Section 30-6. Use to incorporate intelligent compaction requirements in CIR projects.

Use bid item: 306100A Intelligent Compaction (Cold In Place Recycling) LS

Replace section 30-6 with:

30-6.01 PAVEMENT RECYCLING WITH INTELLIGENT COMPACTION

30-6.01A GENERAL

30-6.01A(1) Summary

1

This is a pilot project for evaluating intelligent compaction and the Department will not consider a VECP that substitutes the processes or equipment specified in this section 30-6.

2

Section 30-6 includes specifications for compaction of cold in-place recycling (CIR) utilizing intelligent compaction. Intelligent compaction uses vibratory steel drum rollers with intelligent compaction equipment and static pneumatic tire rollers equipped with automated machine guidance system that produce data for standardized software Veda. For Veda, go to www.intelligentcompaction.com. Use Veda to analyze the data for coverage uniformity and intelligent compaction measurement values.

3

Intelligent compaction does not waive any specifications for CIR.

4. Use if electronic design files are available and delete para 5 and 6. Insert CAice (.kcm), Civil 3d (.dwg), or landxml (.xml).

The Department furnishes project plan layout files in ___________ format.

5. Use if electronic design files are not available for project layout sheets .Delete para 4 and 6.

Create project layout files for the intelligent compaction system from the project plans.

6. Use if electronic design files or project layout plans are not available and as built plans must be used. Delete pars 4 and 5

Create project layout files for the intelligent compaction system from the as built plans.

30-6.01A(2) Definitions

7

all passes data: Compaction data that contain measurements from all passes.

automated machine guidance roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including GPS, temperature sensor, on-board documentation system, and displays.

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.

compaction data: Data collected by intelligent compaction equipment and automated machine guidance compaction equipment.

coordinated universal time (UTC): A time measurement system commonly referred to as Greenwich Mean Time (GMT) based on a 24-hour time scale from the mean solar time at the Earth's prime meridian (zero degrees longitude) located near Greenwich, England

coverage: Roller single pass over a given area.

final coverage: Compaction data that contain the last pass measurements for a given area.

foot: Unit of measurement equal 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. GPS refers to all GPS-related signals including US GPS, and other Global Navigation Satellite Systems (GNSS). GPS satellite signals are subject to interference from canyons, buildings, trees or even fencing. Not all locations are suitable for GPS techniques, and it is your responsibility to determine if the site conditions are practical for GPS, and to notify the Engineer if they are not.

GPS base station: A single ground-based system consisting 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 correction service subscription: A service that can be subscribed to receive differential GPS correction signals for 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 rover: A portable L1/L2 GPS antenna, mount, and receiver with telemetry equipment for Real Time in-situ point measurements.

GPS site calibration or localization: A process to establish a relationship between the observed GPS coordinates and the known grid coordinates.

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

intelligent compaction measurement value: A generic term for measurements of resistance to deformation of underlying material based on the responses of the roller drum vibrations in units specific to the roller manufacturer.

intelligent compaction equipment: Measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays.

intelligent compaction roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays**.**

network real time kinematic (Network RTK): A system of 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 (RTK-GPS): A system 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.

roller pass: The area covered by one width of the roller in a single direction.

30-6.01A(3) Submittals

30-6.01A(3)(a) General

8

Not Used

30-6.01A(3)(b) Mapping Existing Pavement

9

At least 10 days before sampling for mix designs for CIR, submit color layouts of intelligent compaction measurement value for the existing pavement determined by mapping the existing pavement under section 30-6.01C(3). Use an interval length of 100 feet.

30-6.01A(3)(c) Just In Time Training

10

Submit a list of names participating in the JITT training at the time of the mix design submittal. Identify each participant's name, employer, title, and role in intelligent compaction.

30-6.01A(3)(d) GPS Site Calibration or Localization Report and Check Testing

11

Submit GPS site calibration or localization report and check testing results for compaction rollers within 1 business day of calibration, localization or check testing.

