S-1 (2016) QUALITY MANAGEMENT SPECIAL – INTELLIGENT COMPACTION (IC) METHOD

REVISED 01/09/17 ◄DO NOT REMOVE THIS. IT NEEDS TO STAY IN FOR THE CONTRACTORS.
SP2016-66

This write-up is to be used for the given specification and tied project when the net lane miles requiring compaction are greater than or equal to 4; when adequate data cellular coverage is available at least one time per day during the compaction efforts; when adequate global navigation satellite system (GNSS) coverage is available throughout the project limits; and on 2353, only when used in conjunction with 2360. Note to Designer – The Designer and Construction personnel will decide which specifications (highlighted in the following paragraph) to include to require the IC method.

MnDOT 2215 Stabilized Full Depth Reclamation (SFDR), 2331 Cold-In-Place Recycled Bituminous (CIR), 2353, 2360 and 2365 are modified with the following:

S-1.1 DESCRIPTION

This work consists of using the Intelligent Compaction (IC) Method to continually monitor compaction efforts during grading and/or asphalt paving operations.

The Advanced Materials and Technology Manual, Veta and forms are available on the MnDOT Advanced Materials and Technology (AMT) Website at: http://www.dot.state.mn.us/materials/amt/index.html.

A Definitions

Refer to Section 210 "Definitions" in the MnDOT Advanced Materials and Technology Manual for definitions related to the intelligent compaction method not included below.

A.1 ADVANCED MATERIALS AND TECHNOLOGY MANUAL. A Department manual that contains requirements, best practices and examples related to the use of technologies such as the paver mounted thermal profile method, intelligent compaction method and 3D production monitoring for excavation. References to the **Advanced Materials and Technology Manual** from the contract are to the edition in effect on the letting date.

A.2 AUXILIARY LANE. See MnDOT 1103 "Definitions". This provision is required only on continuous left turn lanes and passing lanes. Exclude auxiliary lane tapers, ramps, shoulders, cross-overs, non-continuous turn lanes, loops, bypass lanes, acceleration/deceleration lanes and intersecting streets.

A.3 CUMULATIVE MEASUREMENT PASS COUNT. The **gridded final coverage data** for pass count (the number of passes). The pass **count** reflects the number of roller passes in one area of the mat (e.g., 0.3 m by 0.3 m [1 ft by 1 ft area]), not the total number of passes across the width of the mat for a given roller.

A.4 LOT ROLLER COVERAGE (LRC). The percent of **roller coverage (RC)** for the given lot.

A.5 DRIVING LANE. See **traffic lane**.

A.6 GRIDDED ALL PASSES DATA. Includes all **measurement passes** recorded for a given grid.

A.7 GRIDDED FINAL COVERAGE DATA. Data that **summarizes** the final (last) **measurement pass** recorded for a given grid (e.g., total pass count, last stiffness, last temperature). Grid sizes are typically at a mesh size of 1 ft (0.3 m) in the X and Y direction for post-processed data.

A.8 INTELLIGENT COMPACTION. Compaction **efforts** completed using an **instrumented roller**.

A.9 INSTRUMENTED ROLLER. A self-propelled roller integrated with a global position monitoring system and onboard documentation system that can display real-time color-coded maps of roller location, number of passes, roller speeds, and amplitude and vibration frequencies of the roller drum. Some systems

are also equipped with drum vibration instrumentation, infrared temperature sensors, and/or Automatic Feedback Control. The onboard documentation system on these rollers would also display real-time color-coded maps of stiffness response or pavement surface temperatures, or both.

A.10 LAYER. The total **thickness** of each material type. It may be comprised of single or multiple **lifts**.

A.11 LIFT. A unit of **material** within a **layer** that is placed for compaction.

A.12 MEASUREMENT PASS. A roller pass, performed by an instrumented roller, where all required information, per this provision, is recorded in a data file.

