
Standard Practice for

Continuous Thermal Profile of Asphalt Mixture Construction

AASHTO Designation: PP 80-20¹

**Tech Subcommittee: 5c, Quality Assurance
and Environmental**

Release: Group 1 (April)



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1. SCOPE

- 1.1. This work shall consist of continuous thermal profiling of the asphalt mat temperature immediately behind the trailing edge of the paver screed plate during placement operations.
- 1.2. This system includes a display that allows the operator in the field to view a pavement surface temperature contour plot and automatically stores and saves the data for later review.
- 1.3. This standard practice is intended to be applied for construction quality control.
- 1.4. All tasks are the contractor's responsibility, unless designated otherwise within this provision.

2. TERMINOLOGY

- 2.1. *Definitions:*
 - 2.1.1. *cloud*—a Web-based user interface.
 - 2.1.1.1. *cloud storage*—network storage (typically the Internet) where the thermal profile data are stored in virtualized pools of storage.
 - 2.1.1.2. *cloud computing*—the use of computing resources (hardware and software) that are delivered as a service over a network to enable near-real-time visualization (maps) and manipulation of thermal profile data.
 - 2.1.2. *coordinate system*— a system that uses one or more numbers or coordinates to uniquely determine the position of a point or other geometric element on a manifold such as Euclidean space.
 - 2.1.2.1. *Global Navigation Satellite System (GNSS)*—a satellite system that is used to pinpoint the geographic location of a user's receiver anywhere in the world. Three GNSS systems are currently in operation: the United States' Global Positioning System (GPS), the Russian Federation's Global Orbiting Navigation Satellite System (GLONASS), and Europe's Galileo. Each of the GNSS systems employs a constellation of orbiting satellites working in conjunction with a network of ground stations.

- 2.1.2.2. *Global Positioning System (GPS)*—a space-based satellite navigation system that provides location and time information, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
- 2.1.3. *Distance Measuring Instrument (DMI)*—a sensor attached to a wheel on the paver to calculate distance and velocity.
- 2.1.4. *index*—measure or standard to quantify the uniformity of a hot- or warm-mix asphalt construction operation.
- 2.1.5. *paver mounted thermal profile (PMTF) system*—a system used to continually monitor surface temperature readings of the mat immediately behind the trailing edge of the screed plate during placement operations.
 - 2.1.5.1.1. *contour plot*—a graphic display of data using contour lines and/or color scales. These plots may display raw values or employ varying degrees of smoothing.
 - 2.1.5.1.2. *range*—the difference between the surface temperature readings at the 98.5 and 1 percentile.
 - 2.1.5.1.3. *surface temperature readings*—the temperatures of the mat immediately behind the trailing edge of the paver screed during placement operations.
 - 2.1.5.1.4. *thermal coverage (TC)*—the percent of the total paving area, for the given lift, where surface temperature readings (meeting the requirements of this provision) are collected and stored.
 - 2.1.5.1.5. *thermal profile*—the surface temperature readings and associated GNSS coordinates and time stamps.
- 2.1.6. *traffic lane*—the portion of a traveled way for the movement of a single line of vehicles.
 - 2.1.6.1. *auxiliary lane*—a portion of the roadway adjoining the traveled way for parking, speed-change, or other purposes supplementary to through traffic movement.
 - 2.1.6.2. *centerline offsets*—the location of the left and right edge of the production/compaction area with respect to the centerline, facing in the direction of increasing stationing. Stationing typically increases from west to east and south to north.
 - 2.1.6.3. *direction of travel*—the direction that traffic moves during non-construction conditions (e.g., north bound, southbound, eastbound, westbound).
 - 2.1.6.4. *roadway*—general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.
 - 2.1.6.5. *traveled way*—the portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.
- 2.1.7. *Veta*—a standardized intelligent construction data management (ICDM) software that stores, maps and analyzes geospatial data resulting from intelligent compaction, thermal profiling and spot test data (e.g., density, moisture). This software can perform standardized data processing, analysis and reporting to provide project summary results quickly in the field from various intelligent compaction and thermal profiling manufacturers. In particular, the software can provide statistics, histograms, correlations for these measurements, document coverage area and evaluate the uniformity of compaction and surface temperature measurements as part of the project quality control operations. Veta can be downloaded from the Advanced Materials and Technology Website. (Software can be downloaded from www.intelligentcompaction.com)

3. CONSTRUCTION REQUIREMENTS

3.1. *Equipment Requirements:*

3.1.1. *PMTP System Supplier*—use a thermal equipment supplier that can provide a qualified representative for on-site technical assistance during the initial setup, pre-construction verification, and data management and processing, as needed, during the project to maintain equipment within specifications and requirements.

3.1.2. *PMTP Software:*

3.1.2.1. Provide the agency with access to the cloud storage and cloud computing before the start of paving requiring the PMTP method until 90 days after final acceptance of all work.

3.1.2.2. Use PMTP software, and cloud computing and storage, capable of collecting, mapping, retaining, and analyzing the surface temperature readings during placement; exporting thermal profile data meeting the requirements of this provision; and supporting the following features:

3.1.2.2.1. Filtering by surface temperature readings/location (see Table 3).

3.1.2.2.2. *Display through a map/graph:*

- Surface temperature readings across the required width and with respect to a user defined subplot length,
- Paver speed, and
- Paver stops (location and duration).

