

ITEM #0406606A – DOCUMENTATION OF UNIFORM PLACEMENT OF BITUMINOUS CONCRETE (PAVER)

ITEM #0406607A – DOCUMENTATION OF UNIFORM COMPACTION OF BITUMINOUS CONCRETE (ROLLERS)

1. **Description:** This work shall consist of the continuous real-time tracking and recording the location of all placement (pavers) and compaction (rollers) equipment utilizing Global Positioning System (GPS) technology during the placement of bituminous mixtures within the limits of the work as described in the plans. In addition, the continuous real-time temperature of the pavement under the rollers and immediately behind the paver(s) shall also be measured and recorded.

1a. GPS-Related Definitions:

GPS: A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. In this specification, GPS is referred to all GPS-related signals including US GPS, and other Global Navigation Satellite Systems (GNSS).

Hand-Held GPS rover: A portable GPS radio/receiver for in-situ point measurements.

GPS Base Station: A single ground-based system that consists of a GPS receiver, GPS antenna, radio and radio antenna to provide L1/L2 differential GPS correction signals to other GPS receivers within a range limited by radio, typically 3 miles (4.8 Km) in radius without repeaters.

Network RTK: Network RTK is a system that use multiple bases in real-time to provide high-accuracy GPS positioning within the coverage area that is generally larger than that covered by a ground-based GPS base station; e.g., VRSTM.

GPS Correction Service Subscription: A service that can be subscribed to receive VRS signals in order to achieve higher accuracy GPS positioning normally via cellular wireless data services; i.e., without the need for a ground-based base station. Examples of GPS Correction Service subscriptions are: Trimble VRSTM, Trimble VRS NOWTM, OmniSTAR, etc.

RTK-GPS: Real Time Kinematic Global Positioning Systems based on the use of carrier phase measurements of the available GPS signals where a single reference station or a reference station network provides the real-time corrections in order to achieve centimeter-level accuracy.

UTM Coordinates: Universal Transverse Mercator (UTM) is a 2-dimensional Cartesian coordinates system that divides the surface of Earth between 80°S and 84°N latitude into 60 zones, each 6° of longitude in width and centered over a meridian of longitude. Zone 1 is bounded by longitude 180° to 174° W and is centered on the 177th West meridian. The UTM system uses projection techniques to transform an ellipsoidal surface to a flat map the can be printed on paper or displayed on a computer screen. Note that UTM is metric-based.

Geodetic Coordinates: A non-earth-centric coordinate system to describe a position in longitude, latitude, and altitude above the imaginary ellipsoid surface based on a specific geodetic datum. WGS-84 and NAD83 datum are required for use with UTM and State Plans, respectively.

ECEF XYZ: Earth-Centered, Earth-Fixed Cartesian X, Y, Z coordinates.

Grid: Referred to ECEF XYZ in this specification.

GUI Display: Graphical User Interface Display

State Plane Coordinate: A set of 124 geographic zones or coordinate systems designed for specific regions of the United States. Each state contains one or more state plane zones, the boundaries of which usually follow county lines. The current State Plane coordinate is based on NAD83. Issues may arise when a project crosses state plane boundaries.

UTC: Coordinated Universal Time (UTC) is commonly referred to as Greenwich Mean Time (GMT) and is based on a 24 hours' time scale from the mean solar time at the Earth's prime meridian (zero degrees longitude) located near Greenwich, England.

2. **Equipment:**

a. **Rollers/Pavers** – All rollers used for breakdown, intermediate rolling and finish rolling, and pavers used to place bituminous concrete within the project limits.

1. GPS radio and receiver units shall be mounted on each roller and paver to monitor the speed and location of such equipment during the entire paving operation.
2. The GPS equipment shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of the location, number of passes, pavement surface temperatures, speeds, and for the rollers vibration frequencies and amplitudes of roller drums.
3. The GPS unit shall be capable of transferring the data by means of a USB port.
4. An on-board printer capable of printing the identity of the equipment, the date of measurements, construction area being mapped, and percentage of the construction area mapped. The Engineer may request printouts during the paving operation to confirm operation of the system.

b. **Global Positioning System (GPS).** The Contractor shall provide the GPS technology to achieve accurate and consistent GPS measurements among all GPS equipped devices on the project.

