
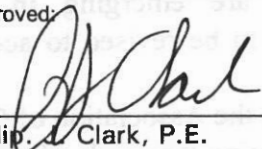


To: SUPERSEDED BY EI 09-031 EFFECTIVE 5/06/10		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 06-007
Title: REVISION TO STANDARD SPECIFICATIONS: SECTION 105-10, SURVEY AND STAKEOUT; SECTION 625, SURVEY OPERATIONS, ROW MARKERS & PERMANENT SURVEY MARKERS			
Distribution: <input type="checkbox"/> Manufacturers (18) <input checked="" type="checkbox"/> Local Govt. (31) <input checked="" type="checkbox"/> Agencies (32) <input checked="" type="checkbox"/> Surveyors (33) <input checked="" type="checkbox"/> Consultants (34) <input checked="" type="checkbox"/> Contractors (39) <input type="checkbox"/> _____ ()	Approved:  Philip Clark, P.E. Deputy Chief Engineer, Design Date: 04/03/06		

ADMINISTRATIVE INFORMATION:

- **Effective Date.** This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of September 7, 2006.
- **Superseded Issuances.** This EI does supersede a portion (Section 105-10) of EI 05-011, which modified Section 100 of the 2002 Standard Specifications.
- **Disposition of Issued Material.** The guidance transmitted in this EI will be incorporated into a future revision of the Standard Specifications.

PURPOSE: The purpose of this EI is to revise the subject specifications and incorporate the use of new technologies into the construction of Capital Projects.

TECHNICAL INFORMATION: The transmitted materials modify the Standard Specification Sections 105-10 and 625 as follows:

- Section 105-10 This specification is revised to incorporate surveying parameters and standards for quality control of positioning terrain data, and provide guidance on the appropriate interpretation of terrain data provided in contract documents.
- Section 625 This specification is revised as follows:
 - To incorporate the use of new survey and automated equipment operations.
 - To require the sharing of electronic engineering data, when available, between the Contractor and Department.
 - To clarify which survey operations require direct oversight by a licensed Land Surveyor or Professional Engineer.
 - To require the submission of a Contract Control Plan at the beginning of a construction contract which describes what control will be jointly used by the Contractor and the Department for the construction of the contract. The Contract Control Plan is intended to document which control points, datum, correction factors, and stakeout methods will be used in the field prior to beginning operations.
 - To standardize engineering data processing and formats to promote sharing of that data between all stakeholders.
 - To incorporate the use of CADD applications in the field for modeling construction features, determining potential conflicts, and calculating quantities.

IMPLEMENTATION:

- The Main Office Design Quality Assurance Bureau will insert these two standard specification shelf notes beginning with projects submitted for the letting of September 7, 2006.

TRANSMITTED MATERIALS:

- Standard Specifications shelf notes of the revised *Section 105-10 Survey & Stakeout*, and *Section 625 Survey Operations, Row Markers & Permanent Survey Marker*.

BACKGROUND:

- New technologies are emerging in the construction industry and NYSDOT Standard Specifications need to be revised to accommodate methods which leverage these new systems and operations.
- The Department and the Association of General Contractors (AGC) have a joint committee which is focused on addressing the needs of emerging technologies. Many of these changes have come about through the discussions of this committee.

CONTACT: Direct questions regarding this EI to Dan Streett of the Design Services Bureau at (518) 485-8227 (e-mail dstreett@dot.state.ny.us).

REVISIONS TO SECTION 105-10, SURVEY AND STAKEOUT

Make the following changes to the Standard Specifications dated January 2, 2002, and as modified by EI 05-011: delete Section 105-10 entirely and add the following:

105-10 SURVEY AND STAKEOUT. Prior to the start of construction work, all right of way markers, property line markers and survey control markers located in or adjacent to areas which may be disturbed during construction shall be properly protected and tied to fixed reference points or located from established contract control. Upon completion of the work, all right of way or property line markers or survey markers that have been disturbed by the Contractor, shall be reset under the direction of a Land Surveyor. Field location notes shall be recorded and made available to the Engineer upon request at no additional cost to the State.

All survey control and boundary location work shall be performed in accordance with the Department's *Land Surveying Standards and Procedures Manual* under the direction of a Land Surveyor.

