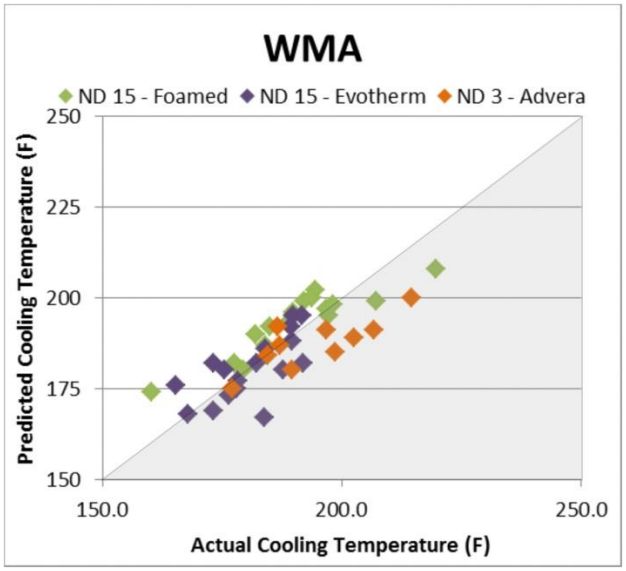
While the observations made above for HMA on both projects and Foamed Asphalt were more consistently in conformance with natural way of cooling, i.e. average layer temperature would be higher than external surface temperature, behavior of WMA Advera and Evotherm was

observed to be against natural cooling pattern with more consistency. Evidently for WMA Advera and Evotherm, MultiCool underestimated within-mat temperature by at least (U_a-U_p) and cooling time by at least (t_a-t_p). Since all the parameters were input in MultiCool as per field observation, thermal diffusivity could be the only parameter causing this conflict since it was assumed to be equal for all types of asphalt mixes as per hypothesis. That is, the hypothesis cannot be accepted, suggesting that the thermal diffusivity value for different types of asphalt mixes may be significantly different.

Figure 9 shows actual vs. predicted cooling temperatures and Figure 10 shows actual vs. predicted time durations at the end of breakdown rolling for all types of asphalt mats from which the aforementioned analysis can be observed. Shaded cells in Table 4 and Table 5 and markers below the diagonal line in shaded areas in Figure 9 and Figure 10 represent samples with unexpected results i.e., opposite to predicted behavior. It is important to note that throughout the range of samples, predicted time and temperature values for HMA in both the projects were consistently higher than the actual values observed (19 out of 26) in the field while predicted time and temperature values for WMA were consistently lower than the actual values observed (18 out of 27) in the field except for foamed asphalt (3 out of 16).

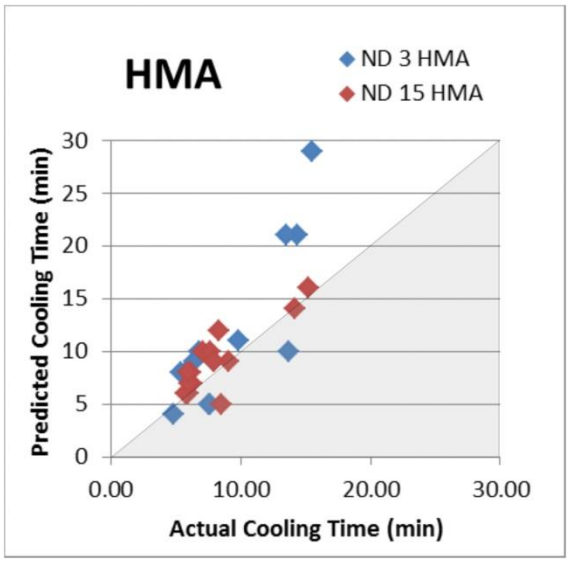


(a)

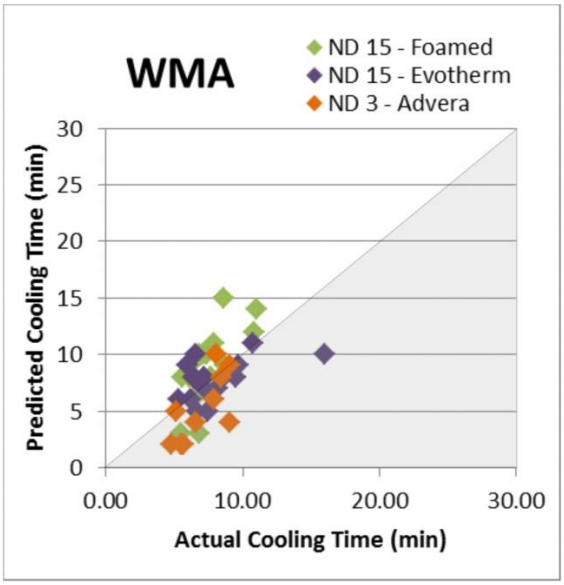


(b)

Figure 9. Actual vs. predicted cooling temperatures for all types of: (a) HMA and (b) WMA



(a)



(b)

Figure 10. Actual vs. predicted cooling times for all types of: (a) HMA and (b) WMA

4.6. Pavement Density

The North Dakota Department of Transportation (NDDOT) Standard Specifications (2008) require taking two cores, adjacent to each other, at a random location and using the average of the two cores for determining the density of each sublot, which is 2,000 feet long and one paver width wide, excluding the shoulders. Core density results of the two projects analysed by Song and Gao (2012) are summarized in Table 6 that were originally included in compaction control reports prepared by independent testing laboratories. It was observed from the review that on average, WMA and HMA sections differed in percent of the theoretical maximum density (TMD) by less than 1 percent point, which can be translated into absolute density differences of 3 to 4 lb/ft^3 at most. The variability in density achieved on each mix type, measured by the sample standard deviation of % TMD values, was no more than 1 percent point, with the Evotherm section being most consistent. Note that the same set of observations as above can be made considering only the cores taken from the sublots that were paved on days when temperature recording was performed. In other words, density results did not vary significantly on later production days when no temperature recording was performed.

Table 6. Core Density Results (Song and Gao, 2012)

Project	Mix Type	No. of Core Locations	% Theoretical Maximum Density	
			Average	St. Dev.
ND 15	HMA	26*	93.1%	1.0%
		39†	92.8%	1.0%
	Evotherm	22*	92.5%	0.6%
		26†	92.5%	0.7%
	Foamed	26*	92.4%	1.0%
		33†	92.4%	0.9%
ND 3	HMA	18*	92.1%	0.9%
		62†	91.9%	0.8%
	Advera	16*	92.5%	0.9%
		24†	92.8%	0.9%

* for paving days on which asphalt temperatures were recorded
† for all paving days

The density results described above suggest that WMA (Advera, Evotherm, and foamed asphalt) can be compacted to the same target density as HMA using same construction practices under similar field conditions. For North Dakota, the target density is 91% of the daily average TMD, below which NDDOT specifications provide for pay adjustment to the production lot. For both asphalt paving projects discussed here, every lot had density greater than 91% of the daily average TMD, and there was no single sublot that had the density less than 89% of the daily average TMD. Thus, no pay adjustment was warranted for any of the lots produced. However, there was some within-lot variability, and several sublots were less than 91% but still above 89% of the daily average TMD. ND 3 HMA section yielded six such sublots on five out of a total of seven production days while ND 3 Advera section had no sublot with less than 91% of TMD. ND 15 HMA and foamed asphalt sections yielded one such sublot each while ND 15 Evotherm section had all sublots greater than 91% of TMD.

4.7. Summary and Discussion

From the review of previous data analysis in Song and Gao (2012), it was observed from ND 3 and ND 15 paving that WMA can be compacted using same compaction method to achieve similar pavement density as of HMA. Although WMA was laid down at temperatures lower by 25°F to 30°F than HMA, WMA temperatures throughout the paving process were less variable from location to location. WMA pavement density test results had less within-lot variability then HMA i.e. WMA produced more consistent pavements in terms of density as compared to HMA. Data analysis performed as part of this thesis research suggests that some types of WMA will cool slowly than expected of HMA under similar environmental conditions. This means that WMA and HMA have different cooling rates with HMA cooling faster, while WMA cooling slower, than predicted by MultiCool. The most important thing to note here is the unnatural behavioral difference between WMA and HMA. The software predicted values are the expected temperatures at various time points and predicted time to cool to a certain temperature (as shown for a sample from ND 3 Advera paving project in Figure 11). When comparing them with the field observed values, it becomes evident that actual cooling times and the corresponding temperatures for HMA and WMA are directed opposite to each other with consistency. Regardless of the range of variation from the expected values, this conflict in the direction of variation is a basis to conclude that WMA cools slowly compared to HMA. It should be noted that MultiCool prediction was affirmative most of the tested cases with HMA whereas the prediction was contradictory most of the time with WMA. Freshly laid asphalt mat is much hotter than the base and ambient air temperature, and its ‘average’ mat temperature at any time during paving cannot possibly be lower and must be higher than its top surface temperature at the same time.

