~~compact the core holes with asphalt concrete mixture. Label the cores and protect them from damage due to handling or temperature during storage.~~

~~Along forms, curbs, headers, walls, and other places not accessible to the rollers, compact the mix with alternate equipment to obtain the required compaction.~~

401.14A Intelligent Compaction. Refer to the "Notice to Bidders" in the bid proposal for information regarding the option to use Intelligent Compaction for Asphalt Mixtures. If the bid option "Intelligent Compaction for Asphalt Mixtures" is **exercised**, the Contractor will compact the asphalt mixtures using Intelligent Compaction rollers.

Intelligent Compaction is a process that uses vibratory rollers equipped with a measurement/documentation system that automatically records various compaction parameters correlated to standard testing protocols in real time during the compaction process. Intelligent Compaction uses roller vibration measurements to assess the mechanistic properties of the underlying compacted materials to ensure optimum compaction is achieved through continuous monitoring of the operations. Table 401-A lists manufacturers of intelligent compaction rollers known to CFLHD and is for informational purposes only. Any intelligent compaction roller that meets the specifications in this document is acceptable regardless of manufacturer.

Provide Intelligent Compaction roller(s) that meet the following requirements:

1. Intelligent Compaction rollers shall be self-propelled double-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compaction effort. Intelligent Compaction rollers shall also be equipped with non-contact temperature sensors for measuring pavement surface temperatures;

2. The output from the roller is designated as the Intelligent Compaction Measurement Value (IC-MV) which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials;

3. The Intelligent Compaction rollers shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of IC-MV including the stiffness response values, location of the roller, number of roller passes, pavement surface temperature, roller speeds, vibration frequencies and amplitudes of roller drums.

4. The display unit shall be capable of transferring the data by means of a USB port.

5. An on-board printer capable of printing the identity of the roller, the date of measurements, construction area being mapped, percentage of the construction area mapped, target IC-MV, and areas not meeting the IC-MV; and

6. Global Positioning System (GPS) radio and receiver units shall be mounted on each Intelligent Compaction roller to monitor the drum locations and track the number of passes of the rollers. The GPS system shall also meet the following requirements:

    a. Set all GPS devices to the Universal Transverse Mercator (UTM) coordinate system, regardless of whether GPS or Grid data are originally recorded. If UTM coordinates are not available, use the State Plane coordinate system. Do not use the local coordinate system. The records shall be in meters;

    b. Provide a GPS system that can be a ground-based base station or Virtual Reference Station (VRS) to achieve Real Time Kinematic Global Positioning Systems (RTK-GPS) accuracy;

    c. Provide GPS receivers on Intelligent Compaction rollers and hand-held GPS receivers that have the same VRS subscription; and

    d. Provide the recorded GPS data, whether from the Intelligent Compaction rollers or hand-held GPS rovers, in the following formats:

        i. The time stamp shall be in military format (HHMMSS.SS) in either UTC or local time zone. 0.01 second is necessary to differentiate sequence of Intelligent Compaction data points during post processing;

        ii. Provide GPS latitudes and longitudes in DDMM.MMMMMMMM or decimal degrees (DD.DDDDDDDD); and

        iii. Provide grid coordinates in meters with at least 3 digits of significance (ie. 001 m or 1 mm).

Table 401-A
Known Manufacturers of Intelligent Compaction Rollers

Vendor	Bomag	Sakai	Wirtgen/Hamm
Model	Asphalt Manager	CIS (Sakai Compaction Information System)	HCQ (HAMM Compaction Quality)
Model No.	BW190AD-4AM	SW880/SW890	HD+ 90 / HD+ 110 HD+ 120 / HD+ 140
IC-MV	Evib (Vibration Modulus)	CCV (Compaction Control Value)	HMV (HAMM Measurement Value)
IC-MV Units	MN/m^2	Unitless	Unitless
Documentation	BCM 05 Office	AithonMT-A	HMV (HAMM Measurement Value)
Company Address	Bomag Americas, Inc. 200 Kentville Road Kewanee, Il. 61443	Sakai America, Inc. 90 International Parkway Adairsville, Ga. 30103	Wirtgen America, Inc. 6030 Dana Way Antioch, TN 37013
Contact Information	Chris Connolly (301) 262-5447 Chris.Connolly@bomag.c	Brandon Crockett (800)-323-0535 B-	Tim Kowalski (615) 501-0600 tkowalski@Wirtgenamerica.c

	om	crockett@sakaiamerica.com	om

Provide sufficient numbers of rollers and other associated equipment necessary to complete the compaction requirements. The primary position for the Intelligent Compaction roller is in the initial phase (breakdown) in the paving sequence. Intelligent Compaction rollers can also be used in the intermediate phase as long as the mat temperatures are sufficient for compaction. The use of Intelligent Compaction rollers in the finish phase is not recommended.

In addition to the acceptance criteria described in Section 401, a minimum coverage of 90 percent of the individual construction area (subsection of the project being continuously worked by the Contractor) must meet or exceed the optimal number of roller passes. A minimum coverage of 70 percent of the individual construction area must meet or exceed target IC-MV values determined from the control strip.

Coordinate with the Intelligent Compaction roller manufacturer to provide on-site technical assistance during the first 7 days of paving and compaction operations and on an as-needed basis for the duration of the paving and compaction operations. At a minimum, the manufacturer's representative will provide assistance during the initial setup and verification testing and also with the data management using the data analysis software (including input and processing of the Intelligent Compaction roller data).

Prior to the start of paving and compaction operations, perform the following to ensure the proper setup of the GPS, hand-held GPS rovers, and Intelligent Compaction rollers:

1. Establish the GPS base station (if required by the GPS) within the project limits and tie the hand-held GPS rovers and Intelligent Compaction rollers into the same GPS base station.