All survey work performed for quality control by the Contractor and for quality assurance by the Department should both utilize: (1) similar levels of measurement precision and methods to perform positional measurements, (2) the same control network from which measurements are made, and (3) the same survey measurement procedures to ensure consistency of results.

Terrain features are measured and positioned by various methods relative to the contract control network established for each contract. The precision with which an instrument or equipment positions a point is related to the quality of the method by which measurements are made, and the ability to duplicate the same measurement. The accuracy of a located point is the closeness of the measured or computed value to a standard or accepted value (actual spatial position on the earth). Positional tolerance is the allowable spatial difference between making measurements by two different methods or by the same method at separate times, all of which have the same level of precision.

Horizontal coordinates and vertical elevations of existing features provided in contract documents are located in the field based on accuracies achievable for each positional point relative to the contract control. Positional accuracies are directly related to the strength of the contract control network closure, the precision of the instruments used to measure to the feature, and how definable the feature is which is being located. Point feature locations represent a single position (for example: property line marker, sign post, utility pole, or fire hydrant) and can be reidentified or verified in the field to within a small variation (high confidence level) from where they were initially positioned. Linear feature locations define the alignment position of that feature. That alignment can be verified to within a specific tolerance depending on the spacing or frequency at which the points were originally measured to define that alignment. Straight or uniformly curved linear features (for example: curblines, edge of roadway, or edge of sidewalk) which can be easily defined in the field should have a relatively small positional variation from their coordinated position when compared to a verified field location. Irregular shaped or not as clearly defined linear features (for example: break lines, ditchlines, treelines, or environmental area perimeters) which are sometimes difficult to define or delineate precisely in the field, could have a larger variation from where they were initially positioned when compared to a field-verified location.

Digital terrain model (DTM) surfaces which are provided in the contract documents are made up of a combination of point and linear features used to produce a DTM surface. The precision of a data collection instrument does not necessarily indicate what positional tolerance should be expected of any feature verified from an existing DTM. The location or elevation of a feature selected from a DTM surface can, at best, be determined by interpolating the horizontal position or elevation between previously positioned points. The verification of any specific elevation on the DTM surface is directly related to: (1) the spacing of collected data used to produce that surface; (2) the uniformity of the surface being measured; (3) the steepness of the slope of that surface; and (4) how obscured the surface is from the measuring technique used to originally locate the surface. Standardized procedures for determining the spacing/frequency of point and linear features (including break lines), are critical to providing consistent results. Department standardized procedures for determining feature locations are described in both the "Land Surveying Standards and Procedures Manual," and the "Specifications for Photogrammetric Stereocompilation."

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Any true verification of the positional tolerance of the DTM surface elevation shall require a comparison of the original collected point data with recollected point data which are measured at the same horizontal locations. Field comparisons to interpolated DTM surfaces or recreated surface information (from paper drawings) shall not be used for verification of the positional tolerance of a feature. Comparisons of remeasured point data can only be made with the original collected point data, not to interpolated positions. Measurements for verification of DTM point data shall also be made from the same contract control network, and by instruments capable of an equal or greater precision.

REVISIONS TO SECTION 625, SURVEY OPERATIONS, ROW MARKERS & PERMANENT SURVEY MARKERS

Make the following changes to Volume II of the Standard Specifications dated January 2, 2002:
page 6-117, line 39 through page 6-122, line 11, ~~delete~~ entirely and **add** the following:

SECTION 625 - SURVEY OPERATIONS, ROW MARKERS, AND PERMANENT SURVEY MARKERS

625-1 DESCRIPTION

625-1.01 Survey Operations. This work shall consist of providing all necessary surveying to establish, spatially position, measure, navigate to and verify the locations of existing and proposed terrain features and measure quantities of items in accordance with the contract documents or as directed by the Engineer. This work includes but is not limited to the establishment or reestablishment of primary and secondary control, the stakeout of proposed features or the initialization and navigation of automated equipment operations, the location or verification of existing terrain or of constructed features, and the coordination and sharing of engineering data with the Department or other contract stakeholders.