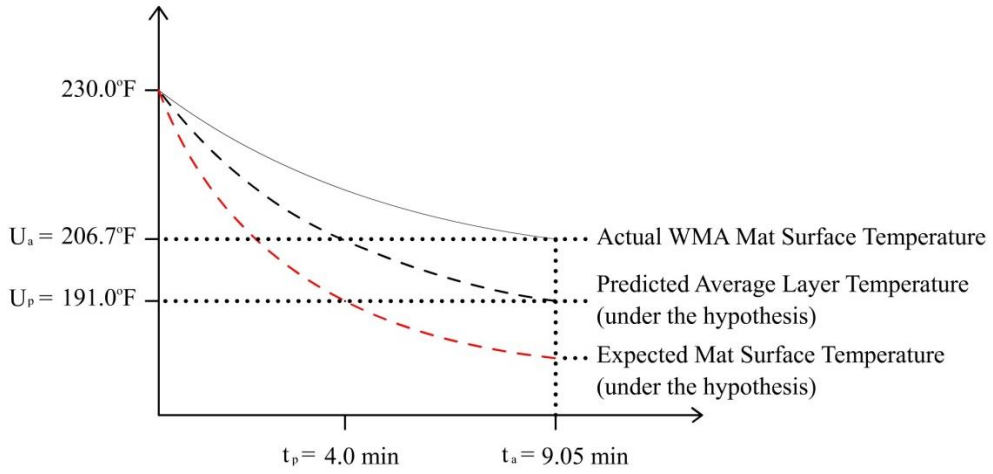


Figure 11. Illustrative diagram showing conflict in actual and predicted temperatures for Advera sample from ND 3 paving project

Remember that the software predicts average layer temperature while the mat temperature observed in the field is the surface temperature. Essentially, average layer temperature must always be higher than the surface temperature which is evident in HMA samples as confirmed by MultiCool prediction. In contrast, MultiCool predicted WMA to have average layer temperature lower than its surface temperature, which is in complete contradiction with a naturally expected behavior. It is also important to note that this comportment has been observed consistently with about 70% HMA samples being in conformance with the natural behavior and at least about 50% of the WMA samples against it. For the sample shown in Figure 11, this contradicting behavior is causing an underestimation of time by atleast ($t_a - t_p$) i.e, 5.05 minutes in breakdown rolling time for this sample. This indicates that WMA may have a thermal diffusivity which may provide more compaction time. In an average duration of 30 minutes paving cycle, an underestimation of 5 minutes may not seem significant but in adverse climatic condition like during winter in North Dakota, an additional few minutes may be very helpful for the contractor to attain the desirable pavement density.

Keep in mind that for calculating the expected mat temperature and cooling time, all inputs including environmental conditions as well as physical characteristics of the pavement were defined exactly as per field observation, except for thermal diffusivity, which was assumed to be similar for all types of asphalt mixes. With every other parameter being as per field data, this contradicting behavior of cooling time indicates that the hypothesis assuming similar thermal properties of HMA and WMA is to be rejected.

Although time rate of temperature change does not depend merely upon the properties of a material, the cooling rate at a point within a material is proportional to a material property called thermal diffusivity and it also depends on the net heat flux into that point (Powers 2006). This is how initial conditions of the material and environmental conditions at its boundaries interplay with the heat diffusion equation, and this is why the equation does not yield unique solutions unless posed together with appropriate initial and boundary conditions. Another complexity is that thermal diffusivity of a material in the heat diffusion equation, though often assumed a constant, relates to thermal conductivity and specific heat of the material and is potentially temperature-dependent. In fact, thermal diffusivity of a given asphalt mix can range from $1.3 * 10^{-6}$ m^2/s at 70°C to $0.5 * 10^{-6}$ m^2/s at 140°C, as experimentally determined for HMA in the laboratory by Chadbourn et al. (1998).

The influence of the variation of thermal diffusivity can be seen more noticeably in paving cycle times. In ND 3 paving, 9 out of 13 HMA samples while only 2 out of 10 WMA samples had more than 50% of the total temperature drop during breakdown rolling. This shows that WMA had higher capacity to retain heat in the initial phase, directly resulting in a 16% longer duration paving cycle of WMA as compared to HMA, which quickly lost heat in the initial phase, as described earlier in the pavement cycle time analysis. The similar effect of

different thermal diffusivity is not clearly apparent in different types of asphalt mix in ND 15 paving which could be due to less variation in the thermal diffusivity value or varying climatic conditions. Therefore, while WMA is increasingly being used in the highway construction industry, it is the need of the time to conduct research to specifically evaluate thermal properties of WMA binders and observe the effects by comparing performance of WMA and HMA using their respective thermal properties' values either in the field or by using computer simulation.

Among the different types of WMA, Evotherm mixture seems to have a low thermal diffusivity relative to foamed asphalt, conducting less heat than keeping. On average, Evotherm mixture was laid down approximately at the same temperature as foamed asphalt and showed about the same temperature decrease overall in the same paving cycle time while being paved under the relatively unfavorable weather conditions (Table 7). This is possible only when thermal diffusivity is lower for Evotherm mix, supposing Evotherm and foamed asphalt mixes had different thermal diffusivity values over the range of temperatures observed in the field. Between Evotherm to Advera mixes, it is hard to tell which one was better at keeping heat. The probable temperature of Advera mix in 21 minutes after laydown was 160 to 165°F (estimated from Figure 7), thus some 60°F decrease from laydown, as opposed to 65°F decrease in 21 minutes for Evotherm mix (estimated from Figure 8). Nevertheless, Advera mixture was also paved in warmer and less windy conditions than Evotherm mixture.

Table 7. Average Temperature Decrease and Weather Conditions

Mix Type	Average Temperature Decrease	Average Cycle Time*	Average Hourly Air Temperature		Average Hourly Wind Speed	
			Low	High	Low	High
Advera (ND 3)	78°F	36 min	63.6°F	71.4°F	4.9 mph	12.3 mph
Foamed (ND 15)	65°F	21 min	57.1°F	74.1°F	6.2 mph	10.5 mph
Evotherm (ND 15)	65°F	21 min	47.4°F	59.3°F	13.3 mph	20.6 mph
HMA (ND 3)	99°F	31 min	44.9°F	77.1°F	7.7 mph	14.8 mph
HMA (ND 15)	76°F	21 min	66.1°F	77.8°F	12.0 mph	21.5 mph

* from laydown to end of finish rolling

5. CONCLUSION AND RECOMMENDATIONS

Based on the field observations from two asphalt paving projects, it is concluded that some types of WMA have different thermal diffusivity than HMA and will cool more slowly under similar field conditions. This is because WMA has higher capacity to retain heat in the initial phase, directly resulting in a 16% longer duration paving cycle of WMA as compared to HMA. Applicability of these conclusions is limited to the situations where comparable in-place density was obtained from WMA and HMA by the same paving contractors using the same types of paving equipment. Thus, the same conclusions may or may not be applicable to other situations in which WMA and HMA do not achieve comparable in-place density, or WMA and HMA are paved by different practices and equipment fleet. The above observations made from North Dakota paving jobs can be informative to other states adopting WMA if triangulated to their density requirements, paving practices, environmental conditions, and project conditions. The results provide a basis for researchers to put efforts and resources towards determining the actual thermal diffusivity values for all types of asphalt mixes. Development of temperature prediction models for different asphalt types considering their thermal properties will be the following step which will help the construction industry during planning as well as execution process.

The author does not claim any statistical power or significance regarding the difference in thermal diffusivity between HMA and WMA. Sample size available for the analysis was considered to be too small to justify any assumption as to probability distributions that should underlie statistical hypothesis tests. Song and Gao (2012) used infra-red camera to gather field temperatures. Temperature calibration accuracy of the infrared camera along with the handling error may constitute error to the field observed data. However temperatures recorded on different

types of asphalt mixes would have been subject to similar chances of error. Since the study is comparative in nature, the effect of the errors can be ignored without loss of validity of the main conclusion.

Further research is recommended towards developing a method to estimate thermal diffusivity of an asphalt mix. Research to determine thermal properties of different types of WMA binders may also be of significant importance since among different types of WMA, some may cool more slowly than others and may allow for comparatively longer compaction time to produce pavement with the same density.

Mathematical method should be developed for calculating cooling time based on field data using asphalt mat *surface* temperature instead of average mat temperature. The average mat temperature varies instantaneously throughout the thickness of the asphalt layer depending upon the boundary conditions and existing methods of finding average mat temperature used in the field may provide erroneous average temperature values. On the other hand, surface temperatures observed by infra-red thermal imaging are precise. An exact solution is not expected as an outcome of research in this direction since calculation of unknown thermal diffusivity will involve a large number of variables including physical and climatic parameters. Nevertheless importance of developing such a method and in turn knowing thermal diffusivity of an asphalt mix cannot be stressed enough. New computational tool can be developed based on aforementioned mathematical model which will have provision of allowing user to input thermal diffusivity value along with other physical and environmental parameters. Knowledge of thermal diffusivity will then enable people in the field to predict the cooling time of asphalt mix ahead of time using such computational tool. The predicted cooling time can be used to plan and adjust the paving operations accordingly. Once the method attains maturity in terms of precise thermal

diffusivity values and accurate predicted cooling time, it can be very useful for preconstruction planning as more realistic scheduling will be possible. In severe conditions such as extremely low temperatures, night time, or with a long haul distance from the mix plant, construction managers will even be able to make decisions for initiating or terminating the paving process in the field.

