Section 39-1.35. Use for intelligent compaction pilot projects.

Most pilot~~Pilot~~ projects will~~must~~ be HMA including OGFC that are placed under the method compaction specification 39-3.04.

Use bid item 390030 Intelligent Compaction

Pay Measurement is Lump Sum

Contact Ebi Fini ebi.fini@dot.ca.gov for use of this pilot specification.

Replace section 39-1.35 with:

39-1.35 HOT MIX ASPHALT COMPACTION~~COMPACTED~~ WITH INTELLIGENT COMPACTION

39-1.35A General

39-1.35A(1) Summary

1

Section 39-1.35~~39-1.32~~ includes specifications for compaction of HMA~~the asphalt mixtures~~ utilizing intelligent compaction rollers. Intelligent compaction~~Compaction (IC) rollers. IC~~ is a process that uses vibratory rollers equipped with a measurement devices and documentation system that automatically records various critical compaction parameters in real time during the compaction process. Intelligent compaction~~ IC~~ 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.

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2

Standardized data analysis software ~~(~~Veda~~)~~ is available on the website www.intelligentcompaction.com. The software program utilizes~~will utilize the IC-MV~~ data from the intelligent compaction~~IC~~ roller for analysis of coverage~~,~~ uniformity, HMA mat temperature and stiffness values during HMA construction operations.

3

Use intelligent compaction rollers ~~IC roller~~ for the initial breakdown compaction and intermediate compaction. Do not use roller vibration when the compacted HMA layer is 0.15' or less to collect intelligent compaction measurement value for stiffness.

4. Use if electronic design files are available delete para 5.

Insert CAiCE (kcm), Civil 3D (dwg) or landxml (xml).

The Department will furnish project plan layout files in _____.~~_____ format.~~

5. Use if electronic design files are not available delete para 4.

You must~~most~~ create project layout file to be used by intelligent compaction~~IC~~ system from the project plans.

39-1.35A(2) Definitions

6

California Coordinate System of 1983 (CCS83): A set of 6 geographic zones or coordinate systems designed for specific regions of the State of California, the boundaries of which follow county lines. CCS83 is based on NAD83. When a project crosses state plane zone boundaries, a single zone will be used for the entire project.

Foot: Unit of measurement equals to U.S. survey foot.

Geodetic Coordinates: A coordinate system to describe a position in longitude, latitude, and altitude above the imaginary ellipsoid surface based on a specific geodetic datum. The NAD83 datum is required for use with CCS83 State Plane Coordinates.

Global Positioning System (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). GPS satellite signals can be subject to interference from canyons, buildings, trees or even fencing. Not all locations are suitable for GPS techniques, and it is the Contractor's responsibility to determine if the site conditions are practical for GPS, and to notify the engineer if they are not.

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GPS Base Station: A single ground-based system that consists of a GPS receiver, GPS antenna, and telemetry equipment (typically radio and radio antenna or cellular phone) to provide L1/L2 differential GPS correction signals to other GPS receivers.

GPS Rover: A portable L1/L2 GPS antenna, mount, and receiver with telemetry equipment for Real Time in-situ point measurements.

GPS Correction Service Subscription: A service that can be subscribed to receive differential GPS correction signals in order to achieve higher accuracy GPS positioning without the need of a GPS Base Station. Signals are normally received via cellular wireless data services. Examples of GPS correction service subscriptions are: Trimble VRS™, Leica Smart RTK™, Topcon TopNet™ or OmniSTAR™.

GPS Site Calibration or Localization: A GPS site calibration, also known as localization, establishes a relationship between the observed GPS coordinates and the known grid coordinates.

Grid: A Cartesian system of XY (or North-East) coordinates. For this specification, the California State Plane Coordinates, known as the California Coordinate System of 1983 (CCS 83).

~~**GUI Display:** Graphical User Interface Display~~

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 single GPS base station.

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

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.

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39-1.35A(3) Submittals

39-1.35A(3)(a) General

7

Not used.

~~With the JMF submittal as specified in section 39-1.03C, submit:~~

~~Manufacturer and model of the IC rollers you propose to use~~

39-1.35A(3)(b) Just in Time Training

8

With the JMF submittal, submit a list of names participating in the just in time training. Identify each participant's name, employer, title, and role in the production and placement of HMA compacted with intelligent compaction.~~IC.~~

39-1.35A(3)(c) GPS Site Calibration or Localization Report and Check Testing~~Data and Software Analysis Results~~

9

Submit GPS site calibration or localization report and checking testing results for intelligent compaction rollers within one business day of calibration or check testing.