625-1.02 Right of Way Markers. This work shall consist of furnishing, installing and certifying right of way markers at the specific positions described on the right of way appropriation maps, and in accordance with the details shown on the appropriate Standard Sheet.

625-1.03 Permanent Survey Markers. This work shall consist of furnishing, installing, and certifying permanent survey markers in accordance with the details shown on the appropriate Standard Sheet.

625-2 MATERIALS

625-2.01 Survey Operations. None specified

625-2.02 Concrete Right of Way Markers. Concrete right of way markers shall conform to the requirements of §712-05 *Precast Concrete Right-of-Way Markers*, and shall be in accordance with the details shown on the appropriate Standard Sheet.

625-2.03 Steel Pin and Cap Right of Way Markers. Reinforcing steel used for the shank shall conform to ASTM A615, Grade 300 or Grade 420. It shall be epoxy coated for its entire length in accordance with the coating application requirements of §705-14 *Longitudinal Joint Ties* or §709-04 *Epoxy Coated Bar Reinforcement*.

The cap shall be aluminum or a corrosion resistant aluminum alloy. The cap shall weigh a minimum of 50 grams and fasten to the shank by means of threading or force fitting.

A commercial grade silicone sealant shall be used between the cap and the shank. All aluminum or aluminum alloy surfaces to be in contact with cement concrete shall be coated with Zinc Chromate Primer meeting the requirements of §708-04 or an alternate material approved by the Materials Bureau.

Steel Pin and Cap-Type Markers shall be anchored into rock using Concrete Grouting Material meeting the requirements of §701-05.

625-2.04 Permanent Survey Markers. The concrete shall meet the requirements of Class A Concrete in Section 501 *Portland Cement Concrete--General*, except that the requirements for inspection facilities, automated batching controls and recordation do not apply. The batching, mixing and curing methods, and the inspection facilities shall meet the approval of the Department. The Contractor may submit for approval by Director, Materials Bureau, a mix at least equivalent to the specified Class A Concrete.

REVISIONS TO SECTION 625, SURVEY OPERATIONS, ROW MARKERS & PERMANENT SURVEY MARKERS

625-3 CONSTRUCTION DETAILS

The following types of Survey Operations shall be completed under the direction of a Land Surveyor. This requirement is directly or indirectly associated with the professional license requirements contained in Article 145 of the NYS Education Law.

1. Establishment or reestablishment of primary or secondary control which shall be used for:
 - a. Establishing boundaries of new right of way appropriated for this contract.
 - b. Location of property or highway boundary markers.
 - c. Tie measurements to, or resetting of control points.
2. Location or resetting of existing highway and property boundary markers by reference ties to or from contract control to protect their integrity.
3. Establishment or certification of location of right of way markers and permanent survey markers.

The following types of Survey Operations shall be completed under the direction of either a Land Surveyor or Professional Engineer:

1. Establishment or reestablishment of primary or secondary control which shall be used for:
 - a. Establishing location for horizontal or vertical roadway alignment.
 - b. Establishing location for the horizontal or vertical alignment of a structure.
 - c. Establishing reference station for Global Positioning System (GPS) control work.
2. Establishing new horizontal or vertical roadway alignment in the field from contract control either by conventional stakeout methods or by use of automated equipment operations.

Contract Control Plan – The Contractor shall develop and submit a Contract Control Plan for all contracts which include the *Contract Pay Item 625.01 Survey Operations*. Contract control includes all primary and secondary horizontal and vertical control which will be used for the construction of the contract. Upon the Contractor's completion of initial survey reconnaissance and control verification, but prior to beginning primary field operations, the Contractor shall submit a Contract Control Plan document (signed and sealed by the Land Surveyor or Professional Engineer who oversees its preparation) for acceptance by the Engineer which includes:

1. A control network diagram of all existing horizontal and vertical control recovered in the field as contract control.
2. Include a summary of the calculated closures of the existing control network, and which control has been determined to have been disturbed or out of tolerance from its original positioning.
3. An explanation of which horizontal and vertical control points will be held for construction purposes (include a NYSPCS coordinate list). If necessary, include all adjustments which may have been made to achieve required closures.
4. An explanation of what additional horizontal and vertical control (including base stations) was set to accomplish the required stakeout or automated machine operations. Include how the position of these new control points was determined.
5. Describe the proposed method and technique (technology and quality control) for utilizing the control to establish the existing and/or proposed feature locations and to verify the completed feature location and/or measured quantity.
6. A listing of the horizontal and vertical datums to be used, the NYS Plane Coordinate System (NYSPCS) zone, and the combined factor to be used to account for the ellipsoidal reduction factor and the grid scale factor.

