

**00745.00 Scope** - Add the following paragraph to the end of this subsection:

Compaction of the asphalt mixtures shall be done utilizing intelligent compaction (IC) rollers within the limits of the work as described in the plans. A thermal profile will be collected directly behind the paver with a mount infrared sensor system.

**00745.02 Definitions** - Add the following definitions to this subsection:

**Intelligent Compaction-** A process that uses vibratory rollers equipped with a measurement and documentation system that automatically records various critical compaction parameters in real time during the compaction process.

**Thermal Profile Measurement** – Measurement of the thermal profile that identifies the presence of thermal segregation of an uncompacted mat of HMAC, using a paver-mounted infrared sensor.

- Thermal Profile: Infrared temperature measurements taken behind the paver screed, evaluated in 150 foot segments
- Thermal Profile Area: The total area where the thermal profile measurements are generated on a given lift.

**00745.23 HMAC Pavers** - Add the following at the end of the subsection:

**(e) Thermal imaging system requirements.** Equip each paver with a Paver Mounted Thermal Imaging system capable of the following:

- Uses infrared sensors measuring from 40°F – 475°F with an accuracy of  $\pm 2^\circ\text{F}$  or  $\pm 1\%$  of reading, whichever is greater.
- Profiles entire pavement width, excluding pavement edges.
- Measures distance using a Distance Measuring Instrument (DMI) and equipped with GPS in accordance with 00745.25.
- Collects, displays, saves, and analyzes temperature readings while in operation, using the latest software available.
- Produces output files of pavement temperatures for each day's placement and daily summary in an approved test report that identifies locations of thermal segregation with a recording of the temperature at such locations.
- Provides software capable of developing and analyzing thermal profiles for the entire project.
- Provides an operating system with at least one USB port to save test results to a portable USB memory device.
- In-cab color display.
- Includes sufficient training for the operator(s) supplied by a representative of the manufacturer of the equipment.

- Produces data files compatible with data analysis software, Veda Version 2.1 or later, available at no cost at [www.intelligentcompaction.com](http://www.intelligentcompaction.com).

**00745.24 Compactors** – Replace this subsection, except for the subsection number and title, with the following:

Provide the specified self-propelled rollers capable of reversing without backlash, as follows:

**(a) Steel-Wheeled Rollers** - Provide steel-wheeled rollers with a minimum gross static weight as follows:

	<b>Level 1 and Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Breakdown and Intermediate	8 ton	10 ton	12 ton
Finish	6 ton	8 ton	10 ton

**(b) Vibratory Rollers** - Vibratory rollers shall be:

- Equipped with amplitude and frequency controls.
- Specifically designed to compact HMAC.
- Capable of at least 2000 vibrations per minute.
- Have a minimum gross static weight meeting the requirements of 00745.24(a).

Do not operate in vibratory mode for lifts thinner than two times the maximum aggregate size for the type of HMAC being compacted.

If vibratory rollers are used for finish rolling, they shall:

- Have a minimum gross static weight meeting the requirements of 00745.24(a).
- Not be operated in the vibratory mode.

**(c) Pneumatic-tired Rollers** - Pneumatic-tired rollers shall:

- Be tandem, or multiple axle, multiple wheel type.
- Have smooth-tread, pneumatic tires of equal size.
- Have tires staggered on the axles, spaced and overlapped to provide uniform compacting pressure for the full compacting width.
- Have a minimum total load of 2,800 pounds per tire with tire inflation pressures of 45 psi to 90 psi.
- Be fully skirted to reduce tire heat loss and mixture pick up.

**(d) Illumination** - Provide adequate lighting to illuminate each compactor and the roadway in front of and behind each compactor during the period 30 minutes after sunset to 30 minutes before sunrise, or as deemed necessary by the Engineer. Shield lighting from

adjacent traffic as necessary. Provide a minimum light level of 10 footcandles as measured by the Engineer on the roadway surface at a distance of 60 feet from the front and back edges of each compactor.

**(e) Intelligent Compaction** - Equip each steel production roller and 1 reserve roller (X total) with the following equipment for Intelligent Compaction:

**(1) GPS Radio and Receiver unit** – Equip rollers with GPS radio and receiver units to monitor the equipment locations and track the number of roller passes, meeting the requirements of 00745.25

**(2) Temperature Measurement** - Equip rollers with non-contact temperature sensors for measuring pavement surface temperatures

**(3) Integrated On-Board Documentation System** – Equip IC rollers with an on-board documentation system capable of displaying real-time color-coded maps, location of the roller, number of roller passes, pavement surface temperatures, roller speeds, vibration frequencies, and amplitudes of roller drums. Transfer data from the display unit by means of a USB port. Data files shall be compatible with IC data analysis software, Veda Version 2.1 or later, available at no cost at [www.intelligentcompaction.com](http://www.intelligentcompaction.com).

At the end of each work day or shift, operators shall make daily data files available for download to Agency Project Manager's personnel for review.

Add the following subsection:

**00745.25 GPS System** – Provide the supplier, make, model and unique identifier of the GPS system to be utilized for Intelligent Compaction. Supply sufficient training for the operator(s) by a representative of the manufacturer of the equipment.

Provide GPS receivers that use Universal Transverse Mercator (UTM) or the Oregon State Plane coordinate system and have a survey tolerance of not greater than 3.0 in. in both the horizontal (x and y) directions. Use the same coordinate system for all rollers on the entire project and make use of the same reference system. Provide a ground-based base station or network-RTK, to achieve RTK-GPS accuracy if necessary. Provide one hand-held GPS receiver (Rovers) meeting the above requirements..

Provide GPS data shall be in the following format:

- Time: Military, local time zone, hhmmss.ss
- GPS: Latitude/Longitude, degrees/minutes ddmm.mmmmmmmm or decimal degrees dd.dddddddd
- Grid: Feet, 0.01 ft

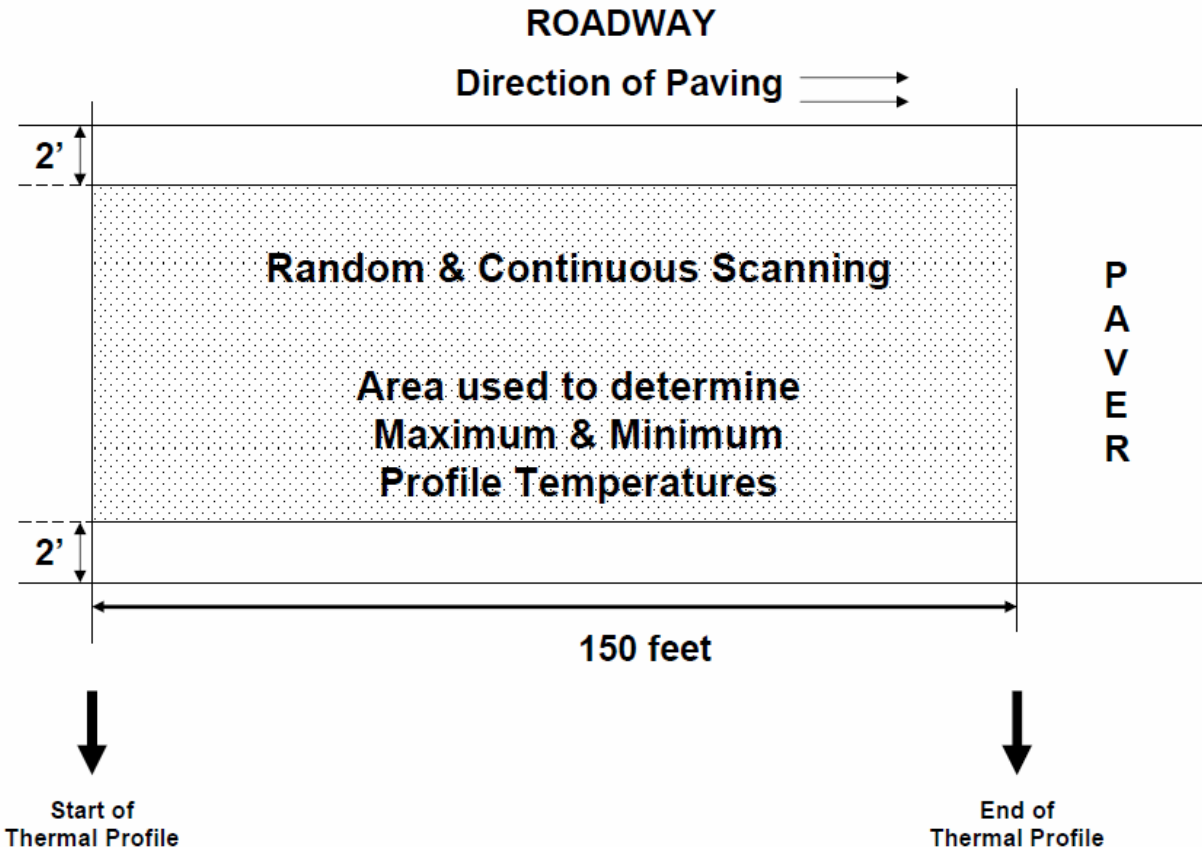
Provide a field technical representative from the GPS equipment supplier to be present for training and technical support at project startup and for the first three days (minimum) of production.