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APPENDIX A. CLIMATIC DATA

Table A1. Climatic Data for ND-3 Paving Project from September 01, 2011 to September 02, 2011

Hour CDT	Air Temp ^{o}F	Wind Speed mph	Sol Rad Lys
1400	68.2	12.3	26.8
1500	67.9	12.3	25.2
1600	66.1	12.2	14.5
1700	65.5	10.0	11.4
1800	66.7	9.5	14.2
1100	63.6	6.0	42.1
1200	66.6	4.9	50.0
1300	67.2	8.9	40.7
1400	69.7	9.1	59.8
1500	70.3	8.8	46.4
1600	71.4	9.0	46.4

Table A2. Climatic Data for ND-3 Paving Project from September 19, 2011 to September 21, 2011

Hour CDT	Air Temp ^{o}F	Wind Speed mph	Sol Rad Lys
1000	59.1	7.7	25.0
1100	65.2	15.3	30.7
1200	65.2	14.8	26.3
1300	68.4	12.0	37.9
1400	71.7	10.7	54.8
1500	74.1	10.6	50.9
1600	76.6	11.3	46.4
1700	77.1	11.1	36.1
1100	44.9	10.3	9.1
1200	44.8	13.5	11.2
1300	45.9	13.8	17.8
1400	47.0	13.2	19.3
1500	48.4	12.4	25.3
1600	50.2	12.3	36.2
1700	51.5	11.3	28.1
1800	52.3	10.4	20.5

Table A3. Climatic Data for ND-15 Paving Project from May 21, 2012 to May 22, 2012

Hour CDT	Air Temp ^{o}F	Wind Speed mph	Sol Rad Lys
800	53.204	3.848	8.024
900	57.488	4.982	20.193
1000	61.934	7.246	33.867
1100	64.13	12.286	44.66
1200	66.542	14.37	38.012
1300	66.164	14.186	34.486
1400	66.092	13.241	35.518
1500	68.936	18.614	52.684
1600	70.448	18.838	49.785
1700	71.942	21.549	41.22
1800	71.204	19.757	15.884
1900	69.908	13.052	6.674
2000	69.53	12.739	5.557
800	56.822	6.471	13.82
900	60.548	5.107	22.111
1000	64.526	6.48	38.055
1100	68.702	12.862	59.779
1200	70.736	14.202	64.672
1300	73.58	15.465	73.1
1400	76.37	17.539	72.842
1500	76.604	18.368	44.436
1600	77.342	17.203	26.763
1700	78.224	14.558	19.307
1800	77.81	11.982	14.302
1900	77.504	11.469	12.341
2000	75.848	7.943	5.226

Table A4. Climatic Data for ND-15 Paving Project from May 24, 2012 to May 25, 2012

Hour CDT	Air Temp °F	Wind Speed mph	Sol Rad Lys
800	50.666	9.925	15.437
900	54.338	11.135	29.343
1000	57.506	14.768	41.891
1100	58.658	16.442	53.767
1200	58.982	16.979	63.21
1300	59.252	17.45	72.756
1400	58.874	18.682	74.562
1500	58.262	19.734	65.446
1600	56.498	20.63	52.288
1700	54.734	19.578	39.173
1800	53.492	20.586	44.849
1900	51.458	20.586	33.987
2000	50.036	18.726	21.517
800	42.165	7.963	18.868
900	46.616	9.596	33.101
1000	47.948	14.164	31.958
1100	49.406	15.837	41.658
1200	47.426	17.539	32.886
1300	48.866	14.204	34.77
1400	49.784	13.483	40.085
1500	52.268	13.279	62.092
1600	52.736	15.158	54.103
1700	52.142	14.336	46.578
1800	51.224	12.519	35.26
1900	50.63	9.952	23.504
2000	49.694	8.539	12.41

Table A5. Climatic Data for ND-15 Paving Project from May 31, 2012 to June 02, 2012

Hour CDT	Air Temp ^{o}F	Wind Speed mph	Sol Rad Lys
800	45.41	14.909	19.548
900	49.856	14.694	34.675
1000	53.834	12.786	49.321
1100	57.56	10.989	62.092
1200	61.286	10.501	72.326
1300	63.878	9.491	80.84
1400	65.246	8.4	86.258
1500	65.858	8.169	82.474
1600	66.668	7.408	69.23
1700	67.172	7.242	69.23
1800	66.632	7.025	50.551
1900	66.434	6.543	35.81
2000	63.86	7.018	16.796
900	57.092	8.241	33.97
1000	61.898	10.037	48.487
1100	66.542	8.599	61.146
1200	69.71	7.381	71.294
1300	72.536	6.18	78.002
1400	74.066	7.125	82.732

APPENDIX B. MULTICOOL SIMULATION OUTPUT

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:04:55 2013
Sample: ND3 Advera N01

PAVING START TIME

Hour:	13
Min.:	35
Mon.:	9
Day:	1
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	146.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	68.2	12.3	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 91.5 F

Lift	Lift time, min
1	30

Total Time of Paving Operation:
30.00 min.

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	230
1	219.04
2	212.06
3	206.6
4	201.91
5	197.72
6	193.9
7	190.38
8	187.11
9	184.06
10	181.2
11	178.52
12	175.99
13	173.61
14	171.35
15	169.22
16	167.19
17	165.26
18	163.43
19	161.68
20	160.01
21	158.42
22	156.89
23	155.43
24	154.03
25	152.68
26	151.39
27	150.14
28	148.94
29	147.79

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:07:13 2013
Sample: ND3 Advera N02

PAVING START TIME

Hour:	14
Min.:	46
Mon.:	9
Day:	1
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	216.1	131.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	67.9	12.3	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 93.5 F

Lift	Lift time, min
1	43

Total Time of Paving Operation:43.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	216.1	30	141.27
1	206.34	31	140.3
2	200.12	32	139.35
3	195.24	33	138.44
4	191.05	34	137.56
5	187.3	35	136.7
6	183.87	36	135.87
7	180.71	37	135.07
8	177.78	38	134.29
9	175.04	39	133.53
10	172.47	40	132.8
11	170.06	41	132.08
12	167.78	42	131.39
13	165.64		
14	163.61		
15	161.68		
16	159.85		
17	158.11		
18	156.45		
19	154.87		
20	153.36		
21	151.92		
22	150.54		
23	149.21		
24	147.94		
25	146.72		
26	145.55		
27	144.42		
28	143.33		
29	142.28		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:09:19 2013
Sample: ND3 Advera N03

PAVING START TIME

Hour:	15
Min.:	38
Mon.:	9
Day:	1
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	217.7	136.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.1	12.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 89.2 F

Lift	Lift time, min
1	34

Total Time of Paving Operation:34.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	217.7	30	139.59
1	207.5	31	138.57
2	200.99	32	137.58
3	195.9	33	136.63
4	191.52		
5	187.6		
6	184.03		
7	180.73		
8	177.67		
9	174.81		
10	172.13		
11	169.62		
12	167.24		
13	165		
14	162.89		
15	160.88		
16	158.97		
17	157.15		
18	155.43		
19	153.78		
20	152.2		
21	150.7		
22	149.26		
23	147.87		
24	146.55		
25	145.27		
26	144.05		
27	142.87		
28	141.74		
29	140.64		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:11:31 2013
Sample: ND3 Advera N04

PAVING START TIME

Hour:	16
Min.:	35
Mon.:	9
Day:	1
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	219	138.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	65.5	10	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 87.9 F

Lift	Lift time, min
1	32

Total Time of Paving Operation:32.00 min

COOLING CURVES (Temp (F))

Actual Time

Time, min	Lift 1	Time, min	Lift 1
0	219	30	140.3
1	208.7	31	139.27
2	202.15		
3	197.03		
4	192.64		
5	188.71		
6	185.12		
7	181.82		
8	178.74		
9	175.87		
10	173.18		
11	170.65		
12	168.26		
13	166		
14	163.87		
15	161.84		
16	159.92		
17	158.09		
18	156.34		
19	154.68		
20	153.09		
21	151.57		
22	150.11		
23	148.71		
24	147.37		
25	146.08		
26	144.83		
27	143.64		
28	142.49		
29	141.38		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:13:20 2013
Sample: ND3 Advera N05

PAVING START TIME

Hour:	17
Min.:	30
Mon.:	9
Day:	1
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	215.5	131.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.7	9.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 87.1 F