3.1.2.2.3. Provide the paving length and duration.

3.1.3. *PMTP System:*

3.1.3.1. *System Requirements:*

3.1.3.1.1. Use a PMTP system that functions independently from the paving crew during normal paving operations. Initial data collection must be initiated by an operator. After initializing the equipment, no operator attendance shall be required for continuous data collection.

3.1.3.1.2. Ensure that the power consumption of all installed equipment does not exceed the capacity of the equipment providing operating power. Complete discharge of this system shall not impact the vehicle's regular electrical system.

3.1.3.1.3. Provide the agency with PMTP system(s) calibrated and installed according to manufacturer's recommendations.

3.1.3.1.4. *Ensure the PMTP system meets the requirements of Table 1 and is instrumented with the following:*

Table 1—PMTP System Requirements

Parameter	Requirement
Longitudinal and Lateral Surface Temperature Readings	≤305 mm [≤12.0 in.] intervals at all paving speeds Tolerance: ±25 mm [±1 in.]
Surface Temperature Readings Total Measurement Width	Traffic / Required Auxiliary Lane(s) paved in one pass.
Surface Temperature Readings	Range: 60 to 250°C [140 to 480°F] Accuracy: ±2°C [±3.6°F] or ±2.0 percent of the sensor reading, whichever is greater.
GNSS ^a	Accuracy: ≤ ±1.2 m [4 ft] in the X and Y directions
DMI Encoder ^a	Accuracy: ±0.025°

^a The DMI and GNSS are both used for determination of the location of surface temperature measurements. The agency shall define whether both the GNSS and DMI encoder are required. DMI is difficult to calibrate with changing hopper loads and, therefore, it is recommended that GNSS be required and used for linear distances.

- (1) Modem, or Wi-Fi, for transferring data to cloud storage.
- (2) *Onboard Documentation System*—Use an onboard documentation system with a minimum of the following capabilities:
 - (2.1) Displays (in real time) a map of the surface temperature readings,
 - (2.2) Displays the total distance, paver speed, and location.
 - (2.3) Reports the surface temperature readings and GNSS status.
 - (2.4) Provides real-time statistical summaries of the surface temperature readings.
 - (2.5) Has the ability to manually export data using a removable media device.
 - (2.6) Allows the operator to define the lot currently being placed.

3.1.3.2. *PMTP Data:*

3.1.3.2.1. *Export the thermal profiling data:*

- (1) As dbase, ASCII, or text format,
- (2) Directly into Veta if a file format compatible with Veta is available (software can be downloaded from www.intelligentcompaction.com), or
- (3) Through a direct transfer of data from cloud storage to Veta.

Note 1—Direct transfer of data from cloud storage to Veta is the preferred import method as this process reduces the number of steps required to export data from the cloud storage/cloud mapping software.

3.1.3.2.2. Ensure the PMTP date/time stamp is reflective of the local time zone for both mapped and exported data.

3.1.3.2.3. Encrypt the data logged in the results files to prevent tampering or manipulation.

3.1.3.2.4. Include the information in Table 2 in the header of each data file or section. Include the fields in Table 3 with each data point.

Table 2—Required Information in Data Header

Description	Example Data
Agency project number, highway, and/or section title	Highway 77
Machine trade name	ABC Company
Machine ID	Temp Bar
Lateral spacing between surface temperature measurements, mm [in.]	305 [12]
Longitudinal spacing between surface temperature measurements, mm [in.]	305 [12]
Vertical distance between temperature sensor(s) and mat, mm [in.]	3050 [120]
Reporting resolution for independent surface temperature data—in the paver moving direction, mm [in.]	305 [12]
Number of lateral surface temperature measurements/sensors	10
Number of surface temperature measurement data blocks	5000

Table 3—Required Fields for Each Data Block

Data Field Name	Example Data
Date stamp	20130607 (YYYYMMDD)
Time stamp	090504.0 (9 hr 5 min 4.0 s) HHMMSS.S (military format)
Longitude, decimal degrees, with at least 8 significant digits	94.85920403
Latitude, decimal degrees, with at least 8 significant digits	45.22777335
Distance, m [ft]	0.3 [1]
Direction heading, degree angle, clockwise from the north; or calculated value, in Veta, using values from the other data blocks	[45]
Speed, m/min [ft/min]	9.1 [30]
Surface temperature reading/Location 1, °C [°F] ^a	143 [290]
...	...
Surface temperature reading/Location N, °C [°F] ^a	149 [300]

^a Surface temperature readings/locations are numbered from 1 to N, left to right, in the direction of paving.

3.2. *Design File:*

Note 2—It is recommended that the agency create the background and alignment file(s). See Appendix X1 for recommended language.

3.2.1. The alignment file allows the user to geospatially view the surface temperature measurements with respect to the given centerline location. This is beneficial when troubleshooting workmanship, overlaying density data (or other measurement data), and/or for identification of PMTP system issues.

3.3. *Field Stationing*—Ensure that field station markers match the centerline stationing used in the background and alignment design file, when used.

3.4. *PMTP System Setup on Paver(s):*

3.4.1. Instrument all pavers that are paving the traffic and required auxiliary lanes with the PMTP system. The PMTP system is not required on the secondary paver for instances where echelon paving is used to assist with the paving of auxiliary lanes not requiring PMTP method. Secondary pavers are those pavers that are not used for paving of traffic lanes, but are used for paving of approaches, ramps, intersecting streets, etc.

3.4.2. Ensure that the installed PMTP system takes measurements within 3 m [10 ft] of the trailing edge of the screed plate and does not restrict the accuracy and functionality of the GNSS or DMI.