Add the following subsection:

**00745.48(d) Placing HMAC with Thermal Imaging** - Measure the thermal profile of the uncompacted mat of HMAC that identifies the presence of thermal segregation.

- Determine the thermal profile using a paver mounted infrared system.
- Operate the paver mounted infrared system in accordance with the manufacturer's recommendations.
- Verify the calibration for each temperature sensor prior to collecting temperature measurements per manufacturer's recommendations.
- Calibrate each temperature sensor to a known standard on an annual basis.
- Do not obtain thermal profiles in miscellaneous paving areas that are subject to handwork such as intersections, driveways, crossovers, turnouts, gores, tapers, and other similar areas.
- Verify the temperature sensor(s), DMI and GPS are working within the requirements of this specification when requested by the Engineer.
- Record thermal profiles in 150 foot segments, as shown in Figure 1.
- Record the beginning and ending station numbers of all thermal profiles.
- Obtain all temperature measurements in units of degrees Fahrenheit.
- Obtain all temperature measurements while the paver is moving.
- Avoid taking temperature measurements within 2 ft. of the edge of the uncompacted mat.
- When performing a thermal profile, if the paver stops for more than 10 seconds, exclude the area 2 feet behind the screed and 8 feet in front of the screed (in the direction of travel) from the thermal profile.
- Obtain a new maximum baseline temperature and minimum profile temperature for every thermal profile measured.
- Obtain the maximum baseline temperature by analyzing the temperature readings recorded throughout the entire 150 ft. length.
- Configure the system to record pavement temperatures at increments of no more than 6 in. of forward movement.
- Refer to the automated test report produced by the thermal imaging system to obtain a summary of the results from the temperature readings.
- Provide a test report for each thermal profile including the locations (in station numbers, GPS coordinates, or other acceptable means) where thermal segregation exists.
- Follow the manufacturer's recommendations to determine the maximum temperature for the area evaluated and designate as the maximum baseline temperature.

- Determine the lowest allowable profile temperature by subtracting 25°F from the maximum baseline temperature.
- At any area having a temperature lower than the lowest allowable profile temperature established, or at any area identified as having thermal segregation by the automated test report generated by the thermal imaging system, record the low temperature value obtained at the edge of paving using spray paint.
- Record the station number to identify the location of the mat for the low temperature measured. Use the GPS rover to obtain the coordinates of each location and incorporate into the IC reporting.



**Thermal Imaging Assistance and Training** – Coordinate on-site technical assistance from the thermal imaging equipment representatives during the initial three 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.

Coordinate on-site training for Contractor's and Agency project personnel related to operation of the thermal imaging technology. Contractor's personnel shall include the paving superintendent, QC technicians (if applicable), and equipment operators. At a minimum, training topics shall include:

- Background information for the specific system(s) to be used.
- Setup and checks for GPS receiver, base-station, DMI and thermal imaging systems.
- Operation of the system(s) on the equipment; i.e., setup data collection, start/stop of data recording and on-board display options.
- Transferring raw data from the equipment; i.e., via USB connections.
- Operation of vendor's software to open and view raw data files and exporting all-passes and proofing data files in Veda-compatible format.
- Operation of Veda software to import data and proofing data files, inspection of maps, input point test data, perform statistical analysis, and produce reports for project requirements.

**00745.49(a) General** – Add the following:

**(3) Intelligent Compaction** – This work consists of the compaction of the asphalt mixtures utilizing intelligent compaction (IC) rollers within the limits of the work as described in the plans.

Supply rollers meeting the requirements of 00745.24.

Apply IC to all asphalt on the project with the exception of the following:

- Driveways,
- Short isolated pavement areas requiring handwork,
- Other areas as may be determined by the Engineer.
  - Exit and entrance ramps
  - Frontage roads

**a. Quality Control During Rolling** – In addition to other QC requirements, provide the following:

- Conduct a daily GPS check test of the GPS equipment and rover.
- Ensure target number of passes matches applicable Control Strip.
- Verify daily that pavement temperature readings are accurate.
- Download and analyze on a daily basis the data from the rollers.
- Include IC information in Pre-paving quality control plan.
- Use the GPS rover to obtain the coordinates of each QC and QA density test locations and incorporate into the IC reporting.

