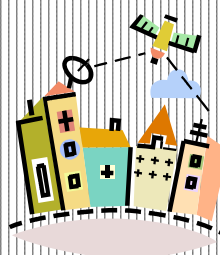
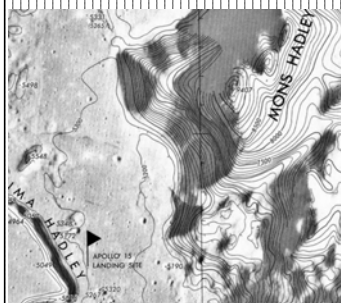


MAPPING STANDARDS

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RCB

GUIDELINES FOR ACCURACY

- Planimetric accuracy
 - Directly proportional to image scale
 - Type of camera (normal angle, wide angle, etc.) plays little role
- Height accuracy
 - Proportional to flying height
 - Or square of object distance

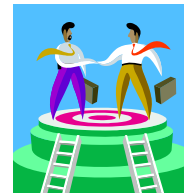


GUIDELINES FOR ACCURACY



- For targeted points:
 - Planimetry: $\sigma_{x,y} = \pm 6 \mu\text{m}$ in photo
 - Height:
 - $\sigma_z = 0.06 \text{ ‰}$ of object distance (normal and wide angle)
 - $\sigma_z = 0.08 \text{ ‰}$ of object distance (super wide angle)
 - If additional calculations performed to compensate for all error influences then 50% improvement in accuracy possible

GUIDELINES FOR ACCURACY



- Example: wide angle camera, photography scale $1'' = 500'$, focal length 150 mm, analytical plotter used in observations
- Expected planimetric error:

$$\sigma_{x,y} = (6,000)(0.0006 \text{ cm}) = \pm 3.6 \text{ cm}$$
- Expected height error:

$$\sigma_z = (6,000)(15 \text{ cm})(0.00006) = \pm 5.4 \text{ cm}$$

GUIDELINES FOR ACCURACY



- Natural targets
 - Consider uncertainty in definition of feature

$$\sigma_{X,Y_{Nat}} = \sqrt{\sigma_{X,Y_{Tar}}^2 + \sigma_{X,Y_{Feat}}^2}$$

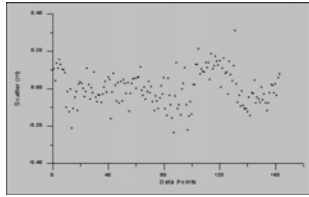
$$\sigma_{Z_{Nat}} = \sqrt{\sigma_{Z_{Tar}}^2 + \sigma_{Z_{Feat}}^2}$$

- Subscript "Nat" is natural target, "Tar" is targeted point, "Feat" is feature definition

NATIONAL MAP ACCURACY STANDARDS

- Horizontal accuracy:
 - For maps at scale larger than 1:20,000, no more than 10% of points tested shall be in error by more than 1/30 inch, measured at publication scale
 - For maps at 1:20,000 or smaller, 1/50 inch
 - Applies to well defined points only – easily visible or recoverable on ground
 - Also determined by what is "plottable" on scale of map within 1/100 inch

NATIONAL MAP ACCURACY STANDARDS



- Vertical accuracy:
 - Applies to contour maps at all scales
 - No more than 10% of elevations tested shall be in error by more than 1/2 the contour interval
- Accuracy tested by comparing points or elevations with corresponding positions determined by a survey of higher order

ASPRS STANDARDS

- Expressed in terms of limiting root mean square (rms) error

$$\text{rms} = \sqrt{\frac{\sum_{i=1}^n d_i^2}{n}}$$

- d is discrepancy between mapped coordinates in ground units and surveyed coordinates
- n is number of points tested

ASPRS STANDARDS

- rms computed for each coordinate
 - Example, rms error in X-direction is:

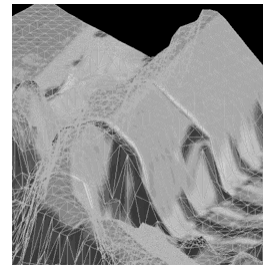
$$\text{rms}_X = \sqrt{\frac{\sum_{i=1}^n d_{x_i}^2}{n}}$$