Lift	Lift time, min
1	38

Total Time of Paving Operation:38.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	215.5	30	138.48
1	205.43	31	137.46
2	199.02	32	136.48
3	194.02	33	135.53
4	189.73	34	134.6
5	185.9	35	133.71
6	182.39	36	132.84
7	179.16	37	132
8	176.15		
9	173.34		
10	170.71		
11	168.23		
12	165.9		
13	163.69		
14	161.6		
15	159.62		
16	157.73		
17	155.94		
18	154.23		
19	152.59		
20	151.03		
21	149.54		
22	148.11		
23	146.74		
24	145.42		
25	144.15		
26	142.93		
27	141.76		
28	140.63		
29	139.54		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:15:24 2013
Sample: ND3 Advera S01

PAVING START TIME

Hour:	10
Min.:	30
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	214.1	146.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	63.6	6	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	84.5 F

Lift	Lift time, min
1	34

Total Time of Paving Operation:34.00 min

COOLING CURVES (Temp (F))

Actual Time

Time, min	Lift 1	Time, min	Lift 1
0	214.1	30	148.56
1	204.69	31	147.79
2	198.9	32	147.04
3	194.48	33	146.32
4	190.75		
5	187.44		
6	184.44		
7	181.69		
8	179.15		
9	176.79		
10	174.58		
11	172.51		
12	170.57		
13	168.74		
14	167.02		
15	165.39		
16	163.85		
17	162.39		
18	161		
19	159.68		
20	158.42		
21	157.23		
22	156.09		
23	155		
24	153.96		
25	152.96		
26	152.01		
27	151.09		
28	150.22		
29	149.37		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:17:18 2013
Sample: ND3 Advera S02

PAVING START TIME

Hour:	11
Min.:	26
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	156.6

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.6	4.9	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 95.9 F

Lift	Lift time, min
1	37

Total Time of Paving Operation:37.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	230	30	161.76
1	220.25	31	160.93
2	214.26	32	160.14
3	209.68	33	159.37
4	205.81	34	158.63
5	202.37	35	157.92
6	199.26	36	157.23
7	196.41		
8	193.77		
9	191.31		
10	189.01		
11	186.86		
12	184.84		
13	182.93		
14	181.13		
15	179.43		
16	177.82		
17	176.29		
18	174.84		
19	173.46		
20	172.14		
21	170.89		
22	169.69		
23	168.55		
24	167.45		
25	166.4		
26	165.4		
27	164.43		
28	163.5		
29	162.61		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:19:09 2013
Sample: ND3 Advera S03

PAVING START TIME

Hour:	12
Min.:	39
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	150.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	67.2	8.9	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 98 F

Lift	Lift time, min
1	34

Total Time of Paving Operation:34.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	230	30	153.92
1	219.82	31	152.94
2	213.39	32	151.99
3	208.4	33	151.08
4	204.13		
5	200.32		
6	196.84		
7	193.64		
8	190.67		
9	187.9		
10	185.31		
11	182.87		
12	180.58		
13	178.41		
14	176.36		
15	174.42		
16	172.58		
17	170.82		
18	169.16		
19	167.57		
20	166.05		
21	164.6		
22	163.21		
23	161.88		
24	160.6		
25	159.38		
26	158.2		
27	157.07		
28	155.98		
29	154.93		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:30:09 2013
Sample: ND3 Advera S04

PAVING START TIME

Hour:	13
Min.:	39
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	142.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	69.7	9.1	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	114.4 F

Lift	Lift time, min
1	57

Total Time of Paving Operation:57.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	230	30	160
1	220.88	31	159.07
2	215.07	32	158.18
3	210.53	33	157.31
4	206.63	34	156.47
5	203.14	35	155.66
6	199.96	36	154.87
7	197.01	37	154.1
8	194.28	38	153.36
9	191.72	39	152.63
10	189.33	40	151.93
11	187.07	41	151.25
12	184.95	42	150.58
13	182.94	43	149.94
14	181.04	44	149.31
15	179.23	45	148.69
16	177.52	46	148.09
17	175.88	47	147.51
18	174.33	48	146.94
19	172.84	49	146.38
20	171.42	50	145.84
21	170.06	51	145.31
22	168.76	52	144.79
23	167.51	53	144.28
24	166.31	54	143.78
25	165.16	55	143.3
26	164.05	56	142.82
27	162.98		
28	161.95		
29	160.96		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:31:52 2013
Sample: ND3 Advera S05

PAVING START TIME

Hour:	15
Min.:	16
Mon.:	9
Day:	2
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	230	163.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	71.4	9	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	108.3 F

Lift	Lift time, min
1	24

Total Time of Paving Operation:24.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	230
1	220.43
2	214.34
3	209.59
4	205.51
5	201.85
6	198.52
7	195.44
8	192.58
9	189.9
10	187.4
11	185.04
12	182.81
13	180.71
14	178.72
15	176.83
16	175.03
17	173.32
18	171.69
19	170.13
20	168.65
21	167.22
22	165.86
23	164.55

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:43:29 2013
Sample: ND3 HMA N01

PAVING START TIME

Hour:	10
Min.:	52
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	233.5	157.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	44.9	10.3	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	65.6 F

Lift	Lift time, min
1	18

Total Time of Paving Operation:18.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	233.5
1	220.43
2	212.17
3	205.73
4	200.22
5	195.3
6	190.81
7	186.68
8	182.85
9	179.27
10	175.92
11	172.77
12	169.81
13	167.02
14	164.37
15	161.87
16	159.49
17	157.23

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:46:27 2013
Sample: ND3 HMA N02

PAVING START TIME

Hour:	12
Min.:	17
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	238.7	147.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	45.9	13.8	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	66.7 F

Lift	Lift time, min
1	23

Total Time of Paving Operation:23.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	238.7
1	225.07
2	216.39
3	209.6
4	203.78
5	198.58
6	193.84
7	189.47
8	185.42
9	181.64
10	178.11
11	174.79
12	171.67
13	168.72
14	165.94
15	163.3
16	160.8
17	158.43
18	156.17
19	154.02
20	151.97
21	150.01
22	148.13

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:48:19 2013
Sample: ND3 HMA N03

PAVING START TIME

Hour:	12
Min.:	54
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	249.6	106.4

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	47	13.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	71.1 F

COOLING DATA

The calculated times assume a continuous paving operation. The lift time is the time for the lift to cool to the designated stop temperature,after the lift has been placed.

Lift	Lift time, min
1	76

Total Time of Paving Operation:76.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	249.6	39	131.36
1	235.43	40	130.33
2	226.4	41	129.33
3	219.34	42	128.37
4	213.28	43	127.43
5	207.87	44	126.51
6	202.94	45	125.62
7	198.39	46	124.76
8	194.17	47	123.92
9	190.23	48	123.1
10	186.55	49	122.3
11	183.09	50	121.52
12	179.84	51	120.76
13	176.77	52	120.01
14	173.87	53	119.29
15	171.12	54	118.58
16	168.51	55	117.89
17	166.04	56	117.22
18	163.68	57	116.56
19	161.44	58	115.92
20	159.29	59	115.29
21	157.25	60	114.67
22	155.29	61	114.07
23	153.41	62	113.48
24	151.61	63	112.9
25	149.89	64	112.33
26	148.23	65	111.78
27	146.64	66	111.24
28	145.1	67	110.7
29	143.63	68	110.18
30	142.2	69	109.67
31	140.83	70	109.17
32	139.5	71	108.68
33	138.22	72	108.19
34	136.98	73	107.72
35	135.79	74	107.26
36	134.63	75	106.8
37	133.5		
38	132.41		

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:51:49 2013
Sample: ND3 HMA N04

PAVING START TIME

Hour:	13
Min.:	55
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	262.9	161.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	48.4	12.4	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	67.3 F

Lift	Lift time, min
1	22

Total Time of Paving Operation:22.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	262.9
1	247.47
2	237.67
3	230.01
4	223.45
5	217.6
6	212.26
7	207.34
8	202.78
9	198.53
10	194.55
11	190.82
12	187.3
13	183.99
14	180.86
15	177.89
16	175.08
17	172.4
18	169.86
19	167.44
20	165.13
21	162.92

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:58:16 2013
Sample: ND3 HMA N05

PAVING START TIME

Hour:	15
Min.:	5
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	232.6	171

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	50.2	12.3	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	76.7 F

Lift	Lift time, min
1	13

Total Time of Paving Operation:13.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	232.6
1	220.29
2	212.46
3	206.34
4	201.08
5	196.39
6	192.11
7	188.16
8	184.5
9	181.08
10	177.88
11	174.87
12	172.03

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 18:00:24 2013
Sample: ND3 HMA N06

PAVING START TIME

Hour:	15
Min.:	38
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	262.2	118.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	50.2	12.3	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	78.3 F

COOLING DATA

The calculated times assume a continuous paving operation. The lift time is the time for the lift to cool to the designated stop temperature,after the lift has been placed.

