Normes pour les levés géodésiques ou topographiques

19 Mars 2018

Agenda

Introduction

Normes pour les levés à Abu Dhabi (2014)

- **Présentation du projet**
- **Contrôle des levés : c**ontrôle qualité et spécifications ISO

Autres exemples

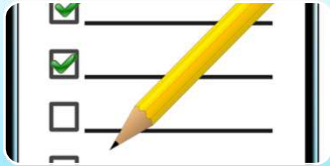
- FGDC
- US Army Corps of Engineers

Introduction

Objectifs

- Présentation et commentaire sur les normes concernant les levés, existantes ou proposées
  - Avec un intérêt particulier pour le projet ”Abu Dhabi Land Survey Act Standards and Specifications” de 2014

Abu Dhabi LSA : Project Goals and Objectives



Unifying survey standards and specifications of Abu Dhabi Emirate

Organizing the licensing and registration of the surveyors and survey companies

Why? To ensure that

all surveys executed		are carried out by skilled and competent		using and applying		
on behalf of municipalities or	**submitted** to municipalities	surveyors	companies	Municipal Spatial Reference System	Positioning Infrastructures	Standards and Guidelines

Existing standards global inventory

ISO standards

- ISO 19000 Geographic information
- ISO 17000 and 12000 Optics and optical instruments
- ISO 2800 Sampling procedures

Marine standards

- **IHO standards** (Dictionary, Manual of Hydrography, Standards)
- **IOC Manual on Sea Level Measurement and Interpretation , Volume IV**
- **ICAO** Catalog of ICAO publication
- **UNESCO** Procedure for the application of article 247 of the ***UNCLOS*** - *United Nation Convention on the Law of the Sea* by the Intergovernmental Oceanographic Commission of UNESCO