- where

$$d_{x_i} = X_{\text{map}_i} - X_{\text{survey}_i}$$

ASPRS STANDARDS

- Standard introduces 3 classes of maps based on limiting rms error
 - Class 1 – highest
 - Class 2 – limiting rms error twice that of Class 1
 - Class 3 – allowable rms error three times Class 1



PLANIMETRY STANDARDS IN IMPERIAL UNITS

Typical Map Scale	Limiting rms error in X or Y		
	Class 1	Class 2	Class 3
1:60	0.05	0.1	0.15
1:120	0.1	0.2	0.3
1:240	0.2	0.4	0.6
1:360	0.3	0.6	0.9
1:480	0.4	0.8	1.2
1:600	0.5	1.0	1.5
1:1,200	1.0	2.0	3.0
1:2,400	2.0	4.0	6.0
1:4,800	4.0	8.0	12.0
1:6,000	5.0	10.0	15.0
1:9,600	8.0	16.0	24.0
1:12,000	10.0	20.0	30.0
1:20,000	16.7	33.3	50.0

PLANIMETRY STANDARDS IN SI UNITS

Typical Map Scale	Limiting rms error in X or Y		
	Class 1	Class 2	Class 3
1:50	0.0125	0.025	0.0375
1:100	0.025	0.050	0.075
1:200	0.050	0.100	0.150
1:500	0.125	0.250	0.375
1:1,000	0.25	0.50	0.75
1:2,000	0.50	1.00	1.50
1:4,000	1.00	2.00	3.00
1:5,000	1.25	2.50	3.75
1:10,000	2.50	5.00	7.50
1:20,000	5.00	10.00	15.00

ASPRS VERTICAL ACCURACY

- Limiting rms error for elevations 1/3 the contour interval (CI)
 - 1/6 CI for spot heights

Target CI, ft.	Limiting rms errors					
	Topographic feature points for class			Spot or Digital Terrain Model Elevation point for class		
	1	2	3	1	2	3
0.5	0.17	0.33	0.5	0.08	0.16	0.25
1	0.33	0.66	1.0	0.17	0.33	0.50
2	0.67	1.33	2.0	0.33	0.67	1.00
4	1.33	2.67	4.0	0.67	1.33	2.00
5	1.67	3.33	5.0	0.83	1.67	2.50

ASPRS STANDARDS

- Compliance done by comparing mapped position at ground scale to location of points from survey of higher accuracy
 - Follow FGCS standards where standard deviation no greater than 1/3 of limiting rms error

ASPRS STANDARDS

- FGCS standards use horizontal distance between points in determining accuracy

- Distance represented by

$$a = \frac{d}{s}$$

- Where a = distance accuracy denominator (1:a), d = distance between points, s is standard deviation of distance as determined from least squares adjustment

ASPRS STANDARDS

- ASPRS standard uses diagonal distance across map as distance

- If diagonal distance is 6,000' and scale is 1:1200, then limiting rms error is 1'
 - Survey accuracy is 1/3 this, or 0.33'
 - Denominator of distance accuracy is

$$a = \frac{d}{s} = \frac{6,000'}{0.33'} = 18,182$$

ASPRS STANDARDS

- Vertical control surveys have slightly different criteria
 - Planimetric position of map point can be shifted up to twice the limiting rms error
 - Level check survey must be conducted so rms error in elevations at check point does not exceed 1/20th CI
 - Like planimetric survey, standard is dependent upon distance (d) between benchmarks and is taken as diagonal distance

ASPRS STANDARDS

- Elevation difference accuracy (b) is:

$$b = \frac{s}{\sqrt{d}}$$

- Classification of elevation accuracy standards is given as

Classification	Maximum Elevation Difference Accuracy
First-Order, Class I	0.5
First-Order, Class II	0.7
Second-Order, Class I	1.0
Second-Order, Class II	1.3
Third-Order	2.0