30-6.01A(3)(e) Data and Software Analysis Results

30-6.01A(3)(e)(i) General

12

Within 1 business day of compaction work, submit:

1. Compaction data from rollers in file format readable by Veda
2. Hardcopy and Adobe *.pdf file of the compaction quality control report from data analysis performed using Veda software.
3. Post processed Veda data file *.icp used for creating the CIR compaction quality control report

13

For each test strip submit:

1. Test strip data including:
    1.1. Nuclear gage density per location
    1.2. GPS measured coordinates per location
2. All passes compaction curves from Veda
3. All passes correlation analysis report from Veda

30-6.01A(3)(e)(ii) Data

14

Submit compaction information and data elements using Veda. You may combine roller data for multiple rollers operating in echelon into a section file.

15

Name the compaction data file using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_TOR_TC_T_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 no leading zero
RRR = Route number, no leading zeros
DB = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) maximum 6 characters with no leading zero.

E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero
TOR = Type of reclamation "CIR" for cold in place recycling or "FDR" for full depth reclamation
TC= Type of compaction "IC" for initial compaction, "SC" for supplemental compaction
T= Type of roller "R" for rubber tire, "S" for steel drum

16

Use the following header information for each compaction 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
9	Unit index for intelligent compaction measurement values
10	Reporting resolution for independent intelligent compaction measurement values – 90 degrees to the roller moving direction (inch)
11	Reporting resolution for independent intelligent compaction measurement values – in the roller moving direction (inch)
12	CCS83 Zone
13	Offset to UTC (hrs)
14	Number of compaction data points

17

Use the following data field names for each compaction 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-	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)	0.0236
14	Intelligent compaction measurement values	20.0

Note: Provide either items 3 and 4 or items 5 and 6

18

The GPS coordinate for each compaction data point recorded in data files must be at the center of the drum or center of the roller in front.

19

The size of the data mesh after post processing must be less than 1.5 feet by 1.5 feet in the X and Y directions.

30-6.01A(3)(d)(iii) Software Analysis Results

20

Analyze the compaction data daily using Veda and include nuclear gage data points, target values for passes and intelligent compaction measurement values. For a fixed interval report use an interval length of 100 feet.

21

For each day of production at the end of initial compaction, prepare a compaction quality control report that includes:

1. Each roller final coverage histogram of number of passes and when steel drum roller with vibratory on is used, include histogram of intelligent compaction measurement value
2. Each roller final coverage histogram of number of passes for a fixed interval, and when steel drum roller with vibratory on is used, include histogram of intelligent compaction measurement value for a fixed interval.
3. All passes histogram for each roller
4. Color layout plots of roller passes for each roller
5. Color layout plots of intelligent compaction measurement value for steel drum roller with vibratory on

22

For supplemental compaction, prepare a compaction quality control report that includes:

1. Each roller final coverage histogram of number of passes and when steel drum roller with vibratory on is used, include histogram of intelligent compaction measurement value
2. Each roller final coverage histogram of number of passes for a fixed interval, and when steel drum roller with vibratory on is used, include histogram of intelligent compaction measurement value for a fixed interval.
3. All passes histogram for each roller
4. Color layout plots of roller passes for each roller
5. Color layout plots of intelligent compaction measurement value for steel drum roller with vibratory on

23

Plots must be scaled to be legible and must be 11 by 17 inches. Plots must include quality control density testing locations and results.

24

Name the post processed Veda data file using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_TOR_TC_T_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 no leading zero
RRR = Route number, no leading zeros
DB = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) maximum 6 characters with no leading zero

E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero
TOR = Type of reclamation "CIR" for cold in place recycling or "FDR" for full depth reclamation
TC= Type of compaction "IC" for initial compaction, "SC" for supplemental compaction
T= Type of roller "R" for rubber tire, "S" for steel drum

30-6.01A(4) Quality Assurance

30-6.01A(4)(a) General

25

Not Used

30-6.01A(4)(b) Technical Representative

26

A technical representative from the intelligent compaction equipments manufacturer and automated machine guidance system or post manufacture retrofit system must be on site during the initial setup and verification testing of the compaction rollers and the first 2 days of CIR production. If requested, the technical representative must assist the Engineer with data management using Veda including compaction data input and processing.

30-6.01A(4)(c) Just In Time Training

27. Edit the number of Department personnel necessary.

Provide just-in-time training onsite or near the project site for your personnel and Department project personnel. Schedule the just-in-time training with the Engineer at a mutually agreed time and place. Provide training materials for _ Department personnel. Provide an enclosed facility with electrical power for visual presentations.

