




March 13, 2008

**TO:** Kevin Dayton, Olympic Region  
Lorena Eng, Northwest Region  
Keith Metcalf, Eastern Region  
Don Senn, North Central Region  
Craig Stone, Urban Corridors  
Don Wagner, Southwest Region  
Don Whitehouse, South Central Region  
Pasco Bakotich, Headquarters  
Linea Laird, Headquarters

**FROM:** Donald K. Nelson, Director   
Environmental and Engineering Programs

**SUBJECT:** Machine Control Project Delivery Memo # 08-01

**Purpose and Direction**

Automated Guidance Machine Systems (AGMS) utilize robotic and GPS surveying techniques on certain project elements by mounting robotic and GPS equipment directly on earthwork equipment used during construction. At the request of the contracting community, WSDOT performed several pilot projects under construction contracts to examine this practice.

WSDOT endorses the use of AGMS under certain conditions. WSDOT contractors may obtain electronic data used to operate AGMS after bid award or upon request (optional).

**Action Requested**

***Project Development***

In the short term, there will be no substantive changes to the process of project development. Contractors electing to use AGMS may request electronic, two-dimension CAD files in a DGN format. Contractors will likely use this information to create an electronic model providing cut and fill information, as well as volume of earth moved.

In the long term, the overall goal is for WSDOT to provide electronic CAD files in a DGN format and or a model already complete. Contractors will be able to receive this data and compute estimates, etc. prior to bid opening.

WSDOT will not be responsible for electronic data provided. Construction plans provided to the contractor take precedence over any discrepancies between plan sheets and electronic files.

A General Special Provision (GSP) was created and used during AGMS pilot projects. It is recommended to include the GSP in bid packages with AGMS potential.

Potential projects for AGMS include projects with extensive earthwork, those projects with adequate design files available, as well as projects proposed to use contractor surveying and/or others as determined by the project engineer.

The Survey Manual, Chapters 7-10 and 13-16, shall be revised to further refine AGMS impacts on the Survey Program.

***Contract Ad and Award***

The basic function of Ad and Award will not change.

***Construction***

The basic functions of Construction Administration will not change. The process is outlined in the current construction manual. It is recommended to make adequate spot checks to ensure quality control during execution of any work utilizing AGMS.

Please direct questions as follows:

- State Surveyor – Bill Mumma, P.L.S.
- Project Development – Project Engineer
- Contract Ad and Award - Ken Walker
- State Construction Engineer Administration - Craig McDaniel

Additional information is available from the following sources:

- WSDOT Survey Manual
- WSDOT Construction Manual
- <http://cmssc.engr.wisc.edu/Vonderohe2007Apr01.pdf>
- <http://www.wsdot.wa.gov/fasc/EngineeringPublications/>

DKN:slm

Attachments

05091.GR1 Machine Control Grading

(April 7, 2008)

Use in eligible projects that require extensive grading if adequate design files have already been created during the design process. Eligible projects are those that require large areas of linear grading or mass quantities of roadway excavation, and are in locations where satellite signals are not obstructed by natural or manmade feature (such as highly mountainous areas or urban canyons). Requires approval of Region Construction Manager.

Must also use 050412.GR1 (Contractor Surveying - Roadway).

(2 fill-ins) The first fill-in describes the type of data to be provided (cross sections Sta. A to B, digital terrain model, etc.) and the file format of the electronic data. The second fill-in is the name and address of the Project Engineer administering the contract.

---

**(April 7, 2008)**

**MACHINE CONTROL GRADING**

Section 1-05.9 is supplemented with the following:

***General***

This specification contains requirements for the use of machine control grading.

Instead of providing grade control through construction stakes, the Contractor may control grade with equipment that is controlled by a machine control system.

The Contractor may use any type of equipment and machine control system that produces results meeting the requirements of the Contract.

Electronic data is provided for the Contractor's convenience, and is not a part of the Contract. No guarantee or warranty is made by the Contracting Agency that electronic data provided to the Contractor: is compatible with any of the systems that are used by the Contractor; is complete; is representative of actual conditions at the project site, or; accurately reflects the quantities and character of the actual Work required. The furnishing of electronic design data or documentation shall not relieve the Contractor from any risks or of any duty to make examinations and investigations as required by Section 1-02.4 or any other responsibility under the Contract or as required by law. Except as provided above, no corrections, additions, or updates of any kind will made to electronic data provided to the Contractor.