ASPRS STANDARDS

- From previous example, assume
CI = 2'

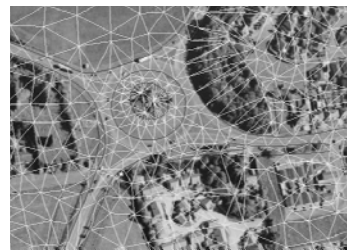
- Then $s = \frac{1}{20} \text{ CI} = 0.10'$

- From which

$$b = \frac{s}{\sqrt{d}} = \frac{(0.1') \left(\frac{12 \text{ in}}{\text{ft}} \right) \left(\frac{25.4 \text{ mm}}{\text{in}} \right)}{\sqrt{(600') \left(\frac{1200 \text{ m}}{3937 \text{ ft}} \right) \left(\frac{1 \text{ km}}{1000 \text{ m}} \right)}} = 22.5 \text{ mm} / \sqrt{\text{km}}$$

ASPRS STANDARDS

- If any discrepancy exceeds three times limiting rms error, assumed difference is due to a blunder and must be corrected
- Standard requires a minimum of 20 points to be used for comparison

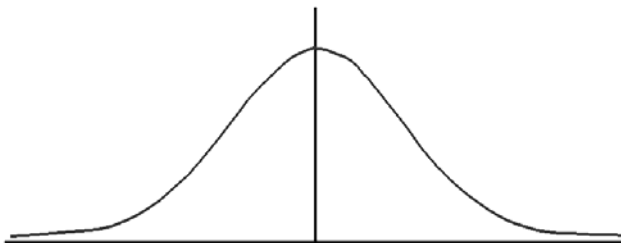




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**Statistics & Formulas Associated
with Accuracy Standards**



Normal Distribution Function - A mathematical function describing the behavior of one-dimensional random errors whose graph is a bell-shaped curve that extends indefinitely in both directions.



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696 Appendix: Statistical tables



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0000	0040	0080	0120	0160	0199	0239	0279	0319	0359
0.1	0398	0438	0478	0517	0557	0596	0636	0675	0714	0753
0.2	0793	0832	0871	0910	0948	0987	1026	1064	1103	1141
0.3	1179	1217	1255	1293	1331	1368	1406	1443	1480	1517
0.4	1554	1591	1628	1664	1700	1736	1772	1808	1844	1879
0.5	1915	1950	1985	2019	2054	2088	2123	2157	2190	2224
0.6	2257	2291	2324	2357	2389	2422	2454	2486	2517	2549
0.7	2580	2611	2642	2673	2704	2734	2764	2794	2823	2852
0.8	2881	2910	2939	2967	2995	3023	3051	3078	3106	3133
0.9	3159	3186	3212	3238	3264	3289	3315	3340	3365	3389
1.0	3413	3438	3461	3485	3508	3531	3554	3577	3599	3621
1.1	3643	3665	3686	3708	3729	3749	3770	3790	3810	3830
1.2	3849	3869	3889	3907	3925	3944	3962	3980	3997	4015
1.3	4032	4049	4066	4082	4099	4115	4131	4147	4162	4177
1.4	4192	4207	4222	4236	4251	4265	4279	4292	4306	4319
1.5	4332	4345	4357	4370	4382	4394	4406	4418	4429	4441
1.6	4452	4463	4474	4484	4495	4505	4515	4525	4535	4545
1.7	4554	4564	4573	4582	4591	4599	4608	4616	4625	4633
1.8	4641	4649	4656	4664	4671	4678	4685	4693	4699	4706
1.9	4713	4719	4726	4732	4738	4744	4750	4756	4761	4767
2.0	4772	4778	4783	4788	4793	4798	4803	4808	4812	4817
2.1	4821	4826	4830	4834	4838	4842	4846	4850	4854	4857
2.2	4861	4864	4868	4871	4875	4878	4881	4884	4887	4890
2.3	4893	4896	4898	4901	4904	4906	4909	4911	4913	4916
2.4	4918	4920	4922	4925	4927	4929	4931	4932	4934	4936
2.5	4938	4940	4941	4943	4945	4946	4948	4949	4951	4952
2.6	4953	4955	4956	4957	4959	4960	4961	4962	4963	4964
2.7	4965	4966	4967	4968	4969	4970	4971	4972	4973	4974
2.8	4974	4975	4976	4977	4977	4978	4979	4979	4980	4981
2.9	4981	4982	4982	4983	4984	4984	4985	4985	4986	4986
3.0	4987	4987	4987	4988	4988	4989	4989	4989	4990	4990


Table 1 Normal curve areas

For a single variable
1.96 ⇒ 95% confidence
1.645 ⇒ 90% confidence



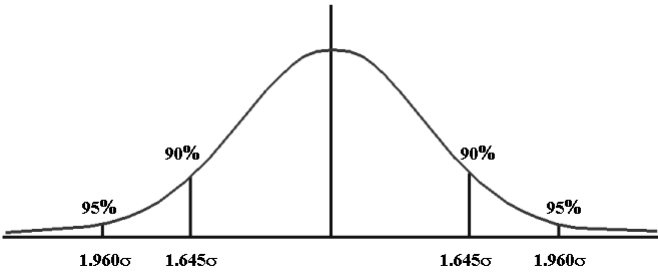
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**Statistics & Formulas Associated
with Accuracy Standards**



☎ Confidence Level and the Bell Shaped Curve


- ☎ 1 sigma (1σ) level equals 68.26% of area under the curve
- ☎ 2 sigma (2σ) level equals 95.44% of area under the curve
- ☎ 3 sigma (3σ) level equals 99.74% of area under the curve





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**Statistics & Formulas Associated
with Accuracy Standards**



☎ Utilizes well defined independent checkpoints
(differences between higher order surveyed coordinates and product test coordinates are calculated for each checkpoint component)

$$Average(\bar{z}) = \frac{\sum_{i=1}^n \Delta z_i}{n}$$

$$StdDev(z) = \sqrt{\frac{\sum_{i=1}^n (\Delta z_i - \bar{z})^2}{n-1}}$$

$$RMSE(z) = \sqrt{\frac{\sum_{i=1}^n (\Delta z_i)^2}{n}}$$

NSSDA STANDARD

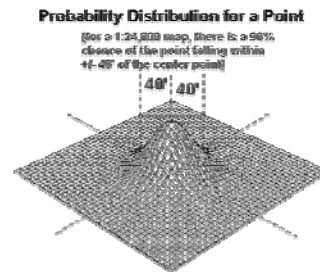
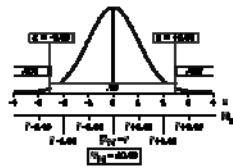
- National Standard for Spatial Data Accuracy – part of the Geospatial Positioning Accuracy Standard
- Uses rmse (root mean square error)
 - rmse – square root of average of set of squared differences between dataset coordinates and coordinates of higher order survey
- Accuracy reported at 95% confidence level
- Weakness: No threshold like ASPRS Standards – just reporting standard

NSSDA STANDARD

- Minimum of 20 check points tested
 - Distributed to reflect geographic area of interest and distribution of error in dataset
 - At 95% CI, one point allowed to fail threshold
- When fewer than 20 points tested, alternative means of evaluation required
 - Deductive estimate
 - Internal evidence
 - Comparison to source

NSSDA STANDARD

- Report accuracy at 95% confidence level for data tested for both horizontal and vertical accuracy
- Positional accuracy values reported in ground distances



NSSDA STANDARD

- Root mean square error computed for each coordinate as

$$\text{rmse}_X = \sqrt{\frac{\sum (X_{\text{data},i} - X_{\text{check},i})^2}{n}}$$

$$\text{rmse}_Y = \sqrt{\frac{\sum (Y_{\text{data},i} - Y_{\text{check},i})^2}{n}}$$

$$\text{rmse}_Z = \sqrt{\frac{\sum (Z_{\text{data},i} - Z_{\text{check},i})^2}{n}}$$

Subscripts "data" refers to point on the map; "check" refers to surveyed coordinate

NSSDA STANDARD

- Horizontal accuracy

$$\begin{aligned} \text{rmse}_r &= \sqrt{\text{rmse}_x^2 + \text{rmse}_y^2} \\ &= \sqrt{\frac{\sum (x_{\text{data},i} - x_{\text{check},i})^2}{n} + \frac{\sum (y_{\text{data},i} - y_{\text{check},i})^2}{n}} \end{aligned}$$

- If $\text{rmse}_x = \text{rmse}_y$

$$\begin{aligned} \text{rmse}_r &= \sqrt{2 \cdot \text{rmse}_x^2} = \sqrt{2 \cdot \text{rmse}_y^2} \\ &= 1.4142 \cdot \text{rmse}_x = 1.4142 \cdot \text{rmse}_y \end{aligned}$$

NSSDA STANDARD

- Accuracy reported at 95% confidence level reported as (assuming system errors eliminated and error normally distributed and independent in x and y components)

$$\begin{aligned} \text{Accuracy}_r &= 2.4477 \cdot \text{rmse}_x = 2.4477 \cdot \text{rmse}_y \\ &= \frac{2.4477 \cdot \text{rmse}_r}{1.4142} \end{aligned}$$

$$\text{Accuracy}_r = 1.7308 \cdot \text{rmse}_r$$

NSSDA STANDARD

- If axes not equal ($rms_x \neq rms_y$)
 - Accuracy approximated by circular standard error (at 39.35% confidence level)
 - Ratio: rms_{min}/rms_{max} between 0.6 - 1.0
 - Circular error approximated by

$$0.5(rms_x + rms_y)$$

- NSSDA approximates using

$$Accuracy_r \approx (2.4477)(0.5)(rms_x + rms_y)$$

Table 2. Accuracy Calculations for Crider, Kentucky USGS 1:24,000-scale Topographic Quadrangle (RMSE_x = RMSE_y assumed)

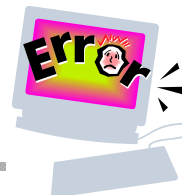
Number	Description	x (computed)	x (map)	diff in x	squared diff in x (1)	y (computed)	y (map)	diff in y	squared diff in y (2)	(1)+(2)	square root of [(1)+(2)]
10351	T-RD-W	1373883	1373894	11	121	298298	298297	-1	1	122	11.05
10352	T-RD-E	1370503	1370486	-17	289	303727	303747	20	400	689	26.25
10353	RD AT RR	1361523	1361537	14	196	302705	302705	0	0	196	14.00
10354	T-RD-SW	1357653	1357667	14	196	298726	298746	20	400	596	24.41
10355	T-RD-SE	1348121	1348128	7	49	299725	299755	30	900	949	30.81
10356	RD AT RR	1345601	1345625	24	576	309911	309910	-1	1	577	24.02
10357	T-RD-E	1350505	1350507	2	4	318478	318477	-1	1	5	2.24
10358	X-RD	1351781	1351792	11	121	307697	307698	1	1	122	11.05
10359	T-RD-E	1352361	1352379	18	324	311109	311099	-10	100	424	20.59
10360	X-RD	1360657	1360645	-12	144	316720	316761	41	1681	1825	42.72
10361	Y-RD-SW	1368215	1368202	-13	169	309842	309869	27	729	898	29.97
10362	T-RD-W	1370299	1370282	-17	289	316832	316849	17	289	578	24.04
10363	T-RD-S	1373855	1373839	-16	256	319893	319886	-7	49	305	17.46
10364	Y-RD-W	1379981	1379962	-19	361	311641	311633	-8	64	425	20.62
10365	T-RD-E	1378625	1378628	3	9	334995	335010	15	225	234	15.30
10366	T-RD-SE	1374735	1374742	7	49	333909	333922	13	169	218	14.76
10367	T-RD-NW	1370581	1370576	-5	25	324098	324095	-3	9	34	5.83
10368	Y-RD-SE	1359379	1359387	8	64	328690	328691	1	1	65	8.06
10369	T-RD-S	1346459	1346479	20	400	330816	330812	-4	16	416	20.40
10370	T-RD-E	1347101	1347109	8	64	335869	335850	-19	361	425	20.62
10371	T-RD-SE	1350733	1350748	15	225	332715	332725	10	100	325	18.03
10372	T-RD-N	1354395	1354411	16	256	335337	335345	8	64	320	17.89
10373	T-RD-S	1358563	1358570	7	49	335398	335406	8	64	113	10.63
10374	X-RD	1365561	1365574	13	169	333873	333877	4	16	185	13.60
10375	X-RD	1373645	1373643	-2	4	339613	339609	-4	16	20	4.47
sum										10066	
average										402.64	
RMSEr										20.07	
Accuracy										per 35	
NSSDA (2.4477 * RMSEr)											

Table 3. Accuracy Computations for Crider, Kentucky USGS 1:24,000-scale Topographic Quadrangle (RMSE_x ≠ RMSE_y)

Number	Description	x (computed)	x (map)	diff in x	squared diff in x	y (computed)	y (map)	diff in y	squared diff in y
10351	T-RD-W	1373883	1373894	11	121	298298	298297	-1	1
10352	T-RD-E	1370503	1370486	-17	289	303727	303747	20	400
10353	RD AT ER	1361523	1361537	14	196	302705	302705	0	0
10354	T-RD-SW	1357653	1357667	14	196	298726	298746	20	400
10355	T-RD-SE	1348121	1348128	7	49	299725	299755	30	900
10356	RD AT ER	1345601	1345625	24	576	309911	309910	-1	1
10357	T-RD-E	1350505	1350507	2	4	318478	318477	-1	1
10358	X-RD	1351781	1351792	11	121	307697	307698	1	1
10359	T-RD-E	1352361	1352379	18	324	311109	311099	-10	100
10360	X-RD	1360657	1360645	-12	144	316720	316761	41	1681
10361	Y-RD-SW	1368215	1368202	-13	169	309842	309869	27	729
10362	T-RD-W	1370299	1370282	-17	289	316832	316849	17	289
10363	T-RD-S	1373855	1373839	-16	256	319893	319886	-7	49
10364	Y-RD-W	1379981	1379962	-19	361	311641	311633	-8	64
10365	T-RD-E	1378625	1378628	3	9	334995	335010	15	225
10366	T-RD-SE	1374735	1374742	7	49	333909	333922	13	169
10367	T-RD-NW	1370581	1370576	-5	25	324098	324095	-3	9
10368	Y-RD-SE	1359379	1359387	8	64	328690	328691	1	1
10369	T-RD-S	1346459	1346479	20	400	330816	330812	-4	16
10370	T-RD-E	1347101	1347109	8	64	335869	335850	-19	361
10371	T-RD-SE	1350733	1350748	15	225	332715	332725	10	100
10372	T-RD-N	1354395	1354411	16	256	335337	335345	8	64
10373	T-RD-S	1358563	1358570	7	49	335398	335406	8	64
10374	X-RD	1365561	1365574	13	169	335873	335877	4	16
10375	X-RD	1373645	1373643	-2	4	339613	339609	-4	16
				sum	4409				5657
				average	176.36				226.28
				RMSE	13.28				15.04
				RMSE _{max} /RMSE _{min}					0.88

Since RMSE_{min}/RMSE_{max} is between 0.6 and 1.0, the formula Accuracy_z = 2.447*0.5*(RMSE_x + RMSE_y) may be used to estimate accuracy according to the NSSDA. Accuracy = 35 feet.

NSSDA STANDARD



- Vertical accuracy
 - Similar to horizontal accuracy
 - Multiplier: 1.9600

$$\text{Accuracy}_z = 1.9600 \text{rms}_z$$



Engineering Map Accuracy Standards - ASCE

- Limiting Standard Error

$$s_x = \frac{\sum_{i=1}^n (\delta X_i - \bar{\delta X})^2}{n-1} \quad s_y = \frac{\sum_{i=1}^n (\delta Y_i - \bar{\delta Y})^2}{n-1} \quad s_z = \frac{\sum_{i=1}^n (\delta Z_i - \bar{\delta Z})^2}{n-1}$$

- where: δ_i = discrepancy between full scale position of feature from map and from survey and $\bar{\delta}$ is the mean algebraic deviation in any coordinate direction defined as:

$$\bar{\delta} = \frac{\sum_{i=1}^n \delta_i}{n}$$

Engineering Map Accuracy Standards - ASCE

- Limiting Standard Error
 - Estimated as the standard deviation from the mean deviation
 - Discrepancies determined at a minimum of 20 well-defined and widely distributed points
 - Limiting standard error used in compliance testing for precision using the χ^2 (Chi-square) distribution within a 95% confidence interval $(1 - \alpha)$ and one-tailed test

Engineering Map Accuracy Standards - ASCE


- Limiting Mean Absolute Error (mean deviation)

$$|\bar{\delta X}| = \left| \frac{\sum_i^n \delta X_i}{n} \right| \quad |\bar{\delta Y}| = \left| \frac{\sum_i^n \delta Y_i}{n} \right| \quad |\bar{\delta Z}| = \left| \frac{\sum_i^n \delta Z_i}{n} \right|$$

- Absolute value of mean position discrepancy at 20 or more well-defined and widely distributed points


Engineering Map Accuracy Standards - ASCE

- Limiting Mean Absolute Error
 - Comparison between mapped points and survey points of higher accuracy
 - Points are withheld during mapping procedure – used for compliance checking
 - Used statistically to test for bias using the student t-distribution with a 95% confidence interval ($1 - \alpha$) and a 1-tailed test




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Common Accuracy Standards




USDOT Reference Guide Outline(1968)

- ☎ Dependent on Map Scale and Contour Interval
- ☎ Accuracy Reporting language not explicitly defined
- ☎ Accuracy Requirements at 90% confidence level
- ☎ Horizontal Accuracy
 - ☎ 90% of planimetric features are within 1/40" at map scale
- ☎ Vertical Accuracy
 - ☎ 90% of elevations determined from contours are within 1/2 contour interval
 - ☎ 90% of spot elevations are within 1/4 contour interval



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Common Accuracy Standards



USDOT Reference Guide Outline(1968)

- ☎ Horizontal Accuracy Standard (typical scales)

<u>Map Scale</u>	<u>Radial Accuracy at 90%</u>	
<u>confidence level</u>	1"=400'	10.00'
1"=200'	5.00'	
1"=100'	2.50'	
1"=50'	1.25'	
- ☎ Vertical Accuracy Standard (typical contour intervals)

<u>Contour Interval</u>	<u>Accuracy @ 90% (contours)</u>	<u>Accuracy @ 90% (spots)</u>
5'	2.50'	1.25'
4'	2.00'	1.00'
2'	1.00'	0.50'
1'	0.50'	0.25'

Virginia Map Accuracy Model (1992)

- 3 classes of accuracy
- Advantages of numerical levels
 - Assist map user in determining if data appropriate for their purpose
 - Provides capability to request & have producers deliver higher class maps
- Model applies to all scales greater than or equal to 1:100,000

Virginia Map Accuracy Model

- Horizontal accuracy
 - Root mean square (rms) error
 - Cumulative result of all errors including those from ground survey, map compilation, final extraction of map dimensions
 - Evaluation at ground scale
 - Limiting rms error – max. permissible for 90% of check points on map
- Vertical accuracy
 - Class I – for elevations: $\frac{1}{2}$ CI
 - For spot heights: $\frac{1}{6}$ CI

Virginia Map Accuracy Model

Planimetric and Vertical Coordinate Accuracy Requirements in Feet Ground X or Y or Z for Well-defined Points¹

Planimetric Classes (Limiting rms error, feet)			Typical Map Scale	Possible Contour Interval in Feet	Vertical Classes (Limiting rms error, feet)		
CLASS 1	CLASS 2	CLASS 3			CLASS 1	CLASS 2	CLASS 3
0.0500	0.1000	0.1500	1:60	0.05	0.0083	0.0167	0.0249
0.1000	0.2000	0.3000	1:120	0.10	0.0167	0.0333	0.0501
0.2000	0.4000	0.6000	1:240	0.20	0.0333	0.0667	0.0999

0.2500	0.5000	0.7500	1:300	0.25	0.0417	0.0833	0.1251
0.3000	0.6000	0.9000	1:360	0.30	0.0500	0.1000	0.1500
0.4000	0.8000	1.1200	1:480	0.40	0.0667	0.1333	0.2001
0.5000	1.0000	1.5000	1:600	0.50	0.0833	0.1667	0.2499
1.0000	2.0000	3.0000	1:1,200	1.00	0.1667	0.3333	0.5001
2.0000	4.0000	6.0000	1:2,400	2.00	0.3333	0.6667	0.9999
4.0000	8.0000	12.0000	1:4,800	4.00	0.6667	1.3333	2.0001
5.0000	10.0000	15.0000	1:6,000	5.00	0.8333	1.6667	2.4999
8.0000	16.0000	24.0000	1:9,600	8.00	1.3333	2.6667	3.9999
10.0000	20.0000	30.0000	1:12,000	10.00	1.6667	3.3333	5.0001
20.0000	40.0000	60.0000	1:24,000	20.00	3.3333	6.6667	9.9999
30.0000	60.0000	90.0000	1:36,000	30.00	5.0000	10.0000	15.0000
40.0000	80.0000	120.0000	1:48,000	40.00	6.6667	13.3333	20.0001
52.8000	105.6000	158.4000	1:63,360	50.00	8.8000	17.6000	26.4000

NEW JERSEY STANDARD

SCALE	CONTOUR INTERVALS	CULTURAL FEATURES	CONTOURS	SPOT ELEVATIONS	MAXIMUM SHEET SIZE
1"=200'	Five feet; accentuate each 25 ft. contour	90% shall be within 5' of the actual position; 10% shall not exceed 10.0' of actual position	90% shall not exceed 2.50' of the actual elevation; 10% shall not exceed 5.0' of actual elevation.	90% shall not exceed 1.25' of the actual elevation; 10% shall not exceed 2.5' of the actual elevation.	5.0 feet long and 2.5 feet wide.
1"=100'	Two feet; accentuate each 10 ft contour.	90% shall be within 2.5' of the actual position; 10% shall not exceed 5.0' of the actual position.	90% shall not exceed 1.00' of the actual elevation; 10% shall not exceed 2.0' of the actual elevation.	90% shall not exceed 0.50' of the actual elevation; 10% shall not exceed 1.0' of the actual elevation.	5.0 feet long and 2.5 feet wide.

NEW JERSEY STANDARD

SCALE	CONTOUR INTERVALS	CULTURAL FEATURES	CONTOURS	SPOT ELEVATIONS	MAXIMUM SHEET SIZE
1"=50' and 1"=30'	One foot; accentuate each 5 ft contour.	90% shall be within 1.0' of the actual position; 10% shall not exceed 2.0' of the actual position.	90% shall not exceed 0.50' of the actual elevation; 10% shall not exceed 1.0' of the actual elevation.	90% shall not exceed 0.25' of the actual elevation; 10% shall not exceed 0.5' of the actual elevation.	5.0 feet long and 3.5 feet wide.
As determined	As determined	90% shall be within 1/40th of the map scale actual position; 10% shall not exceed 1/20th of the map scale actual position.	90% shall not exceed one half of the contour interval of the actual elevation; 10% shall not exceed one contour interval of the actual elevation.	90% shall not exceed one quarter of the contour interval of the actual elevation; 10% shall not exceed one half of the contour interval of the actual elevation.	As determined