**b. GPS Set-up** - Prior to the start of ACP delivery for the shift, ensure that the equipment is set up and operating properly using the following procedure:

1. Establish the GPS base station (if required by the GPS) on a location nearby or within the project limits, and verify that the IC roller and the GPS rover are tied into the same base station.
2. Verify that the roller and rover are working properly and that there is a functioning connection with the base station.
3. Begin ACP placing only after obtaining proper GPS verification. IC vendor's recommended verification process may be used to augment the following procedure. Move the IC roller around until the GPS header computation is initialized. Move the IC roller and park at a selected location. Record the GPS measurements from the IC roller ensuring the distance offsets are applied so that the GPS coordinate is at the center or at left/right edges of the front drum. Mark two locations on the ground adjacent to the right and left edges of the front drum contact patch. Move the IC roller from the marked locations. Use a hand-held rover to measure coordinates at the marked locations. Average the rover GPS measurements if the roller GPS measurement is at the center of the front drum. The differences between the roller GPS and rover measurements shall be within 6 inches (300 mm) for northing and easting. (Ref. FHWA IC spec)

**c. IC Documentation** - At a minimum, provide to the Engineer the essential Intelligent Compaction information and data elements shown in the tables below in either ASCII or text format for post processing:

**Essential Intelligent Compaction Data Information**

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (ft)
6	Drum Diameter (ft)
7	Machine Weight (ton)
8	UTM Zone
9	Offset to UTC (hrs)
10	Number of IC data points

**Essential Intelligent Compaction Data Elements**

Item No.	Date Field Name	Example of Data
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 (ft)	e.g. 354048.300
6	Northing (ft)	e.g. 5009934.900
7	Height (ft)	e.g. 339.9450
8	Roller pass number	e.g. 2
9	Direction index	e.g., 1 forward, 2 reverse
10	Roller speed (mph)	e.g. 4.0
11	Vibration on	e.g., 1 for yes, 2 for no
12	Frequency (vpm)	e.g. 3500.0
13	Amplitude (in.)	e.g. 0.6
14	Surface temperature ( <sup>o</sup> F) -	e.g. 120

Transfer all data from the vendor's software to the Engineer on a daily basis at the end of each day's paving operation. Analyze the equipment data for coverage area and uniformity and submit the results to the Engineer each Monday following the completion of the each week's paving operation.

Upon completion of the contract, submit the following documentation to the Engineer:

1. **Equipment** - Record and submit the name of the manufacturer, model, type of paver, and rollers used each day of asphalt materials operations. Record the positioning of the IC roller(s) in the paving operations for each day.
2. **IC Roller Data** - Submit all electronic data from IC roller(s) upon the completion of the Control Strip and individual IC construction area operations.
3. **IC Roller Analysis** - Analyze the IC roller data for conformance to the requirements for coverage area, temperature and uniformity and submit the results to the Engineer at the completion of the individual IC construction area operations. Export IC data from the vendor's software in both all passes data files and proofing data files. All passes data files include the data from all of the passes and proofing data files include the data from the last pass only within a given area.

Submit color prints of all roller pass coverage and temperature data.

**d. Assistance and Training** – Coordinate on-site technical assistance from the equipment representatives during the initial three days of production and then as needed during the remaining operations. At a minimum, the equipment representative shall be present during the initial setup and verification testing of the equipment. Technical representative will ensure data transfer from equipment to computer software is successful for two consecutive production shifts. Technical representative will ensure contractor and agency personal can import and analyze data in IC data analysis software Veda. The equipment representative shall also assist the Contractor with data management using the data analysis software including data input and processing.



Coordinate office and on-site training for Contractor's and Agency project personnel related to operation of the technology. Contractor's personnel shall include the paving superintendent, QC technicians (if applicable), and equipment operators. At a minimum, training topics shall include:

- Background information for the specific system(s) to be used.
- Setup and checks for system(s), GPS receiver, base-station and hand held rovers.
- Operation of the system(s) on the equipment; i.e., setup data collection, start/stop of data recording, and on-board display options.
- Transferring raw data from the equipment; i.e., via USB connections.
- Operation of vendor's software to open and view raw data files and exporting all-passes and proofing data files in Veda-compatible format.
- 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.

**00745.80 Measurement** - Add the following paragraph to the end of this subsection:

No measurement of quantities will be made for Furnish Thermal Imaging or Furnish Intelligent Compaction.

**00745.90 Payment** - Add the following to the pay item list:

(c) Furnish Thermal Imaging	Lump Sum
(d) Furnish Intelligent Compaction	Lump Sum

Add the following paragraph to the end of this subsection:

Items (c) and (d) include furnishing all equipment, labor, training and incidentals necessary to complete the work as specified.

Add the following subsection:

**00745.97 Intelligent Compaction Quality Target** – At the start of each shift the Contractor and Engineer/Inspector will review each roller record and determine if any single IC roller did not reach a minimum of 90% coverage of the ACP panel with the required number of passes as determined by the applicable Control Strip and analyzed using the Veda software. The review will include the percentage of coverage and the coordinates/stations where proper coverage was not achieved.