



**SPECIAL PROVISIONS
FOR
INTELLIGENT COMPACTION-EMBANKMENT**

**Sac County
NHSX-020-2(89)--3H-81**

**Effective Date
April 20, 2010**

THE STANDARD SPECIFICATIONS, SERIES 2009, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

090063.01 Description.

This specification describes the Contractor's responsibilities for furnishing an Intelligent Compaction–Embankment (IC-E) roller, the required data acquisition and reporting method, the training program requirement, and the data file types and process for transmitting data to the Engineer. IC-E is defined as the gathering of data from a self-propelled roller system involved with the measurement and recording of roller position, date/time, speed, pass count, travel direction, and a compaction measurement value (MV). Real Time Kinematic (RTK) based Global Positions System (GPS) with base station corrections shall be used for determining the position of the roller. Results from the IC shall be displayed to the roller operator on a color coded computer screen in real-time during roller operations and the data saved for transfer and viewing by the Engineer.

IC-E will be required only for materials subject to moisture control per DS-09003. The IC-E results will be used as a guide to supplement QA testing for research purposes. Data collection and reporting shall include roller position, date/time, speed, pass count, travel direction, and compaction measurement value.

Submit to the Engineer a work plan for IC-E at least two weeks prior to the Preconstruction Conference. Describe in the work plan the following:

- **Compaction equipment to be used including:**
 - Vendor
 - Roller model,
 - Roller dimensions and weights,
 - Description of IC-E measurement system and previous field verification results to show that the compaction measurement values are suitable for the project soils, which include cohesive soils as defined in Article 2102.02 of the Standard Specifications,
 - GPS capabilities,
 - Documentation system, and
 - Software.

- Roller data collection methods including sampling rates and intervals and data file types.
- Transfer of data to the Engineer including method, timing, and personnel responsible. Data transfer shall occur at minimum once per day or as directed by the Engineer.
- Training plan and schedule for roller operators, Engineer's personnel, and Iowa State University's research personnel; including both classroom and field training.
- Communication protocol for informing the Iowa State University research team point of contact concerning construction progress and schedule to facilitate research field testing and data collection.

090063.02 Equipment and Materials.

A. Rollers.

The IC-E roller shall be a self-propelled roller with a padfoot configuration weighing at least 10,800 kg with an IC system and as approved by the Engineer. Ensure that IC equipment can measure roller position, date/time, speed, pass count, travel direction, and a compaction measurement value (MV). Provide a computer screen in the roller cab for viewing measured results. Ensure that results are stored for transfer to the Engineer for viewing on a laptop computer. Provide the Engineer and Iowa State University each with a copy of the IC equipment vendor software for viewing results. Ensure results are displayed as color-coded spatial maps based on GPS coordinates.

B. Data Collection, Export, and Onboard Display.

Provide and export the following data in a comma, colon, or space delimited ASCII file format:

- 1) Machine Model, Type, and Serial/Machine Number
- 2) Roller Drum Dimensions (Width and Diameter)
- 3) Roller and Drum Weights
- 4) File Name
- 5) Date Stamp
- 6) Time Stamp
- 7) RTK based GPS position measurements showing Northing, Easting, and Elevation
- 8) Roller Travel Direction (e.g., forward or reverse)
- 9) Roller Speed
- 10) Vibration setting, amplitude, and frequency (if vibration used)
- 11) Pass count
- 12) Compaction Measurement Value

Ensure that the roller's onboard display will furnish color-coded GPS based mapping showing number of roller passes and the compaction measurement value, on a computer screen in the roller operators cab. Provide displayed results to the Engineer for review upon request.

C. Local GPS Base Station.

Provide a real time kinematic global positioning system (RTK-GPS) to acquire northing, easting, and elevation data used in mapping of the IC-E measurements. Ensure the system has the capability to collect data in an established project coordinate system. Furnish a local GPS base station used for broadcasting differential correction data to the rollers with a tolerance less than 30 mm in the vertical and horizontal.