Lift	Lift time, min
1	66

Total Time of Paving Operation:66.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	262.2	34	145.66
1	247.6	35	144.4
2	238.29	36	143.18
3	231.01	37	142
4	224.76	38	140.85
5	219.18	39	139.74
6	214.09	40	138.66
7	209.39	41	137.61
8	205.03	42	136.59
9	200.97	43	135.59
10	197.16	44	134.63
11	193.59	45	133.68
12	190.22	46	132.77
13	187.05	47	131.87
14	184.05	48	131
15	181.2	49	130.15
16	178.5	50	129.32
17	175.93	51	128.51
18	173.49	52	127.72
19	171.16	53	126.95
20	168.93	54	126.19
21	166.8	55	125.45
22	164.77	56	124.73
23	162.82	57	124.02
24	160.94	58	123.33
25	159.15	59	122.65
26	157.42	60	121.99
27	155.76	61	121.34
28	154.16	62	120.7
29	152.61	63	120.08
30	151.12	64	119.47
31	149.69	65	118.87
32	148.3		
33	146.96		

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 18:02:35 2013
Sample: ND3 HMA N07

PAVING START TIME

Hour:	17
Min.:	2
Mon.:	9
Day:	21
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	229.6	135

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	52.3	10.4	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 80.6 F

Lift	Lift time, min
1	33

Total Time of Paving Operation:33.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	229.6	30	138.5
1	217.8	31	137.2
2	210.28	32	135.95
3	204.39		
4	199.33		
5	194.81		
6	190.67		
7	186.85		
8	183.31		
9	179.99		
10	176.88		
11	173.96		
12	171.2		
13	168.59		
14	166.12		
15	163.78		
16	161.55		
17	159.43		
18	157.41		
19	155.48		
20	153.64		
21	151.87		
22	150.18		
23	148.55		
24	146.99		
25	145.49		
26	144.05		
27	142.66		
28	141.24		
29	139.84		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:14:13 2013
Sample: ND3 HMA S01

PAVING START TIME

Hour:	9
Min.:	49
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	244.1	151.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	59.1	7.7	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	84.1 F

Lift	Lift time, min
1	37

Total Time of Paving Operation:37.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	244.1	30	157.32
1	232.07	31	156.26
2	224.56	32	155.23
3	218.77	33	154.25
4	213.85	34	153.29
5	209.47	35	152.38
6	205.49	36	151.49
7	201.83		
8	198.45		
9	195.29		
10	192.35		
11	189.59		
12	186.99		
13	184.54		
14	182.23		
15	180.05		
16	177.98		
17	176.01		
18	174.15		
19	172.37		
20	170.68		
21	169.07		
22	167.53		
23	166.05		
24	164.65		
25	163.3		
26	162		
27	160.76		
28	159.57		
29	158.42		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:23:38 2013
Sample: ND3 HMA S02

PAVING START TIME

Hour:	11
Min.:	19
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	241.7	136

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	65.2	14.8	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	81.7 F

Lift	Lift time, min
1	51

Total Time of Paving Operation:51.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	241.7	30	152.06
1	229.36	31	150.98
2	221.59	32	149.95
3	215.57	33	148.95
4	210.43	34	147.99
5	205.86	35	147.06
6	201.7	36	146.16
7	197.89	37	145.29
8	194.36	38	144.46
9	191.08	39	143.65
10	188.02	40	142.86
11	185.15	41	142.1
12	182.46	42	141.37
13	179.93	43	140.65
14	177.55	44	139.96
15	175.29	45	139.29
16	173.16	46	138.64
17	171.14	47	138.01
18	169.23	48	137.39
19	167.41	49	136.8
20	165.68	50	136.21
21	164.02		
22	162.45		
23	160.95		
24	159.51		
25	158.14		
26	156.82		
27	155.55		
28	154.34		
29	153.18		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:28:31 2013
Sample: ND3 HMA S03

PAVING START TIME

Hour:	12
Min.:	16
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	247.1	162.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	68.4	12	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	96.1 F

Lift	Lift time, min
1	30

Total Time of Paving Operation:30.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	247.1
1	235.48
2	228.17
3	222.5
4	217.67
5	213.36
6	209.44
7	205.84
8	202.5
9	199.4
10	196.5
11	193.78
12	191.23
13	188.82
14	186.55
15	184.4
16	182.37
17	180.44
18	178.6
19	176.86
20	175.2
21	173.61
22	172.1
23	170.65
24	169.26
25	167.94
26	166.66
27	165.44
28	164.26
29	163.13

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:31:32 2013
Sample: ND3 HMA S04

PAVING START TIME

Hour:	14
Min.:	11
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	246.5	127.6

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	74.1	10.6	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	94.2 F

COOLING DATA

The calculated times assume a continuous paving operation. The lift time is the time for the lift to cool to the designated stop temperature,after the lift has been placed.

Lift	Lift time, min
1	92

Total Time of Paving Operation:92.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	246.5	46	147.46
1	234.86	47	146.8
2	227.55	48	146.16
3	221.88	49	145.53
4	217.05	50	144.91
5	212.75	51	144.32
6	208.84	52	143.73
7	205.24	53	143.16
8	201.9	54	142.6
9	198.79	55	142.06
10	195.89	56	141.52
11	193.17	57	141
12	190.6	58	140.49
13	188.19	59	139.99
14	185.91	60	139.5
15	183.75	61	139.02
16	181.7	62	138.55
17	179.75	63	138.09
18	177.91	64	137.63
19	176.14	65	137.19
20	174.46	66	136.76
21	172.86	67	136.33
22	171.33	68	135.91
23	169.86	69	135.49
24	168.45	70	135.09
25	167.1	71	134.69
26	165.81	72	134.3
27	164.56	73	133.91
28	163.36	74	133.53
29	162.21	75	133.16
30	161.1	76	132.79
31	160.03	77	132.43
32	158.99	78	132.08
33	157.99	79	131.73
34	157.02	80	131.38
35	156.09	81	131.04
36	155.18	82	130.71
37	154.3	83	130.38
38	153.45	84	130.05
39	152.63	85	129.73
40	151.82	86	129.41
41	151.04	87	129.1
42	150.29	88	128.79
43	149.55	89	128.49
44	148.84	90	128.19
45	148.14	91	127.89

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:36:27 2013
Sample: ND3 HMA S05

PAVING START TIME

Hour:	15
Min.:	31
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	242.1	147.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	76.6	11.3	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	103.7 F

Lift	Lift time, min
1	46

Total Time of Paving Operation:46.00 min

COOLING CURVES (Temp (F))

Actual Time

Time, min	Lift 1	Time, min	Lift 1
0	242.1	30	160.35
1	231.27	31	159.28
2	224.41	32	158.26
3	219.05	33	157.26
4	214.47	34	156.3
5	210.37	35	155.36
6	206.63	36	154.46
7	203.19	37	153.58
8	200	38	152.72
9	197.02	39	151.89
10	194.22	40	151.09
11	191.6	41	150.3
12	189.13	42	149.54
13	186.8	43	148.8
14	184.59	44	148.07
15	182.5	45	147.36
16	180.52		
17	178.63		
18	176.83		
19	175.12		
20	173.48		
21	171.92		
22	170.42		
23	168.98		
24	167.6		
25	166.27		
26	165		
27	163.77		
28	162.59		
29	161.45		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 17:40:28 2013
Sample: ND3 HMA S06

PAVING START TIME

Hour:	16
Min.:	14
Mon.:	9
Day:	19
Year:	2011

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	269.7	144.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	77.1	11.1	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	97.4 F

Lift	Lift time, min
1	55

Total Time of Paving Operation:55.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	269.7	30	167.79
1	256.18	31	166.47
2	247.61	32	165.19
3	240.92	33	163.96
4	235.19	34	162.76
5	230.07	35	161.6
6	225.41	36	160.48
7	221.11	37	159.39
8	217.12	38	158.34
9	213.4	39	157.31
10	209.92	40	156.31
11	206.65	41	155.34
12	203.58	42	154.4
13	200.67	43	153.48
14	197.93	44	152.58
15	195.32	45	151.71
16	192.85	46	150.86
17	190.5	47	150.03
18	188.27	48	149.22
19	186.14	49	148.43
20	184.1	50	147.65
21	182.15	51	146.9
22	180.29	52	146.16
23	178.5	53	145.44
24	176.79	54	144.73
25	175.14		
26	173.56		
27	172.04		
28	170.57		
29	169.15		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:18:58 2013
Sample: ND15 EVO E01

PAVING START TIME

Hour:	9
Min.:	43
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	229.5	162.6

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	47.9	14.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	72.6 F

Lift	Lift time, min
1	15

Total Time of Paving Operation:15.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	229.5
1	217.02
2	209.06
3	202.83
4	197.48
5	192.7
6	188.34
7	184.33
8	180.6
9	177.13
10	173.88
11	170.83
12	167.96
13	165.25
14	162.69

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:20:53 2013
Sample: ND15 EVO E02

PAVING START TIME

Hour:	10
Min.:	14
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	216.2	154.7

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	49.4	15.8	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	71.1 F

Lift	Lift time, min
1	14

Total Time of Paving Operation:14.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	216.2
1	204.62
2	197.22
3	191.43
4	186.46
5	182.02
6	177.97
7	174.24
8	170.78
9	167.55
10	164.53
11	161.7
12	159.04
13	156.52

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:22:54 2013
Sample: ND15 EVO E03

PAVING START TIME

Hour:	11
Min.:	36
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	220.4	150.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	47.4	17.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	84.5 F