28

Just-in-time training must be at least 4 hours in duration and include the following topics:

1. Background information for the specific intelligent compaction system and automated machine guidance system to be used.
2. Setup and checks for compaction systems including:
   - 2.1. GPS receiver
   - 2.2. GPS base station
   - 2.3. GPS rovers
   - 2.4. Rollers
3. Operation of the intelligent compaction system and automated machine guidance systems on the rollers including:
   - 3.1. Setup data collection
   - 3.2. Start/stop of data recording
   - 3.3. On-board display options
4. Transferring raw compaction data from the rollers using USB connections
5. Operation of vendor's software to open and view raw compaction data files and to export all-passes and proofing data files in Veda-compatible format
6. Operation of Veda software to:
   - 6.1. Import the exported all-passes and proofing data files
   - 6.2. Inspect the compaction maps
   - 6.3. Input point test data
   - 6.4. Perform statistical analysis
   - 6.5. Produce reports for project requirements
7. Coverage and uniformity requirements
8. Method for establishing target intelligent compaction measurement values for stiffness

29

The following personnel must attend just in time training:

1. Project manager
2. Superintendent
3. Technical representative
4. Compaction quality control technicians
5. Roller operators
6. CIR foreman

30-6.01A(4)(d) Quality Control

30-6.01A(4)(d)(i) General

30

Quality control for compaction must document that the number of roller passes comply with the test strip determinations.

31

The number of roller passes and intelligent compaction measurement values are report only and not used for compaction acceptance.

30-6.01A(4)(d)(ii) Quality Control Technician

32

During compaction, provide a quality control technician responsible full time for:

1. GPS site calibration or localization and upload to GPS receivers
2. GPS check testing for the compaction rollers and rovers
3. Accuracy verification 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.
3. During test strip construction, determining the target number for compaction roller passes and target values for intelligent compaction measurement values
4. Construction operation monitoring of the compaction rollers
5. Quality control testing for compaction
6. Backing up compaction data twice per day
7. Downloading data from rollers at the end of the work shift
8. On a daily basis, analyzing the data from the compaction rollers using Veda and producing a daily compaction quality control report
9. Monitoring the final evaluation
10. Daily set-up, take-down, of GPS and compaction roller components

30-6.01A(4)(d)(iii) IC Test Strip

33

On the first day of CIR production and within a 500 foot portion of the test strip specified in section 30-4.01D(4)(b), generate data correlating intelligent compaction measurement values to measured density as follows:

1. After each coverage, use a nuclear gage to measure the density at 3 randomly selected locations throughout the 500 foot section. Record the density readings, number of roller passes, and the GPS coordinates for each test location.
2. Establish the break over point for the test strip by averaging the density of the 3 locations for each coverage.
3. After reaching break over point density, use an intelligent compaction vibratory steel drum roller to make a final coverage with vibration on set at low amplitude. Use a nuclear gage to measure the density at 10 randomly selected locations throughout the 500 foot section. Record the density and the intelligent compaction measurement values. Either of the following may apply based on the density test results:
   - 3.1 If the final coverage produces an increase in density above the break point density, continue rolling with steel drum roller with vibration on until a new break over point density is determined. Use this new break over point density for production. Use pneumatic tire rollers to repair any damage caused by the intelligent compaction vibratory steel drum roller.

3.2 If the final coverage produces a reduction in the compaction below the break point density:

3.2.1 The requirement of maximum density will be waived on the 500 foot portion of the test strip.

3.2.2. Use pneumatic tire rollers to repair any damage caused by the final single pass of the intelligent compaction vibratory steel drum roller.

4. Use Veda to create a compaction curve that relates the final coverage of intelligent compaction roller passes to the intelligent compaction measurement values.

34

On all other test strips, correlating intelligent compaction measurement values to measured nuclear gage density is not required.

30-6.01B MATERIALS

35

Not Used

30-6.01C CONSTRUCTION

30-6.01C(1) General

36

Before CIR production, upload the project plan file into the compaction data analysis software and depending on the roller manufacturer, the on-board documentation system.

30-6.01C(2) Equipment

30-6.01C(2)(a) General

37

Use intelligent compaction rollers and automated machine guidance rollers for initial and supplemental compaction.