REVISIONS TO SECTION 625, SURVEY OPERATIONS, ROW MARKERS & PERMANENT SURVEY MARKERS

7. If the NYS Continuously Operating Reference Stations (CORS) Network was used to establish the initial control for the design of this contract, or if the Contractor proposes to use CORS with any construction operation, the survey reconnaissance and control verification shall include verifying the contract control against at least two NYS CORS Stations, and reporting the accuracy results in the contract control plan.
8. If the Contractor chooses to use automated machine operations as a method for measuring and controlling excavation, fill, material placement or grading operations, the Contract Control Plan shall include the method by which the automated machine guidance system will initially be site calibrated to both the horizontal and vertical contract control, and shall describe the method and frequency of the calibrations to ensure consistent positional results.

All establishment or reestablishment of contract primary or secondary control shall be done in accordance with the Department's "*Land Surveying Standards and Procedures Manual*."

625-3.01 Survey Operations. All available contract control, alignment or terrain data to be used to establish, position, measure, guide and verify the locations and quantities of existing and proposed features for the contract, will be managed and stored by the Department and shared electronically with the Contractor.

Survey Operations shall utilize: *A. Conventional Survey Stakeout* or *B. Automated Machine Operations*, or a combination of both, for the establishment, positioning, equipment guidance or verification of features. The proposed method shall be approved by the Engineer as part of the Contract Control Plan prior to beginning any field construction operations. Both methods include the same basic requirements that: (1) both parties (Contractor and Department) utilize the same contract control, the same existing terrain data, and the same proposed feature data; (2) both parties utilize the same accuracy and tolerance limits; and (3) both parties utilize equivalent survey verification techniques to ensure that field features are constructed as designed.

After completion of the work, the Contractor shall reestablish and retie the contract control points as described in the Department's current "*Land Surveying Standards and Procedures Manual*."

If an existing Digital Terrain Model (DTM) was developed during design and provided for construction purposes, and possibly updated during construction by supplemental survey, the Department will use that information to develop contract pay item quantities. If a proposed Digital Terrain Model (DTM) was developed during design and provided for construction purposes, or revised during construction due to site changes or redesign, the Department may use that information to develop applicable contract pay item quantities. If the Contractor does not agree with any of the information used, it may verify all or any portion of the existing or proposed DTM, at no additional cost to the State. All exceptions/changes to the supplied existing terrain data shall be brought immediately to the attention of the Engineer, in writing, and terrain data modifications shall be mutually agreed upon prior to beginning construction activities within the area(s) being modified. All existing terrain data supplied by the Department shall be considered as being within acceptable tolerances, except where changes or additions have been approved by the Engineer. Terrain data (DTM) changes will not be accepted by the Department where existing terrain is verified to be within Departmental accepted positional tolerances.

If a proposed Digital Terrain Model (DTM) was not developed, the Department may use line and grade information contained in the contract documents, in conjunction with the original ground survey plus any supplemental survey it collected, to develop contract pay item quantities. If the Contractor does not agree with any of the information used, it may verify all or any portion of the information, at no additional cost to the State.

The Contractor shall establish the center line of bearings for bridge abutments and piers, by setting offset hubs or reference points, so located and protected to ensure they remain undisturbed until such time as they are no longer needed. The Contractor shall mark the location of anchor bolts to be installed, establish the elevation of bearing surfaces and check bearing plates to ensure installation at their proper elevation. Before the erection of structural steel the Contractor shall verify the locations, both vertically and horizontally, of all bearings.

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A. Conventional Survey Stakeout. The field location of all features to be constructed shall be established from survey control points which were identified in the Contract Control Plan. Any error, apparent discrepancy or absence in the data shown or required to appropriately accomplish the stakeout survey shall be referred to the Engineer immediately for interpretation when such is observed or required.