Lift	Lift time, min
1	19

Total Time of Paving Operation:19.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	220.4
1	209.25
2	202.06
3	196.4
4	191.52
5	187.14
6	183.15
7	179.46
8	176.04
9	172.85
10	169.86
11	167.06
12	164.42
13	161.92
14	159.57
15	157.34
16	155.22
17	153.21
18	151.29

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:24:37 2013
Sample: ND15 EVO E04

PAVING START TIME

Hour:	12
Min.:	37
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	219.1	156

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	48.9	14.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	80.7 F

Lift	Lift time, min
1	16

Total Time of Paving Operation:16.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	219.1
1	208.01
2	200.92
3	195.36
4	190.58
5	186.3
6	182.39
7	178.79
8	175.45
9	172.33
10	169.41
11	166.66
12	164.08
13	161.64
14	159.33
15	157.15

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:26:04 2013
Sample: ND15 EVO E05

PAVING START TIME

Hour:	13
Min.:	23
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	219.8	153.7

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	49.8	13.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	75.9 F

Lift	Lift time, min
1	17

Total Time of Paving Operation:17.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	219.8
1	208.38
2	201.11
3	195.42
4	190.53
5	186.17
6	182.18
7	178.51
8	175.1
9	171.92
10	168.95
11	166.15
12	163.52
13	161.04
14	158.69
15	156.46
16	154.35

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:27:48 2013
Sample: ND15 EVO E06

PAVING START TIME

Hour:	14
Min.:	22
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	227.1	165.7

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	52.3	13.3	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	83.6 F

Lift	Lift time, min
1	14

Total Time of Paving Operation:14.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	227.1
1	215.63
2	208.3
3	202.56
4	197.62
5	193.2
6	189.17
7	185.45
8	181.99
9	178.77
10	175.75
11	172.92
12	170.24
13	167.72

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:29:15 2013
Sample: ND15 EVO E07

PAVING START TIME

Hour:	15
Min.:	22
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	227.9	152.7

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	52.7	15.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	86.8 F

Lift	Lift time, min
1	21

Total Time of Paving Operation:21.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	227.9
1	216.44
2	209.08
3	203.29
4	198.31
5	193.84
6	189.76
7	186
8	182.5
9	179.24
10	176.18
11	173.31
12	170.61
13	168.06
14	165.64
15	163.36
16	161.19
17	159.12
18	157.16
19	155.28
20	153.49

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:31:41 2013
Sample: ND15 EVO E08

PAVING START TIME

Hour:	16
Min.:	18
Mon.:	5
Day:	25
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	240.9	179.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	52.1	14.3	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	89 F

Lift	Lift time, min
1	12

Total Time of Paving Operation:12.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	240.9
1	228.56
2	220.64
3	214.4
4	209.03
5	204.22
6	199.82
7	195.77
8	192
9	188.48
10	185.19
11	182.09

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:33:19 2013
Sample: ND15 EVO W01

PAVING START TIME

Hour:	11
Min.:	30
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	228.2	175.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	61.3	10.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	98.5 F

Lift	Lift time, min
1	13

Total Time of Paving Operation:13.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	228.2
1	217.92
2	211.36
3	206.22
4	201.82
5	197.87
6	194.27
7	190.94
8	187.85
9	184.97
10	182.27
11	179.73
12	177.33

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:02:05 2013
Sample: ND15 EVO W02

PAVING START TIME

Hour:	10
Min.:	16
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	225.3	145.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	58.7	16.4	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	87.7 F

Lift	Lift time, min
1	28

Total Time of Paving Operation:28.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	225.3
1	214.32
2	207.31
3	201.82
4	197.12
5	192.92
6	189.09
7	185.56
8	182.29
9	179.24
10	176.4
11	173.73
12	171.22
13	168.85
14	166.62
15	164.51
16	162.51
17	160.61
18	158.81
19	157.09
20	155.45
21	153.89
22	152.4
23	150.98
24	149.61
25	148.3
26	147.05
27	145.85

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:03:47 2013
Sample: ND15 EVO W03

PAVING START TIME

Hour:	10
Min.:	59
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	215.1	162.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	58.7	16.4	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	93.6 F

Lift	Lift time, min
1	15

Total Time of Paving Operation:15.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	215.1
1	205.34
2	199.1
3	194.21
4	190.01
5	186.25
6	182.82
7	179.66
8	176.73
9	174
10	171.45
11	169.05
12	166.8
13	164.67
14	162.67

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:05:59 2013
Sample: ND15 EVO W04

PAVING START TIME

Hour:	11
Min.:	38
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	229.4	163.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	59	17	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 98 F

Lift	Lift time, min
1	19

Total Time of Paving Operation:19.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	229.4
1	218.76
2	211.93
3	206.56
4	201.95
5	197.82
6	194.06
7	190.59
8	187.37
9	184.37
10	181.56
11	178.93
12	176.45
13	174.12
14	171.91
15	169.82
16	167.85
17	165.97
18	164.18

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:08:25 2013
Sample: ND15 EVO W05

PAVING START TIME

Hour:	12
Min.:	36
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	231.6	178.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	59.3	17.5	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	98.1 F

Lift	Lift time, min
1	12

Total Time of Paving Operation:12.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	231.6
1	220.76
2	213.79
3	208.32
4	203.61
5	199.4
6	195.56
7	192.02
8	188.73
9	185.67
10	182.81
11	180.12

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:11:14 2013
Sample: ND15 EVO W06

PAVING START TIME

Hour:	14
Min.:	16
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	214.1	157

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	58.3	19.7	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	94.4 F

Lift	Lift time, min
1	16

Total Time of Paving Operation:16.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	214.1
1	204.27
2	197.93
3	192.94
4	188.64
5	184.78
6	181.27
7	178.02
8	175.01
9	172.21
10	169.59
11	167.12
12	164.81
13	162.62
14	160.56
15	158.6

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:12:51 2013
Sample: ND15 EVO W07

PAVING START TIME

Hour:	15
Min.:	6
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	211.1	152.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	56.5	20.6	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	89.9 F

Lift	Lift time, min
1	16

Total Time of Paving Operation:16.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	211.1
1	201.12
2	194.67
3	189.59
4	185.21
5	181.29
6	177.71
7	174.41
8	171.35
9	168.5
10	165.82
11	163.32
12	160.96
13	158.74
14	156.64
15	154.65

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:14:30 2013
Sample: ND15 EVO W08

PAVING START TIME

Hour:	16
Min.:	10
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	227	149.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	54.7	19.6	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	93.5 F

Lift	Lift time, min
1	23

Total Time of Paving Operation:23.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	227
1	215.92
2	208.75
3	203.08
4	198.19
5	193.81
6	189.81
7	186.11
8	182.69
9	179.49
10	176.49
11	173.68
12	171.04
13	168.54
14	166.18
15	163.94
16	161.82
17	159.81
18	157.89
19	156.06
20	154.32
21	152.65
22	151.06

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:16:51 2013
Sample: ND15 EVO W09

PAVING START TIME

Hour:	17
Min.:	13
Mon.:	5
Day:	24
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	215.1	155

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	53.5	20.6	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	98.5 F

Lift	Lift time, min
1	17

Total Time of Paving Operation:17.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	215.1
1	205.19
2	198.71
3	193.57
4	189.12
5	185.12
6	181.46
7	178.08
8	174.93
9	172
10	169.24
11	166.66
12	164.22
13	161.92
14	159.74
15	157.68
16	155.72

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:52:40 2013
Sample: ND15 FOM E01

PAVING START TIME

Hour:	8
Min.:	4
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	216.5	130.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	57.1	8.2	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	68.9 F

Lift	Lift time, min
1	42

Total Time of Paving Operation:42.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	216.5	30	139.66
1	205.59	31	138.76
2	198.84	32	137.89
3	193.65	33	137.05
4	189.26	34	136.24
5	185.37	35	135.47
6	181.84	36	134.72
7	178.59	37	133.99
8	175.6	38	133.3
9	172.81	39	132.63
10	170.2	40	131.98
11	167.77	41	131.35
12	165.48		
13	163.33		
14	161.3		
15	159.38		
16	157.57		
17	155.85		
18	154.22		
19	152.67		
20	151.2		
21	149.79		
22	148.46		
23	147.18		
24	145.96		
25	144.8		
26	143.68		
27	142.61		
28	141.59		
29	140.61		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:54:07 2013
Sample: ND15 FOM E02

PAVING START TIME

Hour:	8
Min.:	36
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	236.1	153.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	57.1	8.2	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	69.6 F

Lift	Lift time, min
1	27

Total Time of Paving Operation:27.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	236.1
1	223.77
2	216.12
3	210.26
4	205.29
5	200.88
6	196.88
7	193.21
8	189.82
9	186.66
10	183.72
11	180.96
12	178.37
13	175.94
14	173.64
15	171.47
16	169.42
17	167.48
18	165.63
19	163.88
20	162.21
21	160.63
22	159.11
23	157.67
24	156.29
25	154.97
26	153.71

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:55:19 2013
Sample: ND15 FOM E03