D. Training.

1. Preconstruction (classroom).

Make available all personnel responsible for roller operations and the IC equipment manufacturer representative to attend a one-day classroom training on IC. Classroom training will involve both the Contractor's and Engineer's personnel, and the Iowa State University research team. Training shall be provided by the IC equipment manufacturer and Contractor and scheduled in coordination with the Engineer.

2. Field (prior to and during compaction operations).

Ensure the IC roller manufacturer provides onsite technical assistance the first two working days of IC roller use.

E. Geotechnical Mobile Lab Parking.

Provide the Engineer an all weather access, parking for the Iowa State University Geotechnical Mobile lab trailer (2.5 m by 13.5 m), and parking for three vehicles at the project site or agreed upon alternative location. The lab trailer will be furnished and operated by Iowa State University which will be under contract with the Contracting Authority to perform IC-E research.

F. Test Strips.

Demonstrate that the IC-E roller and system meets the requirements of this specification by compacting test strips. Test strips shall be identified within the project limits and included with project earthwork operations and be a minimum 5 m wide by 75 m long. Test strips shall be compacted with 12 roller passes. Moisture content tests will be collected within the test strip area at five locations. The moisture content test locations will be selected in consultation with the Engineer and research team members and based on the IC compaction measurement values to represent areas of low to high compaction measurement values. Three test strip areas will be selected by the Engineer to represent different materials or conditions. Results from the test strips will be used for research purposes. Quality acceptance for the earthwork in the test strip areas will be as provided in DS-09003.

G. IC-E Proof Area Mapping.

IC-E proof area mapping is to be implemented for compacted fill within the project limits where quality acceptance follows DS-09003. The IC-E roller shall be used to record the compaction measurement value at the surface of the compacted layers at vertical intervals 0.6 m or less. The IC-E compaction measurement value shall be collected for the entire area at the top of the compaction layer at the specified minimum vertical interval. The surface for IC-E measurements shall be relatively smooth and uniform and shaped to approximately line and grade for each mapping area in accordance with manufacturer guidelines to provide reliable IC-E compaction measurement values. The results will be used to identify additional moisture content tests to be performed by the research team and a means for calculating nominal lift thickness for research purposes. The time between completion of compaction and IC-E proof area mapping should be kept to a minimum. Quality acceptance for the earthwork in the proof mapping areas will be as provided in DS-09003.

090063.03 Construction.**A. Roller Operations.**

Record IC-E roller passes in forward direction only for test strips and IC-E proof mapping areas. Check, verify and recalibrate, if necessary, IC equipment to ensure proper performance. Operate the IC roller according to manufacturer's recommendations to provide reliable and repeatable measurements. Keep roller speed (and vibration frequency and amplitude settings, if operated in vibratory mode) constant during test strip and IC-E proof mapping.

B. Equipment Breakdowns.

In the event of IC equipment breakdowns/IC system malfunctions/GPS problems, the Contactor may operate without IC-E rolling operations, but it is intended that IC-E data shall be collected and provided for a minimum 80% of the required proof areas.

C. Data Submittal.

Furnish to the Engineer an electronic file in a comma, colon, or space delimited ASCII file format with information listed under Article SP-090063.02, B. As a minimum, the file transfer shall occur following the final compaction operations on each working day. The Engineer may request data any time during compaction operations.

090063.04 Method of Measurement.

None. Lump sum item.

090063.05 Basis of Payment.

- A. Payment for IC-E will be the lump sum contract price.
- B. Payment is full compensation for all work associated with providing IC equipped rollers, transmission of electronic data files, two copies of IC equipment manufacturer software, training, and preparing and maintaining work space for Iowa State University's mobile lab and associated parking. Partial payments will be made as follows:
 - 1. Upon receipt of a signed contract, 50% of the lump sum bid price.
 - 2. The remainder 50% will be prorated based on the percent of the project's cubic meters of material subject to moisture control compacted using IC-E. (e.g.: to receive 100% payment for the item the Contractor will have to provide IC-E for at least 80% of the cubic meters compacted for the project.)
- C. Delays due to GPS satellite reception of signals to operate the IC equipment or IC roller breakdowns will not be considered justification for contract modifications or contract extensions.