39-1.35A(3)(d) Data and Software Analysis Results

10

Submit~~,~~ the following within one business day of HMA placement:

1. Electronic~~electronic~~ data from intelligent compaction~~IC~~ rollers.
2. Hardcopy~~rollers,~~ and Adobe pdf file of HMA compaction quality control report from ~~the~~ data analysis performed ~~report~~ using Veda software. ~~within one business day of HMA placement.~~
3. Post processed Veda data file used for creating daily HMA compaction quality control report.

11

When a test strip is required, submit the following:

1. Test strip data including:
   - 1.1. Nuclear gage density per location
   - 1.2. GPS measured coordinates per location
   - 1.3. Nuclear gage correlation to core densities
2. All passes compaction curves from Veda
3. All passes correlation from Veda

39-1.35A(3)(d)(i) ~~10~~

~~Essential IC~~ Data

12

Intelligent compaction data Information and data elements~~IC Data Elements~~ must be available for post processing using Veda software. When multiple rollers are operating in echelon you may combine the roller data into a section file.~~.~~

13

Name the intelligent compaction data file using the following naming convention:

YYYYMMDD_TTCCCRRR_D_L_W_S_X_PT.PPF_Data

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08
RRR = Route number, no leading zeros
D = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
S = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) no leading zero

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X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (i.e., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.)

14

Data header information required for each intelligent compaction data file or section:

~~11~~

~~Essential IC Data Header Information for Each Data File or Section:~~

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (inch)
6	Drum Diameter (Inch)
7	Machine Weight (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	CCS83 Zone
13	Offset to UTC (hrs)
14	Number of IC data points

where:
IC-MV = Intelligent Compaction – Measurement Value

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15

~~12~~

~~Essential IC~~ Data elements required~~Elements~~ for each intelligent compaction data point:~~Each Data Point:~~

Item No.	Data Field Name	Example of Data
1	Date Stamp (YYYYMMDD)	20080701
2	Time Stamp (HHMMSS.SS -military format)	090504.00 (9 hr 5 min. 4.00 s.)
3	Longitude (decimal degrees or degrees minutes-seconds)	94.85920403
4	Latitude (decimal degrees or degrees-minutes-seconds)	45.22777335
5	Easting (Foot)	6,096,666.000
6	Northing (Foot)	1,524,166.650
7	Elevation (Foot)	339.9450
8	Roller pass number	2
9	Direction index	1 forward, 2 reverse
10	Roller speed (mph)	2.0
11	Vibration on	1 for yes, 2 for no
12	Frequency (vpm)	3500.0
13	Amplitude (inch)~~(mm)~~	0.0236~~0.6~~
14	Surface temperature (^{O}F)~~ -~~	270
15	Intelligent compaction measurement values	20.0

16

Provide either items~~13~~

~~Items~~ 3 and 4 or~~can be exclusive with~~ items 5 and ~~6.6, and vice versa.~~ The GPS coordinate for each intelligent compaction data point recorded in data files need to be at the center of the front drum.

17

The size of data mesh ~~?~~after post-processing must be less than 18 inches ~~(450 mm)~~ by 18 inches ~~(450 mm)~~ in the X and Y directions.

39-1.35A(3)(d)(ii) Software Analysis Results

18

Analyze the intelligent compaction data daily using the Veda software use interval length of 100 feet and include target values for passes, HMA temperature and intelligent compaction measurement value for stiffness.

19

For each day of production, prepare a HMA compaction quality control report that includes:

1. Final coverage histogram
2. Final coverage fixed interval report
3. All passes histogram
4. Color layout plots of:
   - 4.1. Roller passes
   - 4.2. HMA temperature for initial roller coverage

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4.3. HMA temperature final intermediate coverage
4.4. When required intelligent compaction measurement value final coverage

20

Plots must be scaled to be legible and may be 11 by 17 inches.

21

Name the post processed Veda data file using the following naming convention:

YYYYMMDD_TTCCCRRR_D_L_W_S_X_PT.PPF_Veda

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08
RRR = Route number, no leading zeros
D = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
S = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) no leading zero
X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (i.e., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.)

39-1.35A(4) Quality Control and Assurance

39-1.35A(4)(a) General

22
~~14~~

Not Used

39-1.35A(4)(b) Technical Representative

23
~~15~~

A technical representative from the roller manufacturer must be on site during the initial 7 days of production and then as needed during the remaining operations. As a minimum, the roller representative must be present during the initial setup and verification testing of the intelligent compaction~~IC~~ rollers. If requested, the roller representative must assist the Engineer with data management using the data analysis software including intelligent compaction~~IC~~ data input and processing.