PAVING START TIME

Hour:	9
Min.:	17
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	229.4	161.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	61.9	10	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	80.3 F

Lift	Lift time, min
1	21

Total Time of Paving Operation:21.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	229.4
1	218.28
2	211.38
3	206.07
4	201.56
5	197.57
6	193.94
7	190.62
8	187.54
9	184.69
10	182.02
11	179.53
12	177.18
13	174.98
14	172.91
15	170.95
16	169.1
17	167.34
18	165.68
19	164.1
20	162.6

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:56:41 2013
Sample: ND15 FOM E04

PAVING START TIME

Hour:	10
Min.:	6
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	233	167.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.5	8.6	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	92.8 F

Lift	Lift time, min
1	23

Total Time of Paving Operation:23.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	233
1	222.62
2	216.19
3	211.26
4	207.07
5	203.36
6	200
7	196.92
8	194.06
9	191.41
10	188.94
11	186.62
12	184.45
13	182.4
14	180.47
15	178.65
16	176.93
17	175.3
18	173.75
19	172.28
20	170.89
21	169.56
22	168.29

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:58:06 2013
Sample: ND15 FOM E05

PAVING START TIME

Hour:	10
Min.:	49
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	211.6	152.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.5	8.6	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	100.8 F

Lift	Lift time, min
1	33

Total Time of Paving Operation:33.00 min

COOLING CURVES (Temp (F))

Actual Time

Time, min	Lift 1	Time, min	Lift 1
0	211.6	30	154.57
1	203.45	31	153.9
2	198.42	32	153.26
3	194.57		
4	191.31		
5	188.41		
6	185.79		
7	183.39		
8	181.16		
9	179.1		
10	177.17		
11	175.37		
12	173.67		
13	172.08		
14	170.58		
15	169.16		
16	167.82		
17	166.54		
18	165.34		
19	164.19		
20	163.11		
21	162.07		
22	161.08		
23	160.14		
24	159.23		
25	158.37		
26	157.55		
27	156.76		
28	156		
29	155.27		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:59:36 2013
Sample: ND15 FOM E06

PAVING START TIME

Hour:	11
Min.:	19
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	231.9	163.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	69.7	7.4	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	104.3 F

Lift	Lift time, min
1	33

Total Time of Paving Operation:33.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	231.9	30	166.13
1	222.53	31	165.34
2	216.74	32	164.59
3	212.3		
4	208.55		
5	205.22		
6	202.2		
7	199.43		
8	196.87		
9	194.49		
10	192.27		
11	190.19		
12	188.24		
13	186.4		
14	184.67		
15	183.03		
16	181.48		
17	180.01		
18	178.62		
19	177.29		
20	176.03		
21	174.83		
22	173.69		
23	172.59		
24	171.55		
25	170.55		
26	169.59		
27	168.67		
28	167.79		
29	166.94		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Fri Jul 12 00:03:03 2013
Sample: ND15 FOM E07

PAVING START TIME

Hour:	12
Min.:	21
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	240.6	181

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	72.5	6.2	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	117.5 F

Lift	Lift time, min
1	21

Total Time of Paving Operation:21.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	240.6
1	231.17
2	225.23
3	220.63
4	216.69
5	213.18
6	209.97
7	207.02
8	204.28
9	201.72
10	199.32
11	197.07
12	194.94
13	192.94
14	191.04
15	189.24
16	187.53
17	185.9
18	184.35
19	182.87
20	181.46

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Fri Jul 12 00:04:54 2013
Sample: ND15 FOM E08

PAVING START TIME

Hour:	12
Min.:	58
Mon.:	6
Day:	2
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	229.4	177.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	74.1	7.1	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	124.9 F

Lift	Lift time, min
1	20

Total Time of Paving Operation:20.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	229.4
1	221.27
2	216.12
3	212.1
4	208.66
5	205.58
6	202.77
7	200.17
8	197.76
9	195.51
10	193.4
11	191.41
12	189.54
13	187.76
14	186.09
15	184.49
16	182.98
17	181.54
18	180.17
19	178.86

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:41:09 2013
Sample: ND15 FOM W01

PAVING START TIME

Hour:	11
Min.:	30
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	228.2	175.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	61.3	10.5	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	98.5 F

Lift	Lift time, min
1	16

Total Time of Paving Operation:16.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	228.2
1	218.45
2	212.37
3	207.69
4	203.71
5	200.17
6	196.96
7	194.01
8	191.29
9	188.75
10	186.38
11	184.16
12	182.08
13	180.12
14	178.27
15	176.52

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:42:41 2013
Sample: ND15 FOM W02

PAVING START TIME

Hour:	12
Min.:	45
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	228.1	162.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	63.9	9.5	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	101.1 F

Lift	Lift time, min
1	28

Total Time of Paving Operation:28.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	228.1
1	218.61
2	212.71
3	208.17
4	204.31
5	200.89
6	197.78
7	194.92
8	192.28
9	189.82
10	187.52
11	185.37
12	183.34
13	181.44
14	179.64
15	177.94
16	176.33
17	174.81
18	173.36
19	171.98
20	170.67
21	169.42
22	168.22
23	167.08
24	165.98
25	164.94
26	163.93
27	162.97

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:39:26 2013
Sample: ND15 FOM W03

PAVING START TIME

Hour:	13
Min.:	44
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	231.4	166.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	65.2	8.4	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	111.9 F

Lift	Lift time, min
1	30

Total Time of Paving Operation:30.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	231.4
1	222.4
2	216.79
3	212.45
4	208.76
5	205.48
6	202.5
7	199.75
8	197.21
9	194.84
10	192.62
11	190.54
12	188.58
13	186.74
14	185
15	183.35
16	181.78
17	180.29
18	178.88
19	177.53
20	176.25
21	175.02
22	173.85
23	172.73
24	171.65
25	170.62
26	169.63
27	168.67
28	167.76
29	166.87

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:44:19 2013
Sample: ND15 FOM W04

PAVING START TIME

Hour:	14
Min.:	41
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	231.6	168

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	65.9	8.2	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	120 F

Lift	Lift time, min
1	31

Total Time of Paving Operation:31.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	231.6	30	168.14
1	223.07		
2	217.7		
3	213.55		
4	209.99		
5	206.82		
6	203.94		
7	201.28		
8	198.81		
9	196.51		
10	194.35		
11	192.32		
12	190.42		
13	188.61		
14	186.91		
15	185.29		
16	183.76		
17	182.3		
18	180.9		
19	179.58		
20	178.31		
21	177.1		
22	175.94		
23	174.82		
24	173.76		
25	172.73		
26	171.74		
27	170.79		
28	169.88		
29	168.99		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:46:06 2013
Sample: ND15 FOM W05

PAVING START TIME

Hour:	15
Min.:	32
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	222.7	169.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.7	7.4	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 107.9 F

Lift	Lift time, min
1	20

Total Time of Paving Operation:20.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	222.7
1	214.04
2	208.63
3	204.45
4	200.88
5	197.71
6	194.82
7	192.16
8	189.69
9	187.38
10	185.22
11	183.19
12	181.28
13	179.48
14	177.77
15	176.15
16	174.62
17	173.16
18	171.76
19	170.43

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:47:29 2013
Sample: ND15 FOM W06

PAVING START TIME

Hour:	16
Min.:	6
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	227.5	163.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	67.2	7.2	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	110.4 F

Lift	Lift time, min
1	28

Total Time of Paving Operation:28.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	227.5
1	218.59
2	212.99
3	208.65
4	204.95
5	201.65
6	198.64
7	195.86
8	193.29
9	190.88
10	188.63
11	186.51
12	184.51
13	182.62
14	180.83
15	179.13
16	177.52
17	175.99
18	174.52
19	173.13
20	171.79
21	170.52
22	169.29
23	168.12
24	166.99
25	165.9
26	164.86
27	163.85

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:48:50 2013
Sample: ND15 FOM W07

PAVING START TIME

Hour:	17
Min.:	6
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	223.1	152.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.6	7	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	108.7 F

Lift	Lift time, min
1	35

Total Time of Paving Operation:35.00 min

COOLING CURVES (Temp (F))

Actual Time			
Time, min	Lift 1	Time, min	Lift 1
0	223.1	30	156.32
1	214.3	31	155.42
2	208.74	32	154.55
3	204.42	33	153.7
4	200.72	34	152.88
5	197.42		
6	194.41		
7	191.62		
8	189.03		
9	186.62		
10	184.35		
11	182.21		
12	180.19		
13	178.29		
14	176.48		
15	174.76		
16	173.13		
17	171.57		
18	170.09		
19	168.67		
20	167.31		
21	166.01		
22	164.76		
23	163.57		
24	162.41		
25	161.3		
26	160.23		
27	159.2		
28	158.21		
29	157.25		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 23:50:50 2013
Sample: ND15 FOM W08

PAVING START TIME

Hour:	17
Min.:	47
Mon.:	5
Day:	31
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	227.2	170.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.6	7	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	108.3 F