The Contractor shall place two offset stakes or reference points along the center line at maximum intervals of 20 meters and at such intermediate locations as required to determine location and direction. From computations and measurements made by the Contractor, these stakes shall be clearly and legibly marked with the center line station number, offset and cut or fill from which the establishment of the centerline location and elevation can be determined. If markings become illegible for any reason the markings shall be restored by the Contractor. The Contractor shall locate and place all cut, fill, slope, fine grade, or other stakes and points for the proper progress of the work (maximum station spacing of 20 meters). All control points shall be properly protected and flagged for easy identification.

The Contractor shall be responsible for the accuracy of the work and shall maintain all applicable reference points, stakes, etc. Damaged or destroyed reference points or bench marks made inaccessible by the progress of the construction shall be replaced or transferred by the Contractor. All control points shall be referenced by ties (4 minimum) to specific points on acceptable objects and recorded. Any alterations or revisions in the ties shall be so noted and the information furnished to the Engineer. All stakeout survey work related to highway control shall be referenced to the control line shown in the contract documents. Computations and survey notes necessary to establish the position of the work from control points, shall be made and maintained in a neat, legible and acceptable format by the Contractor. Computations, survey notes and other survey information shall be made available to the Engineer within 3 days from the request. The Engineer may check all or any portion of the stakeout survey work or notes made by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of the work.

B. Automated Machine Operations. The Contractor may choose an automated method for the establishment, layout, measurement, equipment guidance or verification of work to be constructed. Under this method, all horizontal and vertical control, alignment control, existing terrain data and proposed design data shall be shared/exchanged electronically and kept current between the Contractor and the Engineer. All original active files of electronic contract data shall be maintained and stored by the Department. Prior to beginning field operations, the Contractor and Engineer shall mutually determine acceptable uses of and procedures for the technology being used, and how data can be exchanged for use in stakeout, automated equipment operations, verification and quantity calculations. All engineering data shall be stored and shared in Department standard formats, and shall be derived primarily from the original electronic data provided by the Department.

Automated equipment operations have a high reliance on accurate control networks from which to take measurements, establish positions, and verify locations of features. Therefore, a strong contract control network in the field which is the same or is strongly integrated with the project control used during the design of the contract is essential to the successful use of this technology with the proposed Digital Terrain Model (DTM). Consistent and well designed site calibration for all automated machine operations (as described above under *Contract Control Plan*) are required to ensure the quality of the contract deliverables. The Contract Control Plan is intended to document which horizontal and vertical control will be held for these operations. Continued incorporation of NYS CORS Stations (if included in the initial project control) is essential to maintaining the integrity of positional locations and elevations of features.

The Engineer may perform quality assurance verifications of feature positions and elevations at any time during the contract. Dimensional tolerances shall hold a higher order of importance than positional tolerances, but both may require verification. Quality assurance activities by the Engineer will not relieve the Contractor of any responsibilities for the quality control of the accuracy or completeness of the work.

Verification of the positional locations of features, calculation and creation of supplemental DTM

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surfaces, and the measurement and calculation of quantities shall be developed through the use of Department standard CADD software. Both the Contractor and the Department shall utilize the following standards: (1) All CADD alignment and land boundary data shall be processed using the Department's standard CADD software. (2) All terrain data collected for the purpose of being used for or merged with Department provided terrain data and/or for the calculation of pay quantities shall be formatted and displayed in accordance with the current "*CADD Standards and Procedure Manual*." (3) Field data collection and DTM creation shall be in accordance with procedures required in the current "*Land Surveying Standards and Procedures Manual*." (4) The Department will maintain electronic data files for access by the Contractor using the Department's designated file management system. This will ensure that both parties utilize the same credible data from which to establish locations and measure quantities. The Department will provide all available CADD resource files for use by the Contractor.

The Contractor may choose to introduce an additional new automated method which involves a different technique for positioning features, measuring quantities, or verifying constructed locations. The quality and accuracy of this data produced by this method shall be demonstrated to the Engineer, for acceptance, by a comparison of this method to previously accepted techniques over a mutually agreed upon portion of the work. The new technology shall meet or exceed the quality and accuracy results provided by previously accepted techniques, and the Engineer shall make the final determination as to the acceptability of its use based on the performance, cost savings, and effectiveness of the operation. Previous uses of this same method on other contracts or by other contractors are not acceptable evidence of a technology's viability, due to inherent variations in operator's experience levels, data availability, changing field conditions and differing technologies.

625-3.02 Right of Way Markers. The Contractor shall verify with the Engineer that it has the most current vested Right of Way Acquisition Maps to determine the locations of the proposed right of way markers.

Right of way marker locations shall be determined under the direction of a Land Surveyor from a closed traverse or GPS network which is included in the contract control plan and in accordance with Federal Geographic Data Committee (FGCC) C2-II, Second-Order, Class II (1 part in 20,000) accuracy, ensuring a local positional accuracy of 20 mm as described in the Department's "*Land Surveying Standards and Procedures Manual*."

The Contractor shall install right of way markers at the station/offset positions specified on the vested Right of Way Acquisition Maps in accordance with the Standard Sheets to within an absolute positional tolerance of 20 mm.

The Land Surveyor shall certify the as-built location of each installed right of way marker on certification forms provided by the Engineer, including contract information, and control line station and offset (proposed and as-built) to the marker. The record location of all right of way markers shall be recorded to the nearest millimeter and reflect as-built coordinates from a closed traverse or GPS network which is included in the contract control plan and in accordance with FGCC C2-II, Second-Order, Class II (1 part in 20,000) accuracy.

Prior to placing the cap on a steel pin right of way marker, the cap shall be filled 2/3 full of silicone sealant and then fastened to the bar by threading or by force fit. During the driving operation for the steel pin right of way marker, the lettering on the cap shall be protected by the use of a metal sleeve or cushion block. The marker shall be driven so that the cap is flush with the ground surface.

625-3.03 Permanent Survey Markers. Permanent survey markers shall be installed in accordance with the standard sheet at locations described in the contract documents and approved by the Engineer prior to installation. The sequential numbering required on the permanent survey marker caps shall be coordinated with the Engineer and the Regional Land Surveyor.

The Land Surveyor shall certify the as-built location of each installed permanent survey marker on certification forms provided by the Engineer, including contract information, as-built State Plane Coordinate values, control line and centerline station and offset to the marker, distance and direction to adjacent markers, the elevation of the marker, and a sketch which shows the relative positions to the control line points, four physical ties to the

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markers, and a north arrow. The record location of all permanent survey markers shall be recorded to the nearest millimeter and reflect as-built coordinates from a closed traverse or GPS network which is included in the contract control plan and in accordance with FGCC C2-II, Second-Order, Class II (1 part in 20,000) accuracy as described in the Department's "Land Surveying Standards and Procedures Manual."

625-4 METHOD OF MEASUREMENT

625-4.01 Survey Operations. This work will be measured on a lump sum basis.

625-4.02 Right of Way Markers. The quantity to be measured for payment will be the number of right of way markers installed.

625-4.03 Permanent Survey Markers. The quantity to be measured for payment will be the number of permanent survey markers installed.

625-5 BASIS OF PAYMENT

625-5.01 Survey Operations. The price bid shall include the cost of furnishing all labor, materials and equipment necessary to satisfactorily complete the work. Progress payments will be made in proportion to the amount of work completed as determined by the Engineer.

625-5.02 Right of Way Markers. The unit price bid per each shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work. Payment will be made upon the complete and proper installation of the marker, receipt of the certification form by the Engineer, and approval of the certification by the Regional Land Surveyor.

625-5.03 Permanent Survey Markers. The unit price bid per each shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work. Payment will be made upon the complete and proper installation of the marker, receipt of the certification form by the Engineer, and approval of the certification by the Regional Land Surveyor.

Payment will be made under:

Item No.	Item	Pay Unit
625.01	Survey Operations	Lump Sum
625.03	Concrete Right of Way Markers Type H (High)	Each
625.04	Concrete Right of Way Markers Type L (Low)	Each
625.05	Steel Pin and Cap Right of Way Markers	Each
625.06	Permanent Survey Markers	Each