2. Verify that the GPS hand-held rovers and Intelligent Compaction rollers are working properly and that there is a connection with the GPS base station.

3. Compare the Intelligent Compaction roller coordinates to the hand-held GPS rover coordinates using one of the following methods:

    a. Obtain GPS measurements while the Intelligent Compaction rollers are stationary. Ensure that the offsets are not applied to the center of the front drum (ie. at the receiver position). Place the hand-held GPS rover on top of the GPS receiver mounted on the Intelligent Compaction roller and record the coordinates. The difference between the coordinates between the hand-held GPS rover and the Intelligent Compaction roller must be within 2 inches in both of the horizontal axes (x and y).

    b. Mark a location on the ground and record the coordinates using the hand-held GPS rover. Move the Intelligent Compaction roller so that the center of the front drum is on top of the marked location. Record the coordinates from the

Intelligent Compaction roller and make sure the offsets are applied to be at the center of the front drum. The difference between the coordinates in grid must be within 6 inches in both of the horizontal axes (x and y).

When importing the IC-MV data into the data analysis management program, store the GPS data and associated Intelligent Compaction measurements with minimum data conversions and minimum loss of precisions so that users can then select unit of preference to allow real time unit conversion for the graphical user interface display.

Follow the vendor-specific instructions to export the IC-MV data to Veda-compatible formats. Import the Intelligent Compaction roller data into Veda and enter GPS point measurements from the rover and visually inspect the Intelligent Compaction map and point measurements on the Veda display screen for consistency.

Standardized data analysis software (Veda) is available on the website www.intelligentcompaction.com. The software program will use the IC-MV data from the Intelligent Compaction roller for analysis of coverage, uniformity, and stiffness values during construction operations. At a minimum, provide the essential Intelligent Compaction data information and data elements (shown in Table 401-B and Table 401-C) in either ASCII or text format for post processing.

Table 401-B
Essential Intelligent Compaction Data Information

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (m)
6	Drum Diameter (m)
7	Machine Weight (metric ton)
8	Name index of intelligent compaction measurement values (IC-MV)
9	Unit index for IC-MV
10	Reporting resolution for independent IC-MVs – 90 degrees to the roller moving direction (mm)
11	Reporting resolution for independent IC-MVs – in the roller moving direction (mm)
12	UTM Zone
13	Offset to UTC (hrs)
14	Number of IC data points

Table 401-C
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 (m)	e.g. 354048.300
6	Northing (m)	e.g. 5009934.900
7	Height (m)	e.g. 339.9450
8	Roller pass number	e.g. 2
9	Direction index	e.g., 1 forward, 2 reverse
10	Roller speed (kph)	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 (^{o}C) -	e.g. 120
15	Intelligent compaction measurement values	e.g. 20.0

In addition to the responsibilities described in Section 153, the Quality Control Supervisor (QCS) is responsible for the following:

1. Daily GPS check testing for the Intelligent Compaction rovers.

2. Monitoring the Intelligent Compaction rollers during production and final evaluation operations.

3. Daily download and analysis of the Intelligent Compaction data from the rollers. Provide the CO with the daily download and analysis of the Intelligent Compaction data from the rollers within 24 hours.

4. Daily set-up, take down, and secure storage of GPS and Intelligent Compaction roller components.

Provide the CO with the following documentation at the completion of paving and compaction operations:

1. Equipment: documentation of the manufacturer, model, and type of paver and rollers used for each day of paving and compaction operations. Include the positioning of the Intelligent Compaction rollers.

2. Intelligent Roller Data: the electronic data and analysis from the Intelligent Compaction rollers for each day of paving and compaction operations. Save the Intelligent Compaction roller data as Time History Data and Post-Processed Data. Import the Post-Processed data using the all-passes and proofing-data formats. The all-passes data includes the data from all of the passes and the proofing data is the data from just the last pass within a given area.

3. Construction Area: the limits of and total tons of the asphalt mixture within each construction area.

401.15 Joints, Trimming Edges, and Cleanup. Complete pavement construction of adjacent traffic lanes to the same elevation within 24 hours. If elevation differences exceeding 2 inches between adjacent lanes are left overnight, sign with *"Uneven Lanes"* warning signs and provide a 1V:3H fillet.

At connections to existing pavements and previously placed lifts, make the transverse joints vertical to the depth of the new pavement. Form transverse joints by cutting back the previous run to expose the full-depth course.

To both transverse and longitudinal joints, apply an asphalt tack coat to the joint edge according to Section 412.

Place the asphalt concrete mix as continuously as possible. Do not pass rollers over any unprotected edge of a freshly laid mix.

Dispose of material trimmed from the edges and any other discarded asphalt concrete mix according to Subsection 211.02(a)(2).

401.16 Pavement Roughness. Measure the profile of the pavement surface according to the designated pavement roughness type. In addition, construct all pavement surfaces to meet the requirements of (e) below.

(a) Profile Measurement.

Equipment. Provide an ASTM E 950, class 1, inertial profiling system meeting all the requirements and specifications found in AASHTO M 328 and certified in accordance with AASHTO R 56. At least 21 days before profiling begins, provide copies of the system certification(s). Display a current decal on the equipment indicating the expiration date of the certification(s).

Personnel. Provide an operator certified in accordance with AASHTO R56. At least 21 days before profiling begins provide copies of the operator's certification(s).

Measuring. The CO will identify the beginning and ending points and any excluded areas. Measure the pavement profile in both wheel paths using a sensor path spacing of 65-71 inches