30-6.01C(2)(b) Rollers

38

In addition to the requirements in section 30-4, intelligent compaction roller must meet the following:

1. Be double-drum vibratory steel rollers with accelerometers mounted in or about the drum to measure the interaction between the rollers and compacted materials in order to evaluate the applied compactive effort.
2. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
3. With vibratory on, produce output that represents the stiffness of the material based on the vibration of the roller drums and the measured response from the underlying materials.
4. Have GPS radio and receiver units mounted on each intelligent compaction roller to monitor the steel drum roller 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, including the stiffness response values, vibration frequencies, roller drum amplitude, roller location, number of roller passes, roller speeds and capable of transferring data from a USB port.

39

In addition to the requirements in section 30-4automated machine guidance pneumatic tire rollers must meet the following:

1. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
2. Have GPS radio and receiver units mounted on each automated machine guidance roller to monitor the roller locations and track the number of passes of the rollers.
3. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of roller location, number of roller passes, roller speeds and capable of transferring data from a USB port.

30-6.01C(2)(c) Global Positioning System

40

GPS must be real time kinematic using one of the following:

1. GPS base station
2. Network real time kinematic (RTK)
3. Satellite-based augmentation station system capable of providing position accuracy within 0.25 foot.

41

You may use other high precision positioning systems in lieu of GPS. The positioning system must meet or exceed the precision specified for GPS.

42. Insert the zone number. Caltrans Survey manual: http://www.dot.ca.gove/hq/row/landsurveys/SurveysManual/Manual_TOC.html

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

30-6.01C(2)(d) Correction Signal Source

43

Provide either a GPS base station correction signal or a GPS correction service subscription. The GPS correction signal must be received by the GPS receivers on the compaction roller and the rovers during operations with a survey tolerance of not greater than 0.25 foot in both X and Y horizontal directions.

30-6.01C(2)(e) GPS Site Calibration or Localization and Check Testing

44

Prior to mapping of the existing pavement, perform a GPS site calibration or localization to the survey control points indicated on the Project Control Map in the project plans. Perform a GPS site calibration or localization whenever the GPS base station is moved to a new location.

45. Provide Project Control Map in project plane. Delete para 45.

Survey control points are indicated on the Project Control Map in the project plans.

46. Use if Project Control Map is not available. Delete para 44.

If using GPS base station, request survey control points at least 15 days prior to GPS site calibration or localization check testing.

47

Before the start of daily production and using the same datum, conduct testing for the proper setup of the GPS, the GPS of the rollers and the GPS rover:

1. On a location nearby or within the project limits, the GPS base station, if required by the GPS, must be established and the compaction 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 the roller GPS coordinates by:
   3.1. Stopping the roller at a location
   3.2. Marking the location of both ends of the roller drum or the outside of the front tires on the surface with a tee
   3.3. Recording the GPS measurements from the roller ensuring the distance offsets are applied so that the GPS coordinate is at the center of the front drum or center of front axle.
   3.4. Moving the roller from the marked location
   3.5. Finding the mid-point of the 2 marked ends of the roller and mark this location on the surface. This marked location is the theoretical center of the front drum or the front axle.
   3.6. Using the GPS rover to measure GPS coordinates of the marked location and record the GPS measurements

3.7. Computing the difference between recorded compaction roller GPS coordinates and GPS rover recorded GPS measured coordinates. The differences of the coordinates in grid must be within 0.50 foot in both the horizontal axes X and Y

30-6.01C(3) Mapping Existing Pavement

48

Before CIR, map the existing pavement with a vibratory steel drum roller with intelligent compaction equipment. Use low vibration amplitude and the same settings, including speed and frequency, throughout the section.

30-6.01C(4) Compacting

49

During compaction, monitor each roller's compaction graphical user interface display for roller passes and intelligent compaction measurement values.

50

Use GPS rover to measure coordinates of each quality control nuclear gage reading.

30-6.01C(5) Roller Coverage

51

For a lot, at least 90 percent of the area must meet or exceed the number of passes for each roller type determined from the test strip for that area. When the daily compaction quality control report shows the specified roller passes are not met, take corrective action and notify the Engineer of action taken.

30-6.01D PAYMENT

52

Not Used