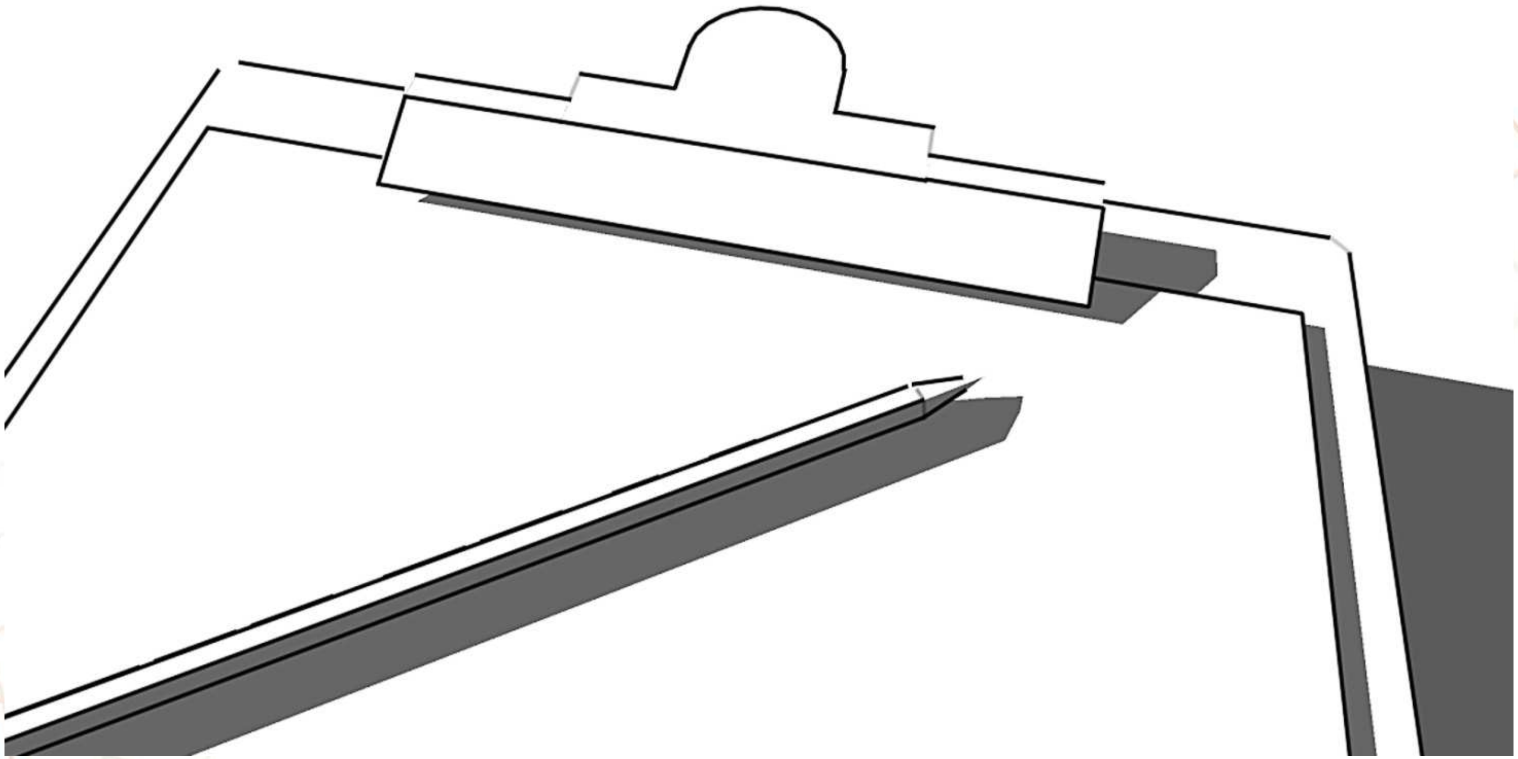
Others

- US Army Corps of Engineers standards
- UK-RICS standards and Guidelines
- UK-TSA (The Survey Association) Guidance notes and guides
- USA NOAA standards
- USA FGDC standards Federal Geographic Data Committee
- Australia & New Zealand ICSM Standards and guidelines
- OGC standards

95% confidence interval for Municipal surveys

Type of survey	95% confidence interval Horizontal (2d)	95% confidence interval Vertical (1d)
Demarcation surveys	7 cm	10 cm
Route surveys	10 cm	3 cm
Geodetic leveling Benchmarks	--------	$4\text{mm}.\sqrt{K}$ *K distance in kilometers*
GCP densification/maintenance	5 cm	6 cm
CORS densification	2.5 cm	3 cm

QUALITY CONTROL



Definitions : Quality assurance

Quality assurance (quality check)

- a way of preventing mistakes or defects in manufactured products
- a way to avoid problems when delivering solutions or services to customers
- applied to products in pre-production to verify what will be made meets specifications and requirements
- applied during production

Two principles included in Quality Assurance

- "Fit for purpose", the product should be suitable for the intended purpose
- "Right first time", mistakes should be eliminated
- to avoid, or at least minimize, issues which lead to the defect(s)

Definitions : Quality control

o ensure a certain level of quality in a product or service

- ghly examining and testing quality of products or results of servi
- roducts or services provided meet specific requirements and ch

ngage in quality control

- typically have a team of workers for testing a certain number of products or observing services being done

Products or services that are examined usually are chosen at random

The goal of the quality control team

- to identify products or services that do not meet a company's specified standards of quality

