

Summary

Goal was to answer the following:

- Verify the accuracy of RTK?
- Can hard surfaces be collected with enough accuracy to pass confidence point standards?
- Can confidence points be collected with GPS single observation?
- How are elevations affected as you go outside of a transformation (site calibration) set?
- How is accuracy affected by distance from the base?
- What is the break point?

What is the accuracy of RTK?

Leica states that 99.9% of the time the accuracy of their GPS System 1200 is 10mm (0.033 ft.) + 1 ppm horizontal and 20mm (0.066 ft.) + 1 ppm vertical. They also recommend that One Step Transformations be no larger than 10 kilometers (about 6 miles).

The standard of 0.10 ft. for a positional tolerance was used to decide if any given horizontal or vertical measurements should be considered "good". As it happens 1 ppm for 6 miles is about 0.032 ft. plus 0.066 ft. equals 0.098 ft., or about 0.10 ft.

Out of about 180 measurements and more than a dozen various transformations applied to those measurements all the values were within 0.10 ft. of true when the rover was within 3 miles of the base and the GDOP was less than 6. For the distances between 3 and 6 miles from the base with the GDOP less than 6 only 4 measurements failed in elevation as follows:

| <u>Error in ft.</u> | <u>Miles From Base</u> |
|---------------------|------------------------|
| 0.13 | 3.0 |
| 0.11 | 5.2 |
| 0.14 | 5.7 |
| 0.11 | 5.8 |

This is about 2.2% of the all the data a bit worse than Leicas stated 0.1%. It should be noted that the conditions at the test site were nearly ideal being located in a farm and small community environment along Highways 99E and 228 in the Shedd, Halsey and Brownsville area. Although there was still many opportunities for multipath from traffic, buildings, trees, poles and trains.

Can hard surfaces be collected with enough accuracy to pass confidence point standards?

Yes, by following proper procedures. Even when following procedures at times there will be what we call a "flier". This is a measurement that happens from time to time, for no apparent reason and falls outside the 0.10 ft. tolerance. During this testing no measurements taken within any of the transformations came close to failing by 3 times or 0.30 ft.

Some exceptions where you wouldn't use GPS on hard surfaces would be:

- Where new construction matches the old.
- Gutter profiles or any area where drainage is critical.
- Bridge decks especially if the grade must be matched by future construction.

Can confidence points be collected with GPS single observation?

Any areas we collect topo data using GPS we should also be able to gather confidence points with the same technique.

How are elevations affected as you go outside of a transformation set?

As shown in the graphs not only the elevations but the northings are adversely affected going outside the transformation. This affect is not always immediate, in some instances the data was still ok as much as one mile outside the transformation limits.

How is accuracy affected by distance from the base?

The decrease in accuracy with distance from the base is not as radical or well defined as going outside the transformation set. Leica states the value of the error when increasing distance from the base as 1 ppm or about 0.01 ft. for every 2 miles. Many times with the rover 10 or 11 miles from the base and inside the transformation set, the measurements were within 0.10 ft or better. This was not consistent and the tendency was that beyond 5 or 6 miles the values would bounce around more as the distance from the base increased.

What is the break point.

The break point is definitely at 5 or 6 miles from the base providing measurements are within the transformation set. Results from this test indicate that within 6 miles of the base and with a GDOP below 6 about 98% of these measurements were better than 0.10 ft.

Conclusion

RTK accuracy is good enough to measure confidence points and most hard surfaces. The exception would be if the values are required to be equal to or less than 0.10 ft. 100% of the time. You can assume there will be an occasional flier. The fliers noted in this testing all fell well inside the confidence point standard for hard surfaces.

Both increases in distance from the base and distance outside the transformation have an adverse affect on accuracy. Distance outside the transformation has a more adverse and predictable effect.

In order to measure points within 0.10 ft. the following guidelines must be adhered to:

- Don't work with a GDOP over 6 or VDOP over 4.
- Maintain a phase solution when storing measurements.
- Keep One Step transformation size to 6 miles square or less.
- Stay close to the base, the closer the better within reason, no farther than 3 miles if possible.
- Stay within the transformation boundary as close as possible.
- Check in on known points periodically throughout the day especially when a long way from the base, when GDOP approaches 6 or if you suspect the possibility of multipath.
- Avoid working close to objects prone to causing multipath.
- A transformation (site calibration) is recommended.