The Engineer may perform spot checks of the Contractor's machine control grading results, calculations, records, field procedures, and quality control measures. If the Engineer determines that the Work being performed is not achieving results that will meet the Contract requirements, the Contractor shall make corrections to the Work at no additional cost to the Contracting Agency.

***WSDOT Responsibilities***

1. The Project Engineer will set the initial horizontal and vertical control points for the project as shown in the Contract documents.
2. The Project Engineer will provide additional datum and scale factor information upon request.
3. After execution of the Contract, the Project Engineer will make available upon written request the following electronic data used to design the project:

\$\$\$ 1 \$\$\$

Data may be obtained by furnishing a written request to the Project Engineer at the following address:

\$\$\$ 2 \$\$\$

***Contractor's Responsibilities***

1. The Contractor shall provide any information or data that is requested by the Contracting Agency for the purpose of performing the verification of quantities, and quality.
2. The Contractor shall be responsible for any edits or conversions of the Contracting Agencies electronic data whether done by the Contractor or a vendor that is hired by the Contractor to perform such edits or conversions.
3. The Contractor shall be responsible for the accuracy and usability of any data or model that is developed from the Contracting Agencies data.
4. The Contractor shall be responsible for checking and recalibrating Machine Control Equipment as required to achieve results that meet the requirements of the Contract.
5. The Contractor shall be responsible for establishing any additional control points needed to achieve results that meet the requirements of the Contract.
6. The Contractor shall provide the Contracting Agency electronic as-built construction data for the final Roadway surface model in a MicroStation format.
7. One week prior to the start of grading operations the Contractor shall meet with the Project Engineers staff to review the grading plans, quality processes, and tolerance requirements.

***Payment***

All costs associated with the use of machine control grading equipment are incidental to related items of Work, and no additional payment will be provided.

**(April 7, 2008)**

**Contractor Surveying - Roadway**

Copies of the Contracting Agency provided primary survey control data are available for the bidder's inspection at the office of the Project Engineer.

The Contractor shall be responsible for setting, maintaining, and resetting all alignment stakes, slope stakes, and grades necessary for the construction of the roadbed, drainage, surfacing, paving, channelization and pavement marking, illumination and signals, guardrails and barriers, and signing. Except for the survey control data to be furnished by the Contracting Agency, calculations, surveying, and measuring required for setting and maintaining the necessary lines and grades shall be the Contractor's responsibility.

Detailed survey records shall be maintained, including a description of the work performed on each shift, the methods utilized, and the control points used. The record shall be adequate to allow the survey to be reproduced. A copy of each day's record shall be provided to the Engineer within three working days after the end of the shift.

The meaning of words and terms used in this provision shall be as listed in "Definitions of Surveying and Associated Terms" current edition, published by the American Congress on Surveying and Mapping and the American Society of Civil Engineers.

The survey work shall include but not be limited to the following:

1. Verify the primary horizontal and vertical control furnished by the Contracting Agency, and expand into secondary control by adding stakes and hubs as well as additional survey control needed for the project. Provide descriptions of secondary control to the Contracting Agency. The description shall include coordinates and elevations of all secondary control points.
2. Establish, the centerlines of all alignments, by placing hubs, stakes, or marks on centerline or on offsets to centerline at all curve points (PCs, PTs, and PIs) and at points on the alignments spaced no further than 50 feet.
3. Establish clearing limits, placing stakes at all angle points and at intermediate points not more than 50 feet apart. The clearing and grubbing limits shall be 5 feet beyond the toe of a fill and 10 feet beyond the top of a cut unless otherwise shown in the Plans.
4. Establish grading limits, placing slope stakes at centerline increments not more than 50 feet apart. Establish offset reference to all slope stakes. If Global Positioning Satellite (GPS) Machine Controls are used to provide grade control, then slope stakes may be omitted at the discretion of the Contractor.
5. Establish the horizontal and vertical location of all drainage features, placing offset stakes to all drainage structures and to pipes at a horizontal interval not greater than 25 feet.
6. Establish roadbed and surfacing elevations by placing stakes at the top of subgrade and at the top of each course of surfacing. Subgrade and surfacing stakes shall be set at horizontal intervals not greater than 50 feet in tangent

sections, 25 feet in curve sections with a radius less than 300 feet, and at 10-foot intervals in intersection radii with a radius less than 10 feet. Transversely, stakes shall be placed at all locations where the roadway slope changes and at additional points such that the transverse spacing of stakes is not more than 12 feet. If GPS Machine Controls are used to provide grade control, then roadbed and surfacing stakes may be omitted at the discretion of the Contractor.