A.13 ROLLER COVERAGE (RC). The percent of required compaction area where the minimum required **cumulative measurement pass count** is achieved.

A.14 THRU LANE. See **traffic lane**.

A.15 TRAFFIC LANE. See MnDOT 1103 "**Definitions**". This provision is required on all traffic lanes with the exception of traffic lane tapers and roundabouts (including the traffic lane between the roundabout and mainline transition prior to and after the radius point of the roundabout).

A.16 VETA. A standardized intelligent construction data management (ICDM) software that stores, maps and analyzes geospatial data resulting from intelligent compaction, thermal profiling and spot test data (e.g., density, moisture). This software can perform standardized data processing, analysis and reporting to provide Project summary results quickly in the field from various intelligent compaction and thermal profiling manufacturers. In particular, the software can provide statistics, histograms, correlations for these measurements, document coverage area and evaluate the uniformity of compaction and surface temperature measurements as part of the Project quality control operations. **Veta** can be downloaded from the Advanced Materials and Technology Website.

B Acronyms and Abbreviations

Refer to Section 220 "Glossary of Acronyms and Abbreviations" in the MnDOT Advanced Materials and Technology Manual for the full name or meaning of acronyms and/or abbreviations used within this provision.

S-1.2 MATERIALS – (BLANK)

S-1.3 CONSTRUCTION REQUIREMENTS

The Department does not guarantee the accuracy and compatibility of electronic data provided by the Department. The Plan documents, originally provided with the Contract, remain the basis of the Contract. The Contractor is responsible for any necessary conversions of the provided electronic data.

A Equipment Requirements

A.1 Intelligent Compaction System Requirements

Use instrumented rollers calibrated according to Manufacturer's recommendations and meeting the requirements of Tables 2016-1 (IC) and 2016-2 (IC). Refer to section 430 "Intelligent Compaction Method" in the Advanced Materials and Technology Manual for recommended system checks of each instrumented roller prior to compaction efforts.

Intelligent compaction systems from multiple manufacturers are allowed; however, use systems from the same manufacturer on rollers working in tandem.

Use intelligent compaction software, and cloud computing, capable of mapping and exporting gridded all passes and gridded final coverage data meeting the requirements of this provision and supporting the following features:

(1) Filtering by: instrumented roller, date and time stamp, and lot designation.
(2) Creating boundaries.
(3) Calculation of gridded final coverage data using filtered data (e.g., gridded final coverage for a given roller and lot; gridded final coverage within the entire Project limits).

Provide the Engineer with access to the cloud storage and cloud computing prior to the start of compaction efforts requiring the IC method until ninety (90) days after final acceptance of all work per MnDOT 1516.2.

Table 2016-1 (IC)
Required Instrumented Roller Equipment

Specification	Description	Instrumented Rollers	Instrumented Roller Components				
			GNSS	Accelerometer	Temperature Sensor	Modem or Wi-Fi	Onboard Documentation System
2215 (SFDR), 2331 (CIR)	Self-Propelled, Vibratory: Smooth, Single-Drum Steel Smooth, Double-Drum Steel Pad (Sheep's) Foot	Required * ‖	Required †	Required ‡	None	Required §	Required † **
2215 (SFDR), 2331 (CIR)	Self-Propelled, Pneumatic Roller			None	None		
2353, 2360, 2365	Self-Propelled, Vibratory: Smooth Double-Drum Steel			Required ‡	Required #		
2360, 2365	Self-Propelled, Pneumatic Roller			None			

* Instrument <u>all rollers</u> used in locations requiring the intelligent compaction method with the technology, where the **net lane miles for the given specification and tied project, are greater than or equal to 4**. Instrumented rollers are required on 2353 only when intelligent compaction is required on 2360.

‖ Use the intelligent compaction method during the duration of compaction efforts in areas requiring this method.

† Capability to use the County Coordinate System file for site calibration and the ability to connect to a RTK-GPS using either a local, ground-based station(s) or a VRS network (use the VRS network only when coverage is available throughout the project limits).