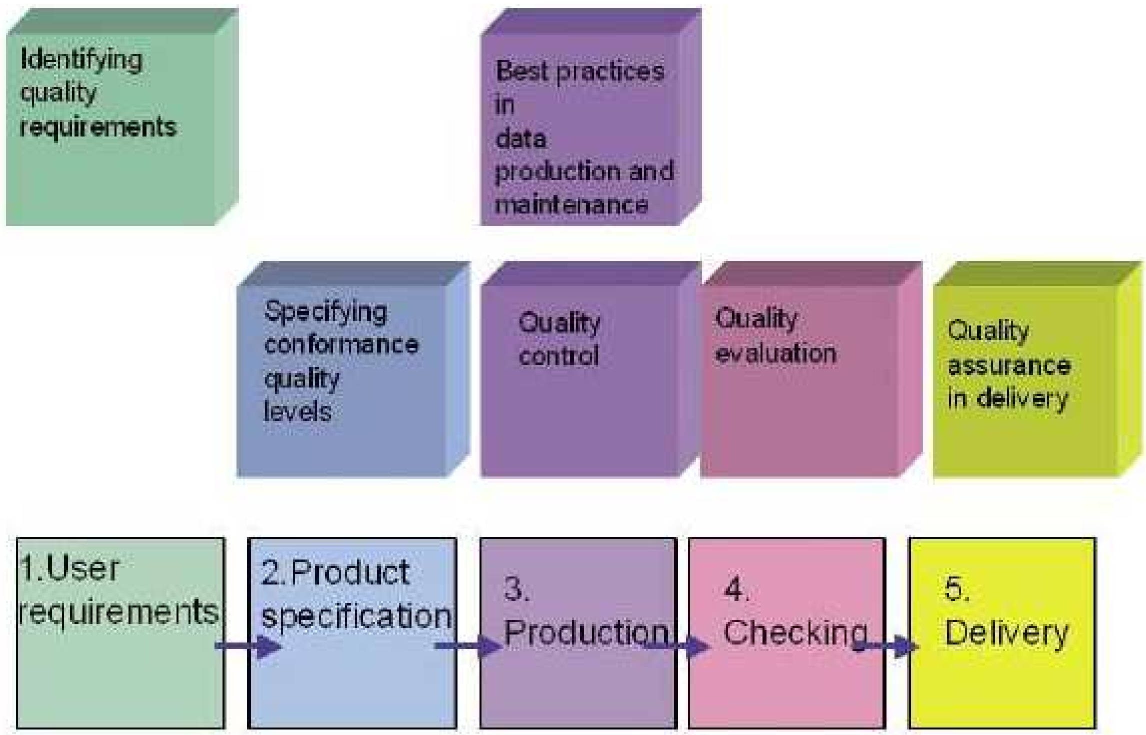
If a problem is identified

- stop production or service until the problem has been corrected

Data Quality-ISO 19157:2013

The ISO 19157:2013 defines taxonomy of the various kinds of differences between dataset and universe of discourse that are usually measured.

•How to identify whether these elements apply to one given dataset,
•How to create additional elements and sub-elements, and
•How to perform the reporting of quality assessment.



1. Completeness
2. Logical consistency
3. Positional accuracy
4. Temporal accuracy
5. Thematic accuracy
6. Usability

RTK Quality control : ISO19157 (1)

In the framework of ISO/CD n°19157

- (Geographic information — Data quality)
- A subset of RTK measurements must be compared to « true positions »
- To simulate true positions, we choose to measure again with a technique twice as accurate (a compromise between cost and accuracy)

Static GNSS post-processing required

Standard deviations of residuals to be tested

- Residual = difference between RTK position and “true” position
- Standard deviation (estimated) :

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \overline{x})^2}.$$

- If test fails, the data set is not validated

RTK Quality control : ISO19157 (2)

Table F.4 — Statistical numbers for testing standard deviation. 95% significance level

ISO table allows to determine size of sample to be checked

Population size From	To	Sample size (n)	$\sqrt{F_{0.05,\,n-1,\,\infty}}$
26	**50**	**5**	**1,54**
51	**90**	**7**	**1,45**
91	**150**	**10**	**1,37**
151	**280**	**15**	**1,30**
281	**400**	**20**	**1,26**
401	**500**	**25**	**1,23**
501	**1200**	**35**	**1,20**
1201	**3200**	**50**	**1,16**
3201	**10000**	**75**	**1,13**
10001	**35000**	**100**	**1,12**
35001	**150000**	**150**	**1,09**
150001	**500000**	**200**	**1,08**
> 500000		**200**	**1,08**

RTK Quality control : ISO19157 (3)

The dataset is not good enough

(i.e. can be rejected with 95% significance)

if the estimated standard deviation divided by the F-value

(taken from Table F.4)

is higher than the Acceptance Quality Limit (AQL) at the standard confidence level

Table F.3 — Symbols and Formulas

Standard deviation estimated based on sample	s
Sample size	
AQL for the st	
F (from the F-(	
Standard devi	$\sqrt{F}$

Population size From	Population size To	Sample size (n)	$\sqrt{F_{0.05,n-1,\infty}}$
26	50	5	1,54
51	90	7	1,45
91	150	10	1,37
151	280	15	1,30
281	400	20	1,26
401	500	25	1,23
501	1200	35	1,20
1201	3200	50	1,16
3201	10000	75	1,13
10001	35000	100	1,12
35001	150000	150	1,09
150001	500000	200	1,08
> 500000		200	1,08