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39-1.35A(4)(c) Just in Time Training

24.~~16.~~ Edit the number of state personnel if necessary.

Provide just in time training onsite or near the project site for your personnel and State project personnel related to operation of the intelligent compaction~~IC~~ technology. Schedule the just in time training with the Engineer at a mutually agreed time and place. Provide training materials for 4 state personnel including the resident engineer and field inspectors. Arrangements must be provided that includes an enclosed facility with electrical availability for visual presentations.

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25
~~17~~

The training should be 4-8 hours in duration and include the following topics:

1. Background information for the specific intelligent compaction~~IC~~ system~~(s)~~ to be used
2. Setup and checks for intelligent compaction~~IC~~ system including:

2.1. ~~(s),~~ GPS receiver
2.2. GPS~~,~~ base-station
2.3. Hand ~~and hand~~ held rovers
2.4. Rollers.

3. Operation of the intelligent compaction~~IC~~ system~~(s)~~ on the rollers:
   3.1. Setup~~roller, i.e., setup~~ data collection
   3.2. Start/stop~~, start/stop~~ of data recording
   3.3. On-board~~, and on-board~~ display options
4. Transferring raw intelligent compaction~~IC~~ data from the rollers~~(s); i.e.,~~ via USB connections
5. Operation of vendor's software to open and view raw intelligent compaction~~IC~~ 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 intelligent compaction~~IC~~ maps, input point test data, perform statistics analysis, and produce reports for project requirements
7. Coverage ~~and~~ uniformity requirements

~~18~~

8. When test strip is required, method for establishing target intelligent compaction measurement value for stiffness.

26

The following personnel must attend the just in time training:

1. Project Manager
2. Superintendent
3. Technical representative for intelligent compaction~~IC~~ rollers
4. Intelligent Compaction~~IC~~ Quality Control Technicians
5. Roller Operators
5. HMA paving foreman

39-1.35A(4)(d) Quality Control

27

Intelligent compaction~~19~~

~~IC~~ provides quality control for method compaction by monitoring the number of roller passes and that the compaction is completed above the specified HMA temperature for initial compaction and intermediate compaction. When HMA thickness is greater than 0.15' intelligent compaction provides quality control for compaction by measuring intelligent compaction measured value for stiffness which is correlated to the specified HMA target density.

28

Data collected for intelligent compaction measurement value for HMA stiffness~~20~~

~~IC-MV values~~ are report only and are not to be used for compaction acceptance.

30-1.35(4)(f) Test Strip

29

If HMA layer thickness is greater than 0.15', on the first day of placement of each layer of HMA construct a test strip at least 600 feet long to determine a compaction curve of the HMA in relationship to the number of roller passes and to the stiffness of HMA. Nuclear gages used must be correlated with density cores under Part 2 of California Test 375.

30

The intelligent compaction rollers must use the same settings (speed, frequency) throughout the test strip. After each roller pass, use a nuclear gage to estimate the density of the material and a hand-held GPS rover to measure the positions of at least 10 locations uniformly spaced throughout the test strip.

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Record the density reading, the number of roller passes and GPS coordinates for each location. Continue roller passes and collecting nuclear gage density readings until density remains constant or decreases.

31

The estimated target density will be the peak of the nondestructive readings within the desired compaction temperature range for the HMA mixture. The intelligent compaction roller data using the Veda data analysis software will create the compaction curve for the HMA mixture. The target intelligent compaction measurement value is the point when the increase in the intelligent compaction measurement value of the material between passes is less than 5 percent on the compaction curve. The compaction curve is defined as the relationship between the intelligent compaction measurement value and the roller passes.

32

Use linear regression relationships between the point test results and the intelligent compaction measurement value results to establish the production target intelligent compaction measurement value for stiffness based on target density (% Gmm) that meets the specified in-place compaction requirements.

39-1.35A(4)(d)(i) Quality Control Technician

33
~~21~~

During HMA compaction provide a full time quality control technician to be responsible for the following functions:

1. Perform GPS site calibration or localization and upload to all GPS receivers.
2. Daily GPS check testing for the intelligent compaction rollers~~IC roller(s)~~ and rovers.~~rover(s).~~
3. Verify the accuracy of the temperature sensor by comparing to a NIST traceable standard. The equipment temperature sensor measurement must be within +/- 3 degrees F of NIST traceable standard.
4. Test section construction to establish target compaction pass counts and target values for the stiffness~~strength~~ of the HMA~~materials~~ using the nondestructive~~standard testing devices; i.e., Nondestructive~~ density gauges, pavement cores, and intelligent compaction rollers.~~IC roller(s).~~
5. ~~4.~~ Monitoring of the construction operations and the intelligent compaction rollers~~IC roller(s)~~ during production~~. and final evaluation operations.~~
6. ~~5.~~ Quality control testing to monitor the pavement temperature and the required level of compaction.
7. Back up ~~6. Daily download and analysis of~~ the intelligent compaction~~IC~~ data from the rollers twice per day to avoid accidental loss of data~~roller(s).~~
8. Download data from rollers at the end of the work shift.
9. On a daily basis analyze the data from the intelligent compaction rollers using the Veda software and produce a daily compaction quality control report.

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39-1.35B MATERIALS

34
~~22~~

Not Used

39-1.35C CONSTRUCTION

39-1.35C(1) General

35
~~23~~

Prior to the start of production upload the project plan file into the intelligent compaction data~~IC Data~~ analysis software and depending on the roller manufacture, the on-board intelligent compaction~~IC~~ computer.

39-1.35C(2) Equipment

39-1.35C(2)(i) Intelligent Compaction Rollers

36
~~24~~

Intelligent compactions rollers must:

1. 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.
2. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
3. ~~3.~~ Produce output from the roller which is designated as the intelligent compaction measurement value~~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.
4. Have GPS receiver, antenna and telemetry equipment mounted on each intelligent compaction~~IC~~ roller to monitor the drum locations and track the number of passes of the rollers.
5. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of intelligent compaction~~IC~~ measurement values including ~~the stiffness response values,~~ location of the roller, number of roller passes, pavement surface temperatures, roller speeds, vibration frequencies and amplitudes of roller drums.
6. Have a graphical user interface
7. Have capability~~display unit capable~~ of transferring the intelligent compaction data by means of a USB port.

~~7. Have 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 target values.~~

39-1.35C(2)(ii)~~39-1.35C(C)(ii)~~ GPS Correction Signal Source

37
~~25~~

A source of GPS correction signal, either a GPS base station or GPS correction service subscription, must be provided. The GPS correction signal must be received by the GPS receivers on the intelligent compaction~~IC~~ roller and the hand-held rovers during operations with a survey tolerance of not greater than 1.6 inch~~.~~ in both X and Y~~the~~ horizontal ~~(x and y)~~ directions.

38.~~26.~~ Insert the zone number. Caltrans Survey manual:http://www.dot.ca.gov/hq/row/landsurveys/SurveysManual/Manual_TOC.html

All GPS devices for this project must be set to the same consistent datum, coordinate system, CCS83 zone, and site calibration or localization. For this project the~~The~~ CCS83 zone must be set to zone no. ____~~. for this project.~~

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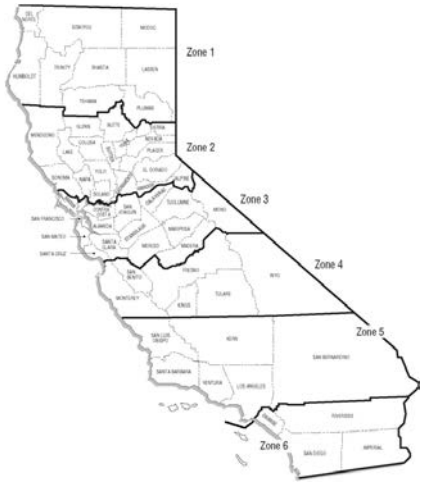

39-1.35C(3) GPS Site Calibration or Localization and Check Testing

39
At least two business days prior~~28~~

~~Prior~~ to the start of production, perform a GPS site calibration or localization to the survey control points indicated on the Project Control Map in the project plans. Whenever the GPS base station is moved to a new location you must perform a GPS site calibration or localization.

40

Prior to the~~Before~~ start of daily production, conduct the following to check the proper setup of the GPS, intelligent compaction rollers~~IC roller(s)~~ 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) must be established and the intelligent compaction rollers~~IC roller~~ and the GPS rover tied into the same base station.
2. Verify that the roller and rover are working properly and that there is a connection with the base station.
3. Verify~~There are two options for comparing~~ the intelligent compaction roller, GPS ~~and rover~~ coordinates by performing~~. Production must not begin until proper GPS verification has been obtained. IC manufacturer recommended verification process can be used to augment either of~~ the following~~: options:~~

   3.1. Stop the intelligent compaction roller at a location.

   ~~3.1.~~ 3.2. Mark the ~~GPS measurement must be conducted while the IC roller is stationary. The GPS coordinated from the roller on-board display must be recorded ensuring that the distance offsets are applied correctly to the center of the front drum (e.g., the measurement is at the roller GPS receiver position). Place the hand-held GPS receiver on top of the GPS antenna mounted on the IC roller and record the coordinates from the hand-held receiver display. The differences of the coordinates between the IC roller GPS receiver and hand-held GPS receiver shall be within 2 inches in both the horizontal axes (X and Y). The check for the vertical axis is not required. <<IF THE OFFSETS ARE APPLIED, HOW WILL THE POISITION OF THE ROVER ON TOP OF THE IC ROLLER ANTENNA BE WITHIN 50mm?>>~~

   ~~A location shall be marked on ground. Move the IC roller so that the center of the front drum is on top of the marked~~ location of both ends of the roller drum on the surface with a tee.

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3.3. ~~.~~Record the GPS measurements from the IC roller ensuring the distance offsets are applied so that the GPS coordinate is at the center of the front drum.

3.3 ~~.~~Move the intelligent compaction~~IC~~ roller from the marked location.

3.4. Find the mid-point of the two marked ends of the roller and mark this location on the surface, this ~~and use a hand- held rover to measure at the marked location. The differences of the coordinates in grid shall be within 6 inches (150 mm) in both the horizontal axes (X and Y). <<THIS SECTION DISAGREES WITH THE PREVIOUS SENTENCES AND FINAL SENTENCE On some IC systems, distance offsets are applied to the roller GPS measurements from the on-board display and the coordinates may be on the left or right side of the drum. In those cases move the IC roller so that the left or right side of the front drum axle is flush with the~~ marked location is the theoretical center of the front drum.

3.5. Use~~. Place~~ the hand-held rover to measure GPS coordinates of~~on~~ the marked location and record the GPS measurements.

~~3.2.~~ 3.6 Compute~~check~~ the difference between recorded intelligent compaction roller~~of both coordinate records.>> The final~~ GPS coordinates and hand-held rover ~~for each IC data point~~ recorded GPS measured coordinates. The differences of the coordinates in grid must be within 6 inches in both the horizontal axes X and Y (longitude and latitude or easting and northing) ~~in data files need to be at the center of the front drum.~~

39-1.35C(4) Compacting

41

During HMA compaction monitor roller intelligent compaction graphical user interface display to ensure required number of roller passes are being met and that the measured HMA temperature is adequate to achieve compaction. When HMA layer thickness is greater than 0.15 foot, monitor roller intelligent compaction graphical user interface display for intelligent compaction measurement value for stiffness to ensure uniform density.

39-1.35C(5) Roller Coverage, HMA Temperature and Intelligent Compaction Measurement Value ~~Requirement~~

42
~~29~~

A minimum coverage of 90 percent~~%~~ of the construction area must meet or exceed the number of roller passes specified. When required roller passes are not met based on daily HMA compaction quality control report take corrective action and notify the engineer of action taken.

43
~~30~~

When roller HMA temperature sensor indicates compaction temperatures are below specified temperatures take immediate corrective action and notify the engineer. The minimum temperature for HMA compaction must be met for 95 percent of the construction area. When compaction is completed after HMA is below minimum temperature based on daily HMA compaction quality control report, implement corrective action before next HMA placement day and notify the engineer of action taken.~~corrective action and notify the Engineer.~~

44

For HMA greater than 0.15' in layer thickness, monitor the intelligent compaction measurement value for stiffness against the target value established in the test strip. If intelligent compaction measurement value for stiffness is 10 percent or more below the target stiffness value use a nuclear gage to verify that HMA compaction complies with density specified requirements.

45

When intelligent compaction measurement daily average value for stiffness is 20 percent or more below the target measurement value for stiffness establish a new target stiffness value using a test strip.

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39-1.35D PAYMENT

46

Not used.

~~31~~

~~Pay Item~~	**~~Unit~~**
~~HMA Intelligent Compaction .....~~	~~LS~~

~~This item includes all costs related to providing the IC rollers, GPS system and other equipment required for the IC process. Item includes all quality control procedures including IC rollers and GPS systems, technical representative support, on-site just in time training and IC data processing using VEDA software to produce daily compaction reports.~~