‡ Mount accelerometer in or about the drum, per the manufacturer's recommendations, to measure the interactions between the rollers and compacted materials.

\# Instrument rollers with one <u>non-contact, temperature sensor</u>, mounted on or near, the front of the roller for measuring pavement surface temperatures. A second temperature sensor may be mounted on, or near, the rear.

§ The modem or Wi-Fi is used for transferring data to cloud storage.

** Use an onboard document system with a minimum of the following capabilities:

(1) Displays real-time, color-coded maps of: line work (alignment file), roller drum location, number of roller passes, intelligent compaction measurement value (ICMV) for systems with an accelerometer, and pavement surface temperature for systems with temperature sensors.

(2) Displays and store current value for: roller speed, vibration frequency, vibration amplitude, GNSS coordinates, and pass count.

(3) Ability to internally store data until data transfer, to automatically transfer data to cloud storage, and to manually transfer data using a removable media device.

(4) Allows operator to define, label, and/or select the standardized name of each lot.

Table 2016-2 (IC) Required Instrumented Roller Equipment Accuracy	
Operating Parameter	**Accuracy**
GNSS	± 2 in (50 mm) in the X and Y Direction
Rolling Speed	± 0.3 mph (0.5 kph)
Frequency	± 2 Hz
Amplitude	± 0.008 in (0.2 mm)
Temperature	± 2.7°F (±1.5°C)

A.2 Intelligent Compaction Measurement Pass Data

Export gridded all passes and gridded final coverage data:

(1) as dbase ASCII or Text Format, or
(2) directly into Veta if a file format compatible with Veta is available.

Include the information in Table 2016-3 (IC) in the header of each data file or section, or with each data point. Include the fields listed in Table 2016-4 (IC) with each data point.

Table 2016-3 (IC) Required Header Information or Information with Each Data Point	
Data Field Name	**Data Format Examples**
Project Identification	SPXXXX-XX

Table 2016-4 (IC) Required Fields in Gridded All Passes and Gridded Final Coverage Data Files for Each Data Point	
Data Field Name * ‖	**Data Format Examples**
Date Stamp † (YYYYMMDD)	20080701
Time Stamp † (HHMMSS.SS –military format)	214622.962 (21 hr 46min. 22.96 s.)
Roller Trade Name	Roller Model
Roller ID	serial number, machine ID
Northing (Y) (ft) ‡ #	153328.47
Easting (X) (ft) ‡ #	524195.65
Height (Z) (ft) ‡ #	909.85
GNSS Mode	RTK Fixed
Roller Pass Number (calculated from Grid)	2
Roller Direction	Forward, Reverse (or an index)
Roller Speed	4.0
Vibration On	Yes, No, On, Off (or an index)
Frequency	38.4
Amplitude	0.6
Surface Temperature §	120
Intelligent Compaction Measurement Value (ICMV) **	20.0

* Include measurement units in a header or as part of the field name.

‖ Use a data mesh size of 18 in (450 mm) or less in the X and Y directions for post-processed data.

† **Ensure the intelligent compaction system's date/time stamp is reflective of the local time zone for both mapped and exported data.**

Table 2016-4 (IC) Required Fields in Gridded All Passes and Gridded Final Coverage Data Files for Each Data Point	
‡	Collect the coordinates, unless otherwise specified, in the County Coordinate System used in the background and alignment file(s) using NAD83 (adjustment as specified by the Department) and NAVD88 vertical datum.
#	Coordinates indicate the left and right edge of the roller drum, or can be used to determine the left and right roller drum edge.
§	Surface temperature measurements are required for rollers instrumented with temperature sensors.
**	ICMVs are required for rollers instrumented with accelerometers.

B Control Points

The Engineer will set temporary control points, prior to the Project start date, meeting the following requirements. Permanent control points meeting the following requirements can be used; however, the Engineer will collect coordinates for these points to ensure that there have been no disturbances.

(1) Two (2) control points, at the start and at the end of the Project (totaling four).
(2) Control points spaced at a maximum of every 3 miles within 150 feet of centerline. Alternate the control points on each side of the alignment. **Contact the contractor to determine whether the number of control points can be reduced. Some intelligent compaction systems allow for an increase in spacing between control points.**
(3) All control points have a clear line of site to satellites to allow for calibration.
(4) Five (5) of the control points, meeting the following requirements (the remaining control points may be two dimensional [2D]):
  (4.1) Three Dimensional (3D),
  (4.2) Accuracy ≤ 0.1 ft in the X-, Y- and Z-Direction,
  (4.3) Equally spaced throughout the Project and
  (4.4) One (1) control point at the start and end of the Project.
(5) The remaining control points with an accuracy of ≤ 0.1 ft in the X- and Y-Direction.

The Engineer will provide control point coordinate information in a *txt or *csv format, for both the permanent and temporary control points, 7 working-days prior to the start of compaction efforts. The Engineer will include the following information in the file(s):

(1) Point Name
(2) X coordinate (Easting)
(3) Y coordinate (Northing)
(4) Z coordinate (Elevation)
(5) Point Code / Description

The Engineer will also include available MnDOT Geodetic Data Sheets that are relevant to the Project limits and the MN County Coordinate System file and name of the zone used to establish the control points.

C Design File

The Engineer will create the background and alignment file(s) containing at a minimum, the following layers: closed complex shapes; **in-place** centerline; station text; tick marks; and labeling for exceptions. See Chapter 7 “Alignment” of the MnDOT Design Scene (http://www.dot.state.mn.us/pre-letting/scene/index.html) for guidance on creation of the complex shapes.

Ensure horizontal positioning of the line work is within ± 2 in (50 mm).

The Engineer will provide the following within three (3) working days of Contract approval:

(1) 2D-DGN and 2D-KMZ for both background and alignment file(s);
(2) County coordinate system used to generate design file(s); and

(3) Total lane miles per lift (rounded to the nearest hundredth) for lane miles requiring the intelligent compaction method.

It is the Contractor's responsibility to convert, as needed, the provided Department design files for use with the selected IC System and/or Software.

The Department is allowed five (5) working days to update files with Department approved changes requested by the Contractor.

Load the alignment file onto the onboard documentation system of each instrumented roller and into the cloud computing mapping software.

D Field Stationing

Ensure that field station markers, when used, match the centerline stationing used in the background alignment design file.

E Site Analysis, Setup and Calibration

Complete the site setup and calibration prior to compaction efforts prior to compaction efforts requiring the intelligent compaction method.

Use the County Coordinate System file for the site calibration.

F Definition of Lot and Sublot for Measurement Passes

F.1 Lot Establishment

The Engineer defines a lot as all measurement passes as defined in Table 2016-5 (IC).

Table 2016-5 (IC)
Lot Establishment Criterion

Specification	Description	All Measurements Passes per:				
		Day	Material Type	Lift	Centerline Offsets	Direction of Travel
2353, 2360*, 2365*	Undivided Highway	√	√	√	√	…
	Divided Highway	√	√	√	√	√
2215 (SFDR), 2331 (CIR)	Undivided Highway	…	√	√	…	…
	Divided Highway	…	√	√	…	√

* The centerline offsets reflect the cumulative paving width of both pavers for cases with echelon paving and use of a single, instrumented rolling train for compaction efforts requiring the IC Method.

Distinctly identify the lots for measurements passes using the standardized format per Tables 2016-6 (IC) and 2016-7 (IC). Ensure that the lot designations are digitally stored with the associated measurement pass data. See section 420 "Lot Establishments" of the Advanced Materials and Technology Manual for examples of the standardized naming convention for lots.

The Engineer will create complex shape layers in the background alignment file(s) for each traffic and required auxiliary lane. Notify the Engineer, fourteen calendar days prior to the start of compaction efforts, if different production widths are anticipated (e.g., 18-ft paving).

The GNSS coordinates contain the date component of the lot designation, and therefore, are not included in the standardized naming convention.

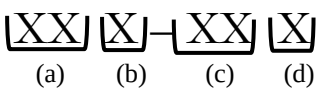
Table 2016-6 (IC) Standardized Naming Convention for Measurement Passes Lots	
Standardized Format*	**Definition**
ROUTE-MATL-L#-XXX-XXX	Undivided Highways (e.g., TH68-HMA-L1-12L-CL)
ROUTE-MATL-L#-XXX-XXX-DT	Divided Highways (e.g., TH68-HMA-L1-12L-CL-NB)
* Add an additional designation behind the ROUTE for instances where more than one site calibration is needed within the project limits (e.g., a site calibration was completed for the northern and southern limits of the project – a "**N**" and "**S**" would be added immediately behind the ROUTE [TH68**N**-HMA-L1-12L-CL, TH68**S**-HMA-L1-12L-CL]).	

Table 2016-7 (IC)
Standardized Abbreviations for Measurement Passes Lots

Abbreviation	Definition
ROUTE	**ROUTE DESIGNATION.** Replace "ROUTE" with the route system, as designated by the following acronyms or short form, immediately followed by the route number (e.g., TH12). **Acronym or Short Form** / Full Name or Meaning **CR** – County Road **CSAH** – County State Aid Highway **MS** – Municipal Street **MSAS** – Municipal State Aid Street **TH** – Trunk Highway
MATL	**MATERIAL/ SURFACE TYPE.** The material/surface type is designated by the following acronyms or short form: Specification / **Acronym or Short Form** / Full Name or Meaning 2215 / **SFDR-P** / Stabilized Full Depth Reclamation – Pulverization per 2215.3.C.3 2215 / **SFDR-I** / Stabilized Full Depth Reclamation – Mixing/Injecting per 2215.3.C.6 2331 / **CIR** / Cold In-Place Recycled Bituminous 2353 / **UTBWC** / Ultrathin Bonded Wearing Course 2360 / **HMA** / Hot Mix Asphalt 2360 / **WMA** / Warm Mix Asphalt 2365 / **SMA** / Stone Matrix Asphalt

<table>
<tr><th colspan="2">Table 2016-7 (IC)
Standardized Abbreviations for Measurement Passes Lots</th></tr>
<tr><th>Abbreviation</th><th>Definition</th></tr>
<tr><td>L#</td><td>LIFT NUMBER. The lift number is designated by the following acronym or short form:

<table>
<tr><th>Acronym or Short Form</th><th>Full Name or Meaning</th></tr>
<tr><td>L1</td><td>Lift 1</td></tr>
<tr><td>L2</td><td>Lift 2</td></tr>
<tr><td>L3</td><td>Lift 3</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Ln</td><td>Lift n</td></tr>
</table></td></tr>
<tr><td>XXX-XXX</td><td>CENTERLINE OFFSET. The location of the left and right edge of the production/compaction area with respect to the centerline, facing in the direction of increasing stationing. Stationing typically increases from West to East and South to North. Each character of the abbreviation is defined as the following:


(a) (b) (c) (d)

(a) The offset distance (in feet rounded to the whole number) from the centerline to the left edge of the production area (e.g., CL, 12, 24). CL reflects the Center Line.

(b) R or L, to reflect Right (R) or Left (L) of Centerline, in the direction of increasing station numbering.

(c) The offset distance (in feet rounded to the whole number) from the centerline to the right edge of the production area (e.g., CL, 12, 24). CL reflects the Center Line.

(d) R or L, to reflect Right (R) or Left (L) of Centerline, in the direction of increasing station numbering.</td></tr>
<tr><td>DT</td><td>DIRECTION OF TRAVEL. The direction of travel is designated by the following acronyms or short form:

<table>
<tr><th>Acronym or Short Form</th><th>Full Name or Meaning</th></tr>
<tr><td>NB</td><td>North Bound</td></tr>
<tr><td>SB</td><td>South Bound</td></tr>
<tr><td>EB</td><td>East Bound</td></tr>
<tr><td>WB</td><td>West Bound</td></tr>
</table></td></tr>
</table>

F.2 Sublot Establishment (Blank)

G Intelligent Compaction Measurement Passes

Complete measurement passes on 100 percent of the following lanes and per the requirements of Table 2016-8 (IC):

(1) **Traffic Lanes** (excluding traffic lane tapers and roundabouts [exclude the traffic lane between the roundabout and mainline transition prior to and after the radius point of the roundabout]) and

(2) the following **Auxiliary Lanes** (excluding auxiliary lane tapers):

(2.1) **Continuous Left Turn Lanes** and

(2.2) **Passing Lanes**

Measurement passes are not required on auxiliary lane tapers, ramps, shoulders, cross-overs, non-continuous turn lanes, loops, bypass lanes, acceleration/deceleration lanes and intersecting streets.

Table 2016-8 (IC)
Required Measurement Pass Locations

Specification *	Measurement Pass Location
2215 (SFDR), 2331 (CIR)	All roller passes on each lift.
2353, 2360, 2365	

* Input (or select) the lot identification, using the on-board display, prior to compacting the given material.

Complete measurement passes on control strips. Provide the Engineer with the date, location and time frame that the control strip compaction was completed to delineate data from the production data set.

Turn data collection and recording off when not performing measurement passes.

Provide the Engineer immediate viewing of the measurement pass data on the instrumented roller's onboard documentation system upon request.

H Instrumented Roller Failure

Instrumented roller failure occurs when the instrumented roller system does not collect and/or store data per the requirements of this provision and/or the roller becomes inoperable.

Contact the Engineer verbally, or via e-mail, when instrumented roller failure occurs and immediately after resolution of the issues. Additionally, provide the Engineer with written notification of the dates of instrumented roller failure, along with a brief description detailing the instrumented roller failure and the compaction areas affected by this failure.

The day of instrumented roller failure notification and the following two (2) working days are accepted as providing a roller coverage of 100 percent for the given roller, for each day of this grace period. The roller coverage is reflective of the actual measurements during subsequent days of instrumented roller failure for the given roller.

I Coordinates

The Engineer will use a rover to collect coordinates for the boundaries of each lot for MnDOT 2353, 2360 and 2365 and of exceptions for MnDOT 2215 (SFDR), 2331 (CIR), 2353, 2360 and 2365. The Engineer will record coordinates per form IC-106.

The Engineer may use a rover to collect the following coordinates:

(1) Verification/quality assurance test locations where the intelligent compaction method is required (e.g., density cores, dynamic cone penetrometer, nuclear gauge, light weight deflectometer). Record coordinates per form IC-107.
(2) Boundaries of areas requiring corrective action (record coordinates per form IC-105).

J Intelligent Compaction Analysis Software

Use the Veta software to plot measurement pass data and to determine roller coverage. Produce *.VETAPROJ filenames in the **SPXXXX-XXX ROUTE IC** standardized format per Table 2016-9 (IC).

Table 2016-9 (IC)
Standardized Naming Convention for *.VETAPROJ Files * ‖

Abbreviation	Definition
SPXXXX-XXX	**STATE PROJECT NUMBER.** Replace the "X's" with the state project numbers (e.g., SP1234-56). Replace "SP" with "SAP" or "CP", as needed.
ROUTE	**ROUTE NUMBER.** Replace "ROUTE" with the route system, as designated by the following acronyms or short form, immediately followed by the route number(s) mapped in the given Veta project. (e.g., TH12, TH12-34, TH12-34-56)
IC	IC reflects the intelligent compaction method, the data set contained within the Veta project file.

Acronym or Short Form	Full Name or Meaning
CR	County Road
CSAH	County State Aid Highway
MS	Municipal Street
MSAS	Municipal State Aid Street
TH	Trunk Highway

* Example *.VETAPROJ filename: **SP1234-56 TH78 IC**

‖ Add the **county name** at the end of the Veta project file name for instances where projects are calibrated for more than one county (e.g., site calibrations are completed in both Carlton and Pine County – two Veta projects are created [SP1234-56 TH78 IC **Carlton**; SP1234-56 TH78 IC **Pine**]).

Designate filter groups and operation filter names using the **LOT# MMDDYY LOTNAME** standardized format per Table 2016-10 (IC).

Table 2016-10 (IC)
Standardized Naming convention for Veta Filter Group and Operation Filter Names *

Abbreviation	Definition
LOT#	**LOT NUMBER.** The lot number is a two-digit number increasing sequentially (01, 02, 03, …, n). Create filter groups and operation filters in sequential order with respect to the lot dates. <u>Lots containing Exceptions and/or Temporary Exceptions:</u> ‖ Include a capital letter, in alphabetical order (A, B, …), immediately after the two-digit lot number to designate the side of the exception, or temporary exception, that the measurement pass data reflects (e.g., 01A, 01B, 02A, 02B, …).
MM	**MONTH** (include leading zeros)
DD	**DAY OF MONTH** (include leading zeros)
YY	**TWO-DIGIT YEAR**
LOTNAME	**STANDARDIZED LOT NAME** per Table 2016-5 (IC)

* Example Filter Group/Operation Filter Name (lot contains no exceptions):
01 070915 TH12-HMA-L1-CL-12R, 02 071015 TH12-HMA-L1-CL-12R, …

* Example Filter Group/Operation Filter Name (lot contains an exception):
01A 070915 TH12-HMA-L1-CL-12R, 01B 070915 TH12-HMA-L1-CL-12R,
02A 071015 TH12-HMA-L1-CL-12R, 02B 071015 TH12-HMA-L1-CL-12R,
…

‖ Temporary exceptions are areas with grading and/or paving completed at a later date.

K Veta Software Operator Certification

Provide a software operator that is knowledgeable in the use of Veta and has taken the hands-on class and/or an E-Learning class provided by the Engineer. Provide documentation that the software operator has completed the class to the MnDOT Advanced Materials and Technology Unit. Certification expires 3 years from

the date of receiving the certification. Certifications will be invalidated (expired) prior to 3 years if significant changes are made to Veta or to the submittal requirements of Veta projects. A list of certified Veta Software Operators, along with expiration dates, is available on the MnDOT Advanced Materials and Technology (AMT) website at: http://www.dot.state.mn.us/materials/amt/veta.html.

L Calculations

L.1 Roller Coverage

Determine roller coverage, independently for each manufacturer's intelligent compaction system, using the cumulative measurement pass count recorded by the instrumented rollers for each lift of the compaction areas as required per S-xx.3.G.

Roller coverage is achieved when the cumulative measurement pass count is greater than or equal to one (1) (measurement pass) times the number of instrumented rollers used for the given lot. Instrumented rollers working in tandem are counted as one (1) instrumented roller.

Evaluate roller coverage for each manufacturer's intelligent compaction system independently for compliance with Table 2016-11 (IC).

Calculate lot roller coverage for each lot per Equation 2016-1 (IC). Calculate the lot roller coverage on each side of an exception separately for a lot extending through exception(s).

Equation 2016-1 (IC): $\text{Lot Roller Coverage} = \left(\frac{Lot\ Area\ Covered}{Required\ Lot\ Area}\right) \times 100$

Where:

Lot Roller Coverage = see S-xx.1.A.4, % (reported to the tenth);
Lot Area Covered = the total measurement pass area where roller coverage was achieved for the given lot, square feet (reported to the nearest whole number); and
Required Lot Area = total area requiring measurement passes for the given lot, square feet (reported to the nearest whole number).

Calculate roller coverage for each lift of a given material per Equation 2016-2 (IC).

Equation 2016-2 (IC): $\text{Roller Coverage} = \left(\frac{\sum_{i=1}^{n}(Lot\ Area\ Covered)_i}{\sum_{i=1}^{n}(Required\ Lot\ Area)_i}\right) \times 100$

Where:

Roller Coverage = see S-xx.1.A.13, % (reported to the tenth);
n = the total number of lots for the entire lift and given material type;
Lot Area Covered = the total measurement pass area where roller coverage was achieved for lot *i*, square feet (reported to the nearest tenth); and
Required Lot Area = total area requiring measurement passes for lot *i*, square feet (reported to the nearest tenth).

L.2 Monetary Price Adjustment – Roller Coverage (RC)

Calculate the monetary price adjustments for roller coverage per Table 2016-11 (IC).

Table 2016-11 (IC)
Monetary Price Adjustment for Roller Coverage (RC)

Roller Coverage (%) (Form IC-108)	Total Price Adjustment Per Lift and Material Type
≥ 70	No Price Adjustment

Table 2016-11 (IC) Monetary Price Adjustment for Roller Coverage (RC)	
Roller Coverage (%) (Form IC-108)	**Total Price Adjustment Per Lift and Material Type**
< 70	Total Price Adjustment (Disincentive) = (20 × RC – $1400) × (LM) where: RC = Roller coverage for the given lift, % (reported to the tenth) LM = Total number of lane miles for the given lift requiring the intelligent compaction method, miles (reported to the hundredth)

M Submittals

M.1 Intelligent Compaction Data Submittal

Store the measurement pass data internally until transfer of data. Transfer the data directly from the roller to the cloud storage within 15-minute intervals, or at least once per day when there is limited cellular coverage.

Notify the Department when cellular coverage is limited or not available.

M.2 Coordinates

The Engineer will provide the lot boundary coordinates weekly per form IC-106.

M.3 Veta Projects

Submit the first Veta project to the Engineer within three (3) days after the start of production for mixture requiring the IC Method. Submit an updated Veta project(s) to the Engineer at least two (2) non-consecutive days per calendar week. Ensure Veta projects include the following:

(1) **Alignment File**
(2) **Gridded All Passes Data**
(3) **Filter Groups** per:
  (3.1) lot (e.g., 01 090415 TH12-HMA-L1-12L-CL),
  (3.2) lane and per lift (e.g., TH12-HMA-L1-12L-CL All Machines) and
  (3.3) lift (e.g., TH12-HMA-L1 All Machines)
(4) **Operation Filters** per Lot (e.g., 01 090415 TH12-HMA-L1-12L-CL)

Update the Location Filter within each Operation Filter upon receipt of the lot boundary coordinates from the Engineer in the subsequent updated Veta submittal.

(5) **Override Filters per Machine ID** per:
  (5.1) lift (e.g., TH12-HMA-L1 Machine ID) and
  (5.2) lane and per lift (e.g., TH12-HMA-L1-12L-CL Machine ID)

Submit the final version of the Veta Project(s) within 14-calendar days of completion of compaction efforts requiring the IC method.

M.4 Forms

Submit updated form IC-108 with Veta projects. Submit final version of form IC-108 within 14-calendar days of completion of compaction efforts requiring the IC method.

S-1.4 METHOD OF MEASUREMENT – (BLANK)

S-1.5 BASIS OF PAYMENT

The Contract lump sum prices for the intelligent compaction method includes all costs related to this Special Provision.

Interruptions in the availability of MnCORS VRS Network and/or satellite signals used to operate this system will not result in any reduction to the lot roller coverage (lot area covered and required lot area) or adjustments to the "Basis of Payment" for any construction items or to Contract time.

The Department will pay for the intelligent compaction method on the basis of the following schedule:

Item No.	Item	Unit
2016.601	Quality Management Special	Lump Sum