7. Establish intermediate elevation benchmarks as needed to check work throughout the project.
8. Provide references for paving pins at 25-foot intervals or provide simultaneous surveying to establish location and elevation of paving pins as they are being placed.
9. For all other types of construction included in this provision, (including but not limited to channelization and pavement marking, illumination and signals, guardrails and barriers, and signing) provide staking and layout as necessary to adequately locate, construct, and check the specific construction activity.
10. The Contractor shall collect additional topographic survey data as needed in order to match into existing roadways such that the transition from the new pavement to the existing pavement is smooth and that the pavement and ditches drain properly. If changes to the profiles or roadway sections shown in the contract plans are needed to achieve proper smoothness and drainage where matching into existing features, the contractor shall submit these changes to the Project Engineer for review and approval 10 days prior to the beginning the work.

The Contractor shall provide the Contracting Agency copies of any calculations and staking data when requested by the Engineer.

To facilitate the establishment of these lines and elevations, the Contracting Agency will provide the Contractor with primary survey control information consisting of descriptions of two primary control points used for the horizontal and vertical control, and descriptions of two additional primary control points for every additional three miles of project length. Primary control points will be described by reference to the project alignment and the coordinate system and elevation datum utilized by the project. In addition, the Contracting Agency will supply horizontal coordinates for the beginning and ending points and for each Point of Intersection (PI) on each alignment included in the project.

The Contractor shall ensure a surveying accuracy within the following tolerances:

		<u>Vertical</u>	<u>Horizontal</u>
1			
2	Slope stakes	±0.10 feet	±0.10 feet
3	Subgrade grade stakes set		
4	0.04 feet below grade	±0.01 feet	±0.5 feet
5			(parallel to alignment)
6			±0.1 feet
7			(normal to alignment)
8			
9	Stationing on roadway	N/A	±0.1 feet
10	Alignment on roadway	N/A	±0.04 feet
11	Surfacing grade stakes	±0.01 feet	±0.5 feet
12			(parallel to alignment)
13			±0.1 feet
14			(normal to alignment)
15			
16	Roadway paving pins for		
17	surfacing or paving	±0.01 feet	±0.2 feet
18			(parallel to alignment)
19			±0.1 feet
20			(normal to alignment)
21			

22 The Contracting Agency may spot-check the Contractor's surveying. These spot-  
 23 checks will not change the requirements for normal checking by the Contractor.

24  
 25 When staking roadway alignment and stationing, the Contractor shall perform  
 26 independent checks from different secondary control to ensure that the points staked  
 27 are within the specified survey accuracy tolerances.

28  
 29 The Contractor shall calculate coordinates for the alignment. The Contracting Agency  
 30 will verify these coordinates prior to issuing approval to the Contractor for commencing  
 31 with the work. The Contracting Agency will require up to seven calendar days from the  
 32 date the data is received.

33  
 34 Contract work to be performed using contractor-provided stakes shall not begin until the  
 35 stakes are approved by the Contracting Agency. Such approval shall not relieve the  
 36 Contractor of responsibility for the accuracy of the stakes.

37  
 38 Stakes shall be marked in accordance with Standard Plan H-14. When stakes are  
 39 needed that are not described in the Plans, then those stakes shall be marked, at no  
 40 additional cost to the Contracting Agency as ordered by the Engineer.

41  
 42 **Payment**

43 Payment will be made in accordance with Section 1-04.1 for the following bid item when  
 44 included in the proposal:

45  
 46 "Roadway Surveying", lump sum.

47  
 48 The lump sum contract price for "Roadway Surveying" shall be full pay for all labor,  
 49 equipment, materials, and supervision utilized to perform the work specified, including

| DRAFT

- 1 any resurveying, checking, correction of errors, replacement of missing or damaged
- 2 stakes, and coordination efforts.