

## GI AA Mailbag

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Tool tips for circular vials.



Figure 1. Circular vial with bubble centered in inscribed circle.

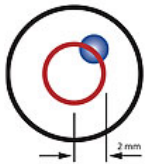


Figure 2. Circular vial with bubble 2 mm out of center.

**Q: When I use my prism/antenna poles, I've noticed that some are easier to hold still than others. My dealer told me this is because the "bubble sensitivity" of one is higher than the other, with the more-difficult-to-hold pole having higher sensitivity. How can this be?**

A: Bubble (or level vial) sensitivity is usually defined by manufacturers as an angular change in the position of the axis of the bubble per 2 mm of bubble movement. On most tubular (plate) vials, graduations are marked at 2 mm intervals. On circular vials, it is common to have an inscribed circle that has a 2 mm radius (4 mm diameter). When you say that some poles are "easier" to hold than others, it is because the easier poles have less sensitive circular vials. While not all-inclusive, the sensitivity of prism/antenna pole bubbles tend to be in the range of 30 to 60 arc-minutes. Thus, easier-to-hold poles

may have circular vials in the 60' range and the harder ones may be in the 30' range. When a pole appears to be easier to hold, it simply means that you see less movement of the bubble itself for a particular amount of movement of the prism or antenna than with a more sensitive vial. The sensitivity of the vial (whether circular or tubular) is controlled by the curvature of the glass; the larger the radius, the more sensitive the bubble.

It is a good idea to evaluate the sensitivity of your level vials if you aren't able to get information from the manufacturer, so that you can determine the impact of the position uncertainty of the prism or antenna in your survey. It can also help you determine whether you need to take extra measures such as using a brace pole to help steady the prism/antenna pole, or a tripod or bipod.

Determining uncertainty of the position of the prism or antenna is quite simple once you know the level vial sensitivity and your observation of the average "out of center" position of the bubble during the typical observation. Figure 1 shows a circular vial with the bubble centered in the inscribed circle. If your typical average is as represented by the bubble position in Figure 2, then the center of the bubble is 2 mm out of position with the center. (Figure 3 shows a tubular vial with the bubble 2 mm out of center.) The distance error would be determined by multiplying the tangent of the angle error represented by the bubble position by the height of the prism pole. If the vial has 60' sensitivity and the pole is 6 ft tall, the horizontal mis-centering would be 0.105 ft ( $\tan 60' \times 6$  ft). The direction of the error would be random and, in the case of total station measurement to a prism, would create a maximum distance error when the bubble is out of center along a direction that is parallel to the line being measured. If the bubble is out of center at right angles to that direction, the maximum angular error would result. In actual practice it would be a combination of the two.

**Q: I've noticed when surveying with my automatic level that even though I've centered the bubble, it moves out of center as I move the telescope right and left. Does this mean it is out of adjustment? How do I know and what should I do?**

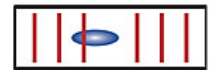


Figure 3. Tubular vial with bubble 2 mm out of center.

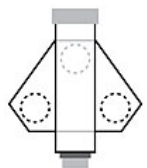


Figure 4. Automatic level telescope alignment in step (1).

A: As with all level vials, you should periodically perform tests to make sure that the vial is properly adjