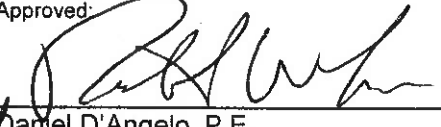


SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 09-031
Title: REVISION TO STANDARD SPECIFICATIONS: SECTION 625 SURVEY OPERATIONS			
Distribution: ☐ Manufacturers (18) ☒ Local Govt. (31) ☒ Agencies (32) ☒ Surveyors (33) ☒ Consultants (34) ☒ Contractors (39) ☐ _____ ()		Approved:  Daniel D'Angelo, P.E. Deputy Chief Engineer, Design Date <u>12/15/09</u>	

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of 5/6/2010.
- This EI supersedes EI 06-007.
- This revision will be incorporated into a future update of the Standard Specifications.

PURPOSE: The purpose of this EI is to issue a revised Standard Specifications Section 625 *Survey Operations*.

TECHNICAL INFORMATION:

This EI is being issued concurrently with EI 09-030 *Revision to Standard Specifications: §105-10 Survey and Stakeout*.

Section 625 is revised as follows:

- Requirements were added which call for the Contractor's review and verification of proposed digital terrain model, when provided, prior to beginning of field operations.
- Supplemental Site Survey was added to survey and map the existing terrain where the site locations are to be determined after award (such as for some signal installations); or to supplement existing terrain mapping where the previously surveyed areas have significantly changed in the field, or there is a need to record/map as-built or field recovered locations of underground utilities.
- Supplemental Site Survey shall not be used to pay for checking previous surveys, such as Contractor verification of existing terrain surface.
- GPS Inspection Units items for GPS Rovers were added for inspectors to use for locating or verifying positions, and for quantity measurements in the field.

IMPLEMENTATION:

The Main Office Design Quality Assurance Bureau will insert the standard specification shelf note into proposals beginning with projects submitted for the letting of 5/6/2010.

- The following Special Specifications in both Metric and US Customary are disapproved:
 625.1001nn01 Survey Grade GPS Unit
 625.1001nn03 Survey Grade GPS Unit
 625.1002nn01 Mapping Grade GPS Unit
 625.1002nn03 Mapping Grade GPS Unit
- The following three new standard specification items in both Metric and US Customary are approved:
 625.07nnnn Supplemental Site Survey
 625.11nnnn Survey Grade GPS Inspection Unit
 625.12nnnn Mapping Grade GPS Inspection Unit

TRANSMITTED MATERIALS:

- Standard Specifications shelf note *Survey Operations* in Metric and US Customary units

BACKGROUND:

New types of survey related technologies are changing the construction industry's field operations. Most project related work is laid out or geospatially positioned in the field using automated technology rather than traditional survey methods. The revision allows supplemental site survey services after contract award. These services are needed to augment available resources for site specific situations which are identified after contract award.

Tools used for inspection of capital projects are advancing the efficiency and accuracy of construction inspection operations. GPS provides Inspectors with the ability to independently verify geospatial positions without dependence on contractor control, and also inspect and measure quantities of completed work at a much faster rate with fewer staff and with greater accuracy compared with traditional survey hand-tool methods.

CONTACT: Direct questions regarding this EI to Steve Roden of the Design Services Bureau at (518) 485-1385 (e-mail: sroden@dot.state.ny.us).

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Make the following changes to the Standard Specifications dated May 4, 2006:
Page 591 - 595, **Delete** Section 625 in its entirety and **Replace** it with the following:

SECTION 625 - SURVEY OPERATIONS

625-1 DESCRIPTION

625-1.01 General.

Some survey work is required be completed under the direction of a Land Surveyor or Professional Engineer in accordance with the professional license requirements contained in NYS Education Law.

625-1.02 Survey Operations.

This work shall consist of providing all necessary survey work to establish, spatially position, 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, reestablishment or localization of primary and secondary control, the stakeout or layout of proposed features, the initialization, calibration and navigation of automated equipment operations, the location or verification of existing terrain or of constructed features, the verification of geospatial data for proposed construction work and the coordination and sharing of engineering data with the Department or other contract stakeholders.

625-1.03 Right of Way Markers.

This work shall consist of furnishing, installing and certifying right of way markers at the positions described on the right of way appropriation maps, in accordance with the contract documents and the Standard Sheet.

625-1.04 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.

625-1.05 Supplemental Site Survey.

This work shall consist of providing all necessary field survey and terrain mapping necessary to locate, spatially position, verify and digitally map the locations of existing above or below ground terrain features as described in the contract documents or as directed by the Engineer. The limits of this supplemental survey will be described in the contract documents.

625-1.06 GPS Inspection Units.

This work shall consist of furnishing, configuring, installing, maintaining and removing Global Positioning System (GPS) units as needed for use by the Engineer and their inspection staff, including the training of the Engineer and their representatives on the use of the GPS units provided.

625-2 MATERIALS

625-2.01 General. None specified.

625-2.02 Survey Operations. None specified.

625-2.03 Right of Way Markers.

A. Concrete Right of Way Markers.

Concrete ROW 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 Standard Sheet.

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

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 Class A Concrete.

625-2.05 Supplemental Site Survey. None specified.

625-2.06 GPS Inspection Units.

Each GPS Unit shall include all necessary components, communication devices, integrated antennae and receiver, controller and/or data collector, cables, software, operating manuals, attachments, and fastening hardware to meet the minimum requirements described below.

A. All GPS Inspection Units.

1. All GPS units provided for a single contract shall be of the same model and manufacturer; and shall include, and be licensed to operate, the same versions of GPS planning software, data collection software, navigation software, stakeout software and post processing software. All software provided (including firmware) shall be the most current available from the manufacturer at the time of delivery of the GPS units. GPS units should be of the same manufacturer as those used by the Contractor. GPS units shall not be more than 2 years old from the date of manufacturing to the time of delivery. To verify the age of the GPS units, the Contractor shall provide a dated copy of the manufacturer's receipt(s) for the purchase, lease or rental of the units.
2. GPS units shall include both standard USB cable and Bluetooth wireless technology for data transfer.
3. Data shall be capable of being copied onto or from a removable industry standard data storage card (eg: secure digital SD Card). Each GPS Unit shall include 2 data storage cards, each with a minimum capacity of 4 GB.
4. GPS units shall include the ability to import/export and display point and alignment data which is in XML format, and also import graphics files which are in DGN or DXF format.
5. GPS units shall have an internal, or modular, rechargeable battery system capable of operating a minimum of 8 hours (may include interchangeable batteries), including the battery charger.
6. GPS units shall include a hard or soft shell carry case, and all appropriate operation manuals.

B. Survey Grade GPS Inspection Units.

1. GPS units shall be equipped to receive Global Positioning System (GPS), GLONASS and GNSS position data.
2. GPS units shall be equipped to receive, and be capable of utilizing, Real Time Kinematics (RTK) correctional data (current version of RTCM format) through internet protocol as provided from the NYS Continuously Operating Reference System (NYS CORS) Network. This shall include all necessary communication devices, repeaters and systems, data service plans and

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communications to meet the minimum required accuracy and not exceed a 2 second latency at the rover. Whichever communication method is utilized by the Contractor to broadcast the NYS CORS RTK correctional data, the Contractor shall ensure that the RTK data shall be available at all locations across the entire contract site during all hours of construction and inspection operations.

3. GPS units shall include the capability to "localize" both the horizontal and vertical control to local project monumentation (also known as calibrate), while utilizing RTK corrections from a reference network.
4. GPS units shall include either an integrated or modular communication device capable of receiving RTK correctional data to satisfy the requirement of using NYS CORS RTK corrections.
5. GPS units shall have the ability to display the number of satellites tracked at any one time, and indicate the accuracy quality of each measurement relative to the strength of signals, and the GDOP (Geometric Dilution of Precision).
6. GPS Unit shall include dual frequency receivers.
7. Minimum Required Kinematic Accuracy relative to primary project control (CORS): Horizontal: 10mm + 1.0 ppm; Vertical: 20mm + 1.0 ppm
8. All necessary hardware and software shall be included (including communication drivers) to connect the GPS unit to a Department provided Tablet PC and communicate/exchange positional data with Bentley™ OnSite software. Firmware used on the GPS unit shall be verified as interoperable with Bentley™ OnSite software. If the firmware cannot be verified as being interoperable with Bentley™ OnSite, the next older version may be used.
9. The data controller shall permit the user to program and store multiple configurations (also known as user preferences) prior to the actual field measurements. Configurations shall be capable of being stored and recalled in the field.
10. GPS units shall include one fixed height rover rod of 2.0 m in length, one attachable bipod which is compatible with the rover rod, and one topo shoe.
11. A GPS unit set up to operate as a base station shall include all necessary additional cables, hardware, fasteners or accessories necessary to install it in a fixed semi-permanent location, . will not be considered as a rover unit, and therefore will not require a rover rod, a bi-pod, or a topo shoe.

C. Mapping Grade GPS Inspection Units.

1. Minimum Required Kinematic Accuracy: less than 1.0 m in real time.
2. GPS units shall also provide standard support for the Wide Area Augmentation System (WAAS) position correction services.

625-3 CONSTRUCTION DETAILS

625-3.01 General.

A. Professional Responsibilities.

The following types of Survey Operations shall be completed by the Contractor 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, reestablishment or localization of primary or secondary control which shall be used for:

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- 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 by the Contractor under the direction of either a Land Surveyor or Professional Engineer.

1. Establishment, reestablishment or localization 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 or localizing reference base 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.

B. Survey/Engineering Geospatial Data.

All establishments or reestablishment of contract primary or secondary control, and the survey collection of terrain data shall be performed in accordance with the standards and procedures required in the Department's *Land Surveying Standards and Procedures Manual*. The Contractor shall incorporate the NYS CORS network into contract control to facilitate the use of GPS survey within the site and on the same datum by other project stakeholders, or to align with other adjacent projects.

When the Department provides electronic copies of engineering data to the Contractor, files should follow the standard file naming conventions listed in Appendix 14 of the Department's *Project Development Manual*.

1. Existing Terrain Data. When an existing digital terrain model was developed during design and provided for construction purposes, and possibly updated during construction by supplemental survey, the Department and Contractor shall use that information as a basis from which to develop contract pay item quantities. The Contractor shall consider all existing terrain data supplied by the Department as being within acceptable tolerances, except where changes or additions have been approved by the Engineer. If the Contractor questions the accuracy of the existing terrain data provided, the Contractor may verify any or all portion(s) of the existing terrain model, at no additional cost to the State, in accordance with §105-10 *Survey and Stakeout*. All exceptions or discrepancies found with the supplied existing terrain data shall be brought to the attention of the Engineer, in writing, and terrain data modifications shall be mutually agreed upon and shared with both parties prior to beginning construction operations within those areas being modified. Changes to existing terrain data will not be accepted by the Department where existing terrain is verified to be within Departmental accepted positional tolerances in accordance with the Department's *Land Surveying Standards and Procedures Manual*, or after the Contractor has disturbed the existing ground surface.

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2. Proposed Data. When proposed digital terrain models (or surfaces), proposed alignments and proposed graphics were developed during design and provided for construction purposes, or revised during construction due to site changes or redesign, the Department and Contractor shall use that information from which to position and compute applicable contract pay item quantities and to field verify positional locations of constructed items. When the Contractor and Department agree to utilize the proposed digital terrain data (surface), alignments or graphics the Contractor shall first review its consistency with all other contract information, and review for any perceived physical conflicts or inconsistencies of information prior to using the data in the field for any construction purpose. All exceptions or discrepancies with the supplied data shall be brought to the attention of the Engineer, in writing, and terrain data, alignment or graphics modifications shall be approved by the Engineer prior to beginning construction operations within those areas being modified. All approved changes shall be shared electronically with both the Department and the Contractor, and both parties shall acknowledge acceptance of such changes before beginning the work.

When proposed digital terrain model (or surfaces), alignments or graphics are not provided by the Department, the Contractor may choose to develop their own terrain model surfaces from the contract plans to facilitate their use of Automated Machine Guidance, at no additional cost to the State. A request by the Contractor to use Automated Machine Guidance shall be made as part of the Contract Control Plan. The Contractor developed terrain model surfaces shall be shared with the Engineer in a Department accepted format prior to beginning construction operations. Generation of proposed terrain model surfaces or other electronic engineering data does not constitute a redesign of the project, and the Contractor retains all responsibility to complete the work in accordance with the engineering intent conveyed in the contract documents unless otherwise agreed to in writing by the Engineer.

625-3.02 Survey Operations.

All Survey Operations shall follow either Traditional *Survey Stakeout* or Automated Stakeout and *Automated Machine Guidance Operations*, or a combination of both, for the establishment, positioning, equipment guidance or verification of construction items. 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 proposed.

The Contractor shall establish the center line of bearings for all 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 or concrete beams the Contractor shall verify the locations, both vertically and horizontally, of all bearings and the distances between associated bearings. Control used to establish center line of bearings shall be included in the contract control plan.

On contracts which include proposed and existing roadway alignments and profiles, the Contractor shall verify the roadway tie-in locations of where existing and proposed alignments meet prior to beginning construction operations and report the results to the Engineer. This requirement is intended to verify that no changes have occurred to the existing roadway and that the proposed design is buildable as designed.

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A. Contract Control Plan.

The Contractor shall develop and submit a Contract Control Plan for all contracts which include the contract pay item for Survey Operations. Contract control includes all statewide or local primary and secondary horizontal and vertical control which will be used for the geospatial positioning of work items. 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 which is to be signed and sealed by a Land Surveyor or Professional Engineer in accordance with §625-3.01.A *Professional Responsibilities*, for acceptance by the Engineer. The Contract Control Plan shall include the below listed required control information and follow the acceptance procedure.

All revisions or additions to contract control for the purpose of stakeout or layout of proposed work items shall be provided in writing to the Engineer prior to beginning that revised portion of stakeout or layout work.

1. Acceptance Procedure.

- a. The Contractor shall document required information and submit electronically to the Engineer at least 10 work days prior to beginning field operations.
- b. The Engineer will coordinate review with the Regional Land Surveyor and provide comments.
- c. Upon acceptance of the procedure by the Engineer, the Contractor shall submit 2 signed and sealed copies to the Engineer.

2. Control Information.

The Contractor shall list the following control information (tabular format is acceptable):

- a. All contract control shown in the contract documents or in the Survey Control Report.
Note: The NYS CORS Network provides primary control for most Department contracts.
- b. The following elements shall be submitted for all contract control points or benchmarks:
 - (1) Recovered in the field and did it appear undisturbed?
 - (2) Contract indicated coordinate or elevation.
 - (3) Field determined coordinate or elevation.
 - (4) Contractor adjusted coordinate or elevation, if necessary.
 - (5) Point or benchmark intended to be used for construction purposes.
- c. Adjustment method is used to balance or adjust the control (ex: Compass Rule for Baseline or Calibration Report for GPS, etc). Attach a copy of the adjustment/calibration report.
- d. Control network diagram (drawn to a legible scale) with roadways indicated.
- e. New York State Plane Coordinate System (NYSPCS) Zone utilized.
- f. Horizontal Datum used.
- g. Vertical Datum used.
- h. Combined Factor used to account for the ellipsoidal reduction factor and the grid scale factor.
- i. Additional (new) control is anticipated to be needed and where will they be set?
- j. When a GPS base station(s) is utilized on a project either for inspection or stakeout, provide the determined coordinate and elevation value of the station, and the datum differential from that localized value to a NYS CORS determined value.

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3. Methods or Procedures.

The Contractor shall document and provide the following survey information on methods or procedures to be used:

- a. Survey method used to verify the control (ex: Total Station, GPS/RTK, Auto Level, etc).
- b. Survey method(s) used to stakeout which types of proposed features.
- c. Survey method(s) used to stakeout proposed ROW Markers.
- d. Survey method used for stakeout of proposed bridge structures (if applicable). How will control be set up and maintained around the bridge(s)?
- e. Proposed manufacturer, model and software version for GPS Inspection Units.
- f. Automated Machine Guidance (AMG) proposed for use on this contract.
- g. Type and frequency of quality control measures included to maintain the proper calibration and adjustment of the AMG systems.
- h. If GPS will be used for stakeout or for AMG, will the NYS CORS Network be used as its reference network or will base station(s) be used?
- i. If a base station is to be used, describe the mounting location, attachment technique, and instrumental protection included which ensures a sound and reliable reference station will be provided.

B. Traditional Survey Stakeout.

The Contractor shall field locate all features to be constructed from survey control points which are 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 references points along the center line at maximum intervals of 15 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 with a 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 (or survey baseline) 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 work 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.

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C. Automated Stakeout and Automated Machine Guidance Operations.

Should the Contractor choose automated methods for the establishment, layout, measurement, equipment guidance or verification of work to be constructed, they shall submit their proposed automated methods including quality control measures as part of their contract control plan for acceptance by the Engineer. When utilizing these methods, all horizontal and vertical survey control, roadway alignment control, existing terrain data and proposed design engineering data shall be shared/exchanged electronically and kept current between the Contractor and the Engineer. All original version 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 machine operations, positional verification, quantity measurements and calculations. All record copies of engineering data shall be stored and shared in Department accepted standard formats, and shall be derived primarily from the original electronic data, when provided by the Department.

Automated survey operations have a high reliance on accurate control networks from which to make measurements, establish positions, and verify geospatial locations of features. Therefore, a strong contract control network in the field which is consistent with the project control used during the design of the contract is essential to the successful use of these technologies with the proposed digital terrain model and alignments. Consistent and well designed site calibration (localization) for all automated machine guidance, as described above under *Contract Control Plan*, is required to ensure the quality of the contract deliverables. The Contract Control Plan is intended to document which local horizontal and vertical control will be used for calibration during construction operations and how that calibration or adjustment will be maintained along the entire contract length. Continued incorporation of NYS CORS Network is essential to maintaining the integrity of positional locations and elevations of features.

The Engineer may perform quality assurance verifications of feature positions at any time during the contract. Dimensional tolerances shall hold a higher order of precedence 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.

The Department's verification of the positional locations of features, calculation and merging of supplemental terrain data surfaces, and the measurement and calculation for quantity payments will be performed using Department standard software. Both the Contractor and the Department shall utilize the following standards: (1) All terrain data collected for the purpose of being used for or merged with Department provided terrain data for the calculation of pay quantities shall be delivered in a format and correctly display in accordance with the current Departmental CADD Standards. (2) The Department will maintain record copies of electronic data files which will be available to the Contractor using the Department's designated file management system or other method. 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 survey method or technology which involves a new 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 resulting performance, cost savings, safety 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