ISO19157 definitions

Accuracy

- Closeness of agreement between test result or measurement result and the true value

Geographic data

- Data with reference to a location relative to the Earth

Completeness

- The presence or absence of features, their attributes and relationships
- Commission = excess data in dataset
- Omission = data absent from dataset

Positional accuracy

- The accuracy of the position within a spatial reference system
- Absolute (external) accuracy = closeness of coordinates values to values accepted as or being true (for instance using a technique/method twice as accurate)

Confidence

- Trustworthiness of a data quality result

Sample

- Size of the sample but also how well it represents the state of the data are crucial

ISO19157 example of application

Population = 256	Geodetic points
Sample size (n) = 15	From table "Statistical numbers for testing standard deviation. 95% significance level"
$\sqrt{F}$ = 1.30	From table "Statistical numbers for testing standard deviation. 95% significance level"
(AQL) σ = 0.020	From quality specification (standard confidence level)
(sample) s = 0.032	From root mean square error of planimetry computation (standard confidence level)

Is $s > \sigma \cdot \sqrt{F}$?

- Yes, since 0.032>0.026

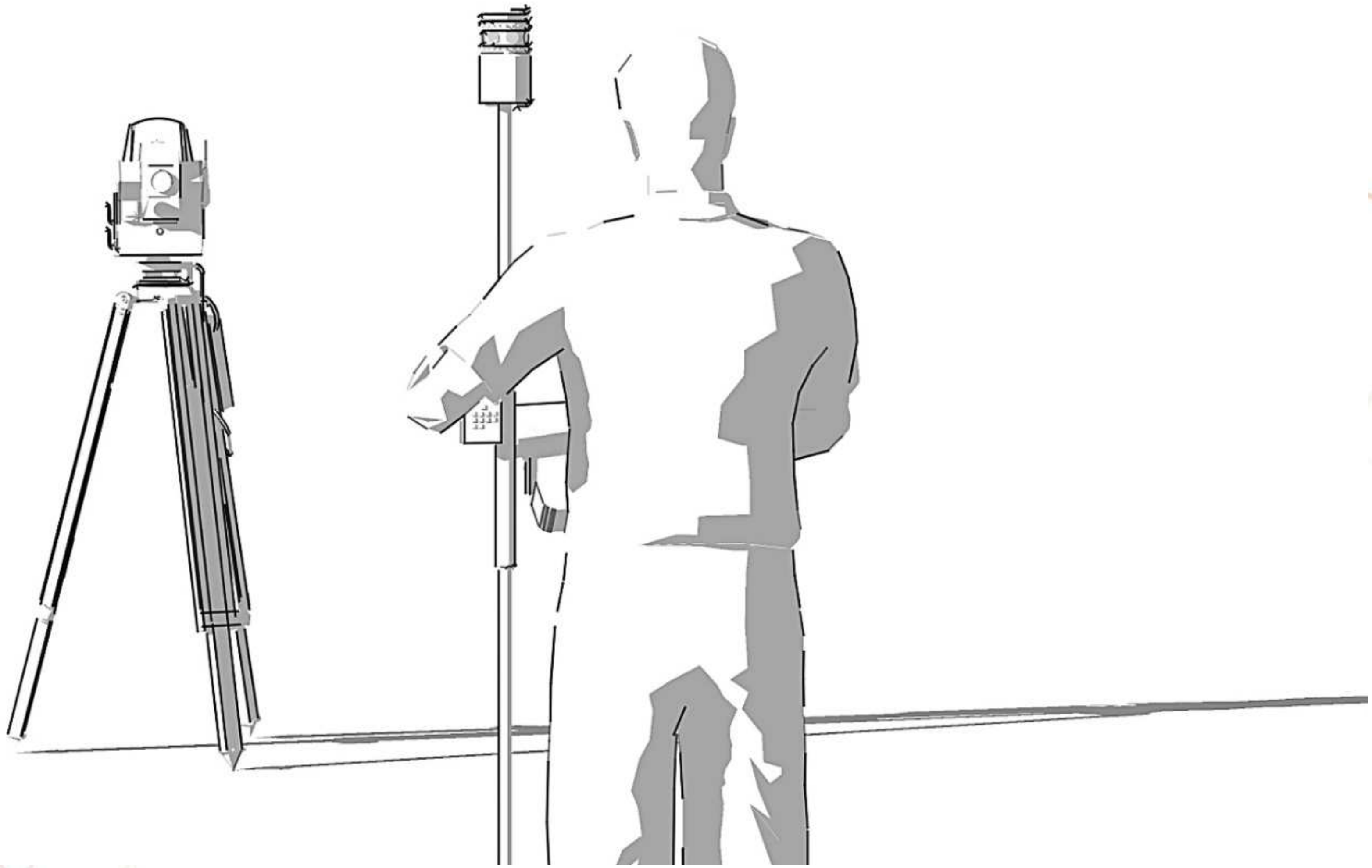
The conclusion is that dataset is not good enough and shall be rejected

Conclusion : what to remember

Quality control

- True positions for a sample must be approximated using a more accurate method
- Two statistical testing methods available : ISO and French decree

Autres exemples de normes et spécifications



Autres exemples : FGDC

Norme FGDC (Federal Geographic Data Committee)

- Geospatial Positioning Accuracy Standards - Part 2: Standards for Geodetic Networks (FGDC-STD-007.2-1998)
  - Le concept d'exactitude (*accuracy*) remplace progressivement celui d'erreur de fermeture (*misclosure*) utilisé auparavant

Table 4-5. FGDC Part 2 Accuracy Standards for Geodetic Networks Horizontal, Ellipsoid Height, and Orthometric Height

Accuracy Classification	95-Percent Confidence Less Than or Equal to:
1-Millimeter	0.001 meters
2-Millimeter	0.002 "
5-Millimeter	0.005 "
1-Centimeter	0.010 "
2-Centimeter	0.020 "
5-Centimeter	0.050 "
1-Decimeter	0.100 "
2-Decimeter	0.200 "
5-Decimeter	0.500 "
1-Meter	1.000 "
2-Meter	2.000 "
5-Meter	5.000 "
10-Meter	10.000 "

NOTE: The classification standard for geodetic networks is based on accuracy. Accuracies are categorized separately according to horizontal, ellipsoid height, and orthometric height. Note: although the largest entry in the table is 10 meters, the accuracy standards can be expanded to larger numbers if needed.

NSDI

National Spatial Data Infrastructure

Autres exemples : US Army Corps (1)

EM 1110-1-1005
1 January 2007

US Army Corps
of Engineers

ENGINEERING AND DESIGN

Control and Topographic Surveying

Assurance qualité

- La démarche mise en avant est l'assurance qualité plutôt que le contrôle qualité

Autres exemples : US Army Corps (2)

Specifications	Traverse/Network Resection Double Tie
Check vertical index error	Daily
Check horizontal collimation	Daily
Measure instrument height and target height	Begin and end of each setup
Use plummet to check position of target and instrument over points	Begin and end of each setup
Measure temperature and pressure and enter ppm correction into total station	First set-up of day
Measure distance to backsight and foresight at each setup	Required
Observe traverse multiple ties to improve least squares adjustment	As Feasible
Close all traverses	Required
Horizontal angle observations, minimum	3D, 3R
Vertical angle observations, minimum	3D, 3R
Angular rejection limit, residual not to exceed	5"
Maximum value for the standard error of the mean	1.2"
Minimum distance measurement to meet horizontal accuracy standard	50 m
Minimum number of distance measurements	3
Distance rejection limit: residual not to exceed	2mm + 2 ppm
Maximum distance measurement to meet vertical accuracy standard	100 m

Figure 4-1. CALTRANS Third-Order horizontal control standards (Total Station)

Autres exemples : US Army Corps (3)