All GPS devices for this project shall be set to the same consistent coordinate datum/system no matter whether GPS or Grid data are originally recorded. The Connecticut State Plane Coordinate System shall be used. The information collected shall be in metric measurements as listed in Tables 2 and 3.

c. **GPS System and Reference System Combination.** Contractor shall provide the GPS system (including GPS receivers on equipment and hand-held GPS receivers (Rovers)) that makes use of the

same reference system that can be a ground-based base station or network-RTK, to achieve RTK-GPS accuracy. Examples of combinations are:

1. GPS receivers on equipment and hand-held GPS rovers referenced to the same on-ground base station.
2. GPS receiver on equipment and hand-held GPS receivers referenced to the same network RTK.

d. GPS Data Records and Formats. The recorded GPS data, whether from the equipment or hand-held GPS rovers, shall be in the following format:

1. Time: The time stamp shall be in military format, hhmmss.ss in either UTC or local time zone. 0.01 second is required to differentiate sequence of data points during post process.
2. GPS: Latitudes and longitude shall be recorded in ddmm.mmmmmmmm or decimal degrees, dd.dddddddd. Longitudes are negative values when measuring westward from the Prime Meridian.
3. Grid: Coordinates shall be in meters with at least 3 digits of significance (0.001 m or 1 mm).

When importing data into the data analysis software, the GPS data and associated measurements shall be stored with minimum data conversions and minimum loss of precisions. Users can then select unit of preference to allow real time unit conversion for the GUI display.

e. Data Analysis Software. Standardized data analysis software (Veda) to be used for this project is available on the website <http://www.intelligentcompaction.com>. As a minimum, the following Essential Data Information and Data Elements shall be included in each data file or section.

Table 2 - Essential Data Information

<u>Item</u>	<u>Description</u>
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum/Screed Width (m)
6	Drum Diameter (m) (roller only)
7	Machine Weight (metric ton)
8	CSPC Zone
9	Offset to UTC (hrs)
10	Number of data points

Table 3 – Essential Data Elements for each Data Point

<u>Item</u>	<u>Data Field Name</u>	<u>Example of Data</u>
1	Date Stamp (YYYYMMDD)	e.g. 20080701
2	Time Stamp (HHMMSS.SS -military format)	e.g. 090504.00 (9 hr 5 min. 4.00 s.)
3*	Longitude (decimal degrees)	e.g. 94.85920403
4*	Latitude (decimal degrees)	e.g. 45.22777335
5*	Easting (m)	e.g. 354048.300
6*	Northing (m)	e.g. 5009934.900
7	Height (m)	e.g. 339.9450
8	Pass number (rollers only)	e.g. 2
9	Direction index	e.g., 1 forward, 2 reverse
10	Speed (kph) (rollers and pavers)	e.g. 4.0
11	Vibration on	e.g., 1 for yes, 2 for no
12	Frequency (vpm)	e.g. 3500.0
13	Amplitude (mm)	e.g. 0.6
14	Surface temperature (°C) (rollers only)	e.g. 120

*Items 3 and 4 can be exclusive with items 5 and 6, and vice versa.

f. **Trained Equipment Operators.** The Contractor will provide equipment operator(s) trained to accomplish work under these items. Sufficient training for the operator(s) shall be supplied by a representative of the manufacturer of the equipment prior to commencement of the work.

g. **Equipment Information.** Prior to commencement of the work, the Contractor shall supply the Engineer with equipment information, to include at a minimum the supplier, make, model, unique identifier, and GPS system supplier to be utilized.

3. Construction Methods and Requirements:

a. **Quality Control:** In addition to all other QC activities, the Contractor shall be responsible for:

1. Daily GPS testing of the roller and paver mounted equipment and rover(s). Establishing target number of passes using field data collected from the project using data collected from standard density testing methods; i.e., portable density gauges or pavement cores.
2. Monitoring the equipment location and GPS system operation.
3. Monitor the pavement temperature during placement and rolling.
4. Download of the data from the rollers and paver(s).
5. Daily set-up, removal, and secure storage of GPS and equipment components.

b. **Data Security:** The Contractor is responsible for obtaining the data from the equipment in a manner and at a frequency necessary to minimize data loss. Any loss of data due to equipment failure, weather conditions, or any other unpredictable event(s) will not be excused from the time

period the material was being placed.

- c. **Data Transfer:** The Contractor shall transfer or make available the raw data to the Engineer within 24 hours of the paving operation.
- d. **Post-Process GPS Check:** The Contractor shall follow the vendor-specific instructions to export data from the equipment to Veda-compatible formats. For each data export, the Contractor shall import the equipment data into Veda and enter GPS point measurements from the rover and visually inspect the map and point measurements on the Veda display screen for consistency. The size of data mesh after post-processing shall be less than 18 inches (450 mm) by 18 inches (450 mm) in the X and Y directions.
- e. **GPS Setup:** Prior to the start of production, the Contractor and representatives of the GPS and equipment manufacturer shall conduct the following to check the proper setup of the GPS, equipment and the rover(s) using the same datum:
 1. On a location nearby or within the project limits, the GPS base station (if required by the GPS) shall be established and the equipment and the GPS rover tied into the same base station.
 2. Verification that the equipment and rover are working properly and that there is a connection with the base station.
 3. There are two options for comparing the equipment and rover coordinates. Production shall not begin until proper GPS verification has been obtained. Vendors' recommended verification process can be used to augment either of the following options:
 - a. GPS verification measurements shall be conducted while the equipment is stationary. The GPS coordinates from the equipment on-board display shall be recorded ensuring that the distance offsets are applied correctly to the center of the front drum (e.g., the measurement is at the equipment GPS receiver position). Place the hand-held GPS receiver on top of the GPS receiver mounted on the equipment and record the coordinates from the hand-held receiver display. The differences of the coordinates between the equipment GPS receiver and hand-held GPS receiver shall be within 2 inches (50 mm) in both the horizontal axes (X and Y). The check for the vertical axis is not required.
 - b. A reference location on the project site shall be selected and marked by the Contractor. The equipment shall be placed so that the center of the front drum or paver hopper is on top of the reference location and location measurement shall be recorded. After moving the equipment from the marked location, a hand-held rover must be used to locate the reference location. The differences of the coordinates in grid shall be within 6 inches (150 mm) in both the horizontal axes (X and Y). The GPS location measurements from the equipment must be used to determine any offsets that are required so that the GPS coordinate of the equipment is at the center of the front drum or hopper. On some systems, distance offsets are applied to the roller/paver GPS measurements from the on-board display and the coordinates may be on the left or right side of the drum or hopper. In those cases the equipment must be moved so that the left or right side of the front drum axle or hopper is flushed with the reference location. The hand-held rover must be placed

on the marked location and the difference of both coordinate records checked. The final GPS coordinate for each data point recorded must be at the center of the front drum or hopper.

4. The project plan file provided by the Department shall be uploaded into the data analysis software and depending on the equipment manufacture, the on-board system.
 5. GPS setup shall be conducted daily during production operations to ensure consistency and accuracy of GPS measurements for all GPS devices prior to the paving and compaction operations.
- 4. Documentation:** In addition to any data documentation requirements listed elsewhere in this Specification, documentation regarding all phases of data collection, processing, and reporting shall be provided to the Engineer to include the following, at a minimum:
1. Equipment. Documentation of the manufacture, model, type of paver, and rollers used each day of paving. The relative positioning of the equipment in the paving operations shall also be noted.
 2. Initial Data. At a minimum, the electronic data from equipment and the data analysis software shall be provided to the Engineer upon the completion of the first days paving.
 3. Production Rollers/Paver Data. The Contractor shall secure the data from the GPS equipment.

A summary of all equipment data shall be given to the Department at the completion of the contract.

5. Assistance and Training:

(a) Technical Assistance. The Contractor shall coordinate for on-site technical assistance from the equipment representatives during the initial seven (7) days of production and then as needed during the remaining operations. As a minimum, the equipment representative shall be present during the initial setup and verification testing of the equipment. The equipment representative shall also assist the Contractor with data management using the data analysis software including data input and processing.

(b) On-Site Training. The Contractor shall coordinate for on-site training for Contractors and Agency project personnel related to operation of the technology. Contractor's personnel shall include the paving superintendent, QC technician(s), and equipment operator(s). Minimum training topics shall include:

1. Background information for the specific system(s) to be used
2. Setup and checks for system(s), GPS receiver, base-station and hand held rovers
3. Operation of the system(s) on the equipment; i.e., setup data collection, start/stop of data recording, and on-board display options
4. Transferring raw data from the equipment; i.e., via USB connections
5. Operation of vendor's software to open and view raw data files and exporting all-passes and proofing data files in Veda-compatible format
6. Operation of Veda software to import the above exported all-passes and proofing data files, inspection of maps, input point test data, perform statistics analysis, and produce reports for project requirements
7. Coverage and uniformity requirements

6. Method of Measurement: Item 0406606A will be measured as the number of tons of PMA S0.5 for the project placed by the paver(s) in accordance with these specifications. 100% of the tons will be measured if the Essential Data Information and Data Elements are collected for the paver (s) and provided to the Engineer for no less than 95% of the time period that the material was placed. Pro-rated measurements of material under this item will not be made.

Item 0406607A will be measured as the number of tons of PMA S0.5 for the project compacted by the rollers in accordance with these specifications. 100% of the tons will be measured if the Essential Data Information and Data Elements are collected for the each roller and provided to the Engineer for no less than 95% of the time period that the material was placed. Pro-rated measurements of material under this item will not be made.

7. Basis of Payment: Item 0406606A will be paid at the contract price for “Documentation of Uniform Placement of Bituminous Concrete (Paver)” which price shall include all materials, equipment, tools, and labor incidental thereto.

Item 0406607A will be paid at the contract price for “Documentation of Uniform Compaction of Bituminous Concrete (Rollers)” which price shall include all materials, equipment, tools, and labor incidental thereto.

<u>Pay Item</u>	<u>Unit</u>
0406606A Documentation of Uniform Placement of Bituminous Concrete (Paver)	ton
0406607A Documentation of Uniform Compaction of Bituminous Concrete (Rollers)	ton