Lift	Lift time, min
1	19

Total Time of Paving Operation:19.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	227.2
1	217.96
2	212.11
3	207.54
4	203.63
5	200.12
6	196.92
7	193.97
8	191.22
9	188.65
10	186.23
11	183.96
12	181.81
13	179.78
14	177.86
15	176.03
16	174.28
17	172.62
18	171.04

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:46:08 2013
Sample: ND15 HMA E01

PAVING START TIME

Hour:	10
Min.:	31
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	264.3	184.3

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	68.7	12.9	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	102 F

Lift	Lift time, min
1	22

Total Time of Paving Operation:22.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	264.3
1	251.78
2	243.9
3	237.79
4	232.58
5	227.94
6	223.73
7	219.86
8	216.28
9	212.95
10	209.85
11	206.94
12	204.21
13	201.64
14	199.22
15	196.93
16	194.77
17	192.72
18	190.77
19	188.93
20	187.17
21	185.49

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:47:52 2013
Sample: ND15 HMA E02

PAVING START TIME

Hour:	11
Min.:	34
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	259.3	182

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	70.7	14.2	Clear & Dry

Latitude 48 degrees

EXISTING SURFACE

Material: AC
Temp: 103.1 F

Lift	Lift time, min
1	22

Total Time of Paving Operation:22.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	259.3
1	247.23
2	239.62
3	233.72
4	228.69
5	224.21
6	220.14
7	216.4
8	212.95
9	209.73
10	206.74
11	203.93
12	201.3
13	198.82
14	196.48
15	194.28
16	192.19
17	190.22
18	188.34
19	186.56
20	184.86
21	183.25

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:52:00 2013
Sample: ND15 HMA E03

PAVING START TIME

Hour:	12
Min.:	44
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	266.9	193.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	73.6	15.5	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	111.3 F

Lift	Lift time, min
1	17

Total Time of Paving Operation:17.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	266.9
1	254.34
2	246.3
3	239.99
4	234.57
5	229.73
6	225.31
7	221.24
8	217.47
9	213.95
10	210.66
11	207.58
12	204.68
13	201.94
14	199.36
15	196.92
16	194.6

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:53:44 2013
Sample: ND15 HMA E04

PAVING START TIME

Hour:	13
Min.:	56
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	269.9	209.2

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	76.4	17.5	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	114 F

Lift	Lift time, min
1	12

Total Time of Paving Operation:12.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	269.9
1	257.16
2	248.96
3	242.51
4	236.96
5	232
6	227.48
7	223.31
8	219.44
9	215.84
10	212.47
11	209.31

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:55:25 2013
Sample: ND15 HMA E05

PAVING START TIME

Hour:	14
Min.:	44
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	249.7	178.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	76.6	18.4	Partly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	120.7 F

Lift	Lift time, min
1	21

Total Time of Paving Operation:21.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	249.7
1	238.97
2	232.03
3	226.54
4	221.8
5	217.56
6	213.68
7	210.1
8	206.78
9	203.68
10	200.78
11	198.06
12	195.5
13	193.09
14	190.8
15	188.64
16	186.59
17	184.64
18	182.79
19	181.02
20	179.33

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:56:50 2013
Sample: ND15 HMA E06

PAVING START TIME

Hour:	15
Min.:	55
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	242.6	166.6

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	77.3	17.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	104.7 F

Lift	Lift time, min
1	22

Total Time of Paving Operation:22.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	242.6
1	231.3
2	224.02
3	218.29
4	213.36
5	208.93
6	204.9
7	201.18
8	197.72
9	194.5
10	191.49
11	188.66
12	185.99
13	183.48
14	181.11
15	178.86
16	176.73
17	174.7
18	172.78
19	170.94
20	169.19
21	167.52

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:58:21 2013
Sample: ND15 HMA E07

PAVING START TIME

Hour:	17
Min.:	21
Mon.:	5
Day:	22
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	256	181.6

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	77.8	12	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	99.8 F

Lift	Lift time, min
1	18

Total Time of Paving Operation:18.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	256
1	243.56
2	235.62
3	229.41
4	224.07
5	219.3
6	214.94
7	210.93
8	207.2
9	203.73
10	200.47
11	197.41
12	194.53
13	191.81
14	189.24
15	186.81
16	184.5
17	182.3

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:34:12 2013
Sample: ND15 HMA W01

PAVING START TIME

Hour:	12
Min.:	5
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	251.4	179.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.2	14.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	94.8 F

Lift	Lift time, min
1	16

Total Time of Paving Operation:16.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	251.4
1	238.84
2	230.81
3	224.52
4	219.11
5	214.28
6	209.87
7	205.81
8	202.04
9	198.52
10	195.23
11	192.15
12	189.24
13	186.5
14	183.91
15	181.46

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:35:39 2013
Sample: ND15 HMA W02

PAVING START TIME

Hour:	12
Min.:	43
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	248.9	174.5

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.2	14.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	97.2 F

Lift	Lift time, min
1	18

Total Time of Paving Operation:18.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	248.9
1	236.7
2	228.89
3	222.76
4	217.49
5	212.78
6	208.48
7	204.52
8	200.84
9	197.41
10	194.2
11	191.19
12	188.35
13	185.68
14	183.15
15	180.75
16	178.48
17	176.32

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:37:32 2013
Sample: ND15 HMA W03

PAVING START TIME

Hour:	13
Min.:	37
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	239.9	146.8

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	66.1	13.2	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	86.2 F

Lift	Lift time, min
1	32

Total Time of Paving Operation:32.00 min

COOLING CURVES (Temp (F))

	Actual Time		
Time, min	Lift 1	Time, min	Lift 1
0	239.9	30	148.2
1	227.75	31	147.04
2	220.02		
3	213.98		
4	208.8		
5	204.18		
6	199.96		
7	196.08		
8	192.48		
9	189.12		
10	185.97		
11	183.02		
12	180.25		
13	177.63		
14	175.15		
15	172.81		
16	170.59		
17	168.48		
18	166.47		
19	164.56		
20	162.73		
21	160.99		
22	159.32		
23	157.73		
24	156.2		
25	154.73		
26	153.32		
27	151.97		
28	150.67		
29	149.41		

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:39:53 2013
Sample: ND15 HMA W04

PAVING START TIME

Hour:	14
Min.:	26
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	251.1	163.4

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	68.9	18.6	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	88.8 F

Lift	Lift time, min
1	22

Total Time of Paving Operation:22.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	251.1
1	237.92
2	229.46
3	222.81
4	217.1
5	211.99
6	207.34
7	203.05
8	199.08
9	195.38
10	191.92
11	188.68
12	185.63
13	182.76
14	180.04
15	177.48
16	175.05
17	172.74
18	170.55
19	168.47
20	166.48
21	164.58

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:41:22 2013
Sample: ND15 HMA W05

PAVING START TIME

Hour:	15
Min.:	56
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	248.7	162.1

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	71.9	21.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	107.3 F

Lift	Lift time, min
1	25

Total Time of Paving Operation:25.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	248.7
1	236.77
2	229.02
3	222.88
4	217.57
5	212.81
6	208.47
7	204.46
8	200.74
9	197.28
10	194.03
11	190.99
12	188.13
13	185.43
14	182.88
15	180.47
16	178.18
17	176.01
18	173.94
19	171.97
20	170.09
21	168.3
22	166.59
23	164.95
24	163.37

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:42:43 2013
Sample: ND15 HMA W06

PAVING START TIME

Hour:	16
Min.:	51
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	248	177.9

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	71.9	21.5	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	91.9 F

Lift	Lift time, min
1	14

Total Time of Paving Operation:14.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	248
1	235.09
2	226.76
3	220.19
4	214.53
5	209.47
6	204.85
7	200.6
8	196.66
9	192.99
10	189.56
11	186.34
12	183.32
13	180.47

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.

MULTICOOL 3.0 - Simulation Output

Time of Simulation:
Thu Jul 11 22:44:22 2013
Sample: ND15 HMA W07

PAVING START TIME

Hour:	17
Min.:	37
Mon.:	5
Day:	21
Year:	2012

PAVEMENT CONDITIONS

Mix: Superpave-Fine
Asphalt: PG 58-28

Lift#	H (in)	Deliv Temp (F)	Stop Temp (F)
1	2	252.9	182.7

***ENVIRONMENTAL CONDITIONS
The following data represent AVERAGE conditions during compaction of a particular lift.

Lift#	Air Temp (F)	Wind Speed (mph)	Sky Condition
1	71.2	19.8	Mostly Cloudy

Latitude 48 degrees

EXISTING SURFACE

Material:	AC
Temp:	92.7 F

Lift	Lift time, min
1	14

Total Time of Paving Operation:14.00 min

COOLING CURVES (Temp (F))

	Actual Time
Time, min	Lift 1
0	252.9
1	239.7
2	231.18
3	224.47
4	218.69
5	213.52
6	208.8
7	204.45
8	200.42
9	196.66
10	193.14
11	189.85
12	186.75
13	183.83

COOLING DATA

The calculated times assume a continuous paving operation.
The lift time is the time for the lift to cool to the designated stop temperature, after the lift has been placed.