EM 1110-1-1005
1 Jan 07

Table 6-1. RECOMMENDED ACCURACIES AND TOLERANCES:
ENGINEERING, CONSTRUCTION, AND FACILITY MANAGEMENT PROJECTS

Project or Activity	Target Map Scale SI/IP	Feature Position Tolerance Horizontal SI/IP	Feature Position Tolerance Vertical SI/IP	Contour Interval SI/IP	Survey Accuracy Hor/Vert
DESIGN, CONSTRUCTION, OPERATION & MAINTENANCE OF MILITARY FACILITIES					
Maintenance and Repair (M&R)/Renovation of Existing Installation Structures, Roadways, Utilities, Etc					
General Construction Site Plans & Specs:	1:500	100 mm	50 mm	250 mm	3rd-I
Feature & Topographic Detail Plans	40 ft/in	0.1-0.5 ft	0.1-0.3 ft	1 ft	3rd
Surface/subsurface Utility Detail Design Plans	1:500	100 mm	50 mm	N/A	3rd-I
Elec, Mech, Sewer, Storm, etc	40 ft/in	0.2-0.5 ft	0.1-0.2 ft		3rd
Field construction layout		0.1 ft	0.01-0.1 ft		
Building or Structure Design Drawings	1:500	25 mm	50 mm	250 mm	3rd-I
40 ft/in	0.05-0.2 ft	0.1-0.3 ft	1 ft	3rd	
Field construction layout		0.01 ft	0.01 ft		
Airfield Pavement Design Detail Drawings	1:500	25 mm	25 mm	250 mm	3rd-I
40 ft/in	0.05-0.1 ft	0.05-0.1 ft	0.5-1 ft	2nd	
Field construction layout		0.01 ft	0.01 ft		

Autres exemples : US Army Corps (4)

HAZARDOUS, TOXIC, RADIOACTIVE WASTE (HTRW) SITE INVESTIGATION, MODELING, AND CLEANUP

General Detailed Site Plans	1:500	100 mm	50 mm	100 mm	2nd-I/II
HTRW Sites, Asbestos, etc.	5-50 ft/in	0.2-1 ft	0.1-0.5 ft	0.5-1 ft	2nd/3rd
Subsurface Geotoxic Data Mapping	1:500	100 mm	500 mm	500 mm	3-II
and Modeling	20-100 ft/in	1-5 ft	1-2 ft	1-2 ft	3rd
Contaminated Ground Water	1:500	1000 mm	500 mm	500 mm	3rd-II
Plume Mapping/Modeling	20-100 ft/in	2-10 ft	1-5 ft	1-2 ft	3rd
General HTRW Site Plans &	1:2500	5000 mm	1000 mm	1000 mm	3rd-II
Reconnaissance Mapping	50-400 ft/in	2-20 ft	2-20 ft	2-5 ft	3rd

Autres exemples : US Army Corps (5)

c. Feature location tolerances. This requirement establishes the primary surveying effort necessary to delineate physical features on the ground. In most instances, a construction feature may need to be located to an accuracy well in excess of its plotted/scaled accuracy on a construction site plan; therefore, feature location tolerances should not be used to determine the required scale of a drawing or determine photogrammetric mapping requirements. In such instances, surveyed coordinates, internal CADD grid coordinates, or rigid relative dimensions are used. Table 6-1 indicates recommended positional tolerances (or precisions) of planimetric features. These feature tolerances are defined relative to adjacent points within the confines of a specific area, map sheet, or structure--not to the overall project or installation boundaries. Relative accuracies are determined between two points that must functionally maintain a given accuracy tolerance between themselves, such as adjacent property corners; adjacent

2. The feature position or elevation tolerance of a planimetric feature is defined at the 95% confidence level. The positional accuracy is relative to two adjacent points within the confines of a structure or map sheet, not to the overall project or installation boundaries. Relative accuracies are determined between two points that must functionally maintain a given accuracy tolerance between themselves, such as adjacent property corners; adjacent utility lines; adjoining buildings, bridge piers, approaches, or abutments; overall building or structure site construction limits; runway ends; catch basins; levee baseline sections; etc. The tolerances between the two points are determined from the end functional requirements of the project/structure (e.g., field construction/fabrication, field stakeout or layout, alignment, locationing, etc.).

3. Horizontal and vertical control survey accuracy refers to the procedural and closure specifications needed to obtain/maintain the relative accuracy tolerances needed between two functionally adjacent points on the map or structure, for design, stakeout, or construction. Usually 1:10,000 Third-Order (I) control procedures (horizontal and vertical) will provide sufficient accuracy for most engineering work, and in many instances of small-scale mapping or GIS rasters, Third-Order, Class II methods and Fourth-Order topo/construction control methods may be used. Base- or area-wide mapping control procedures shall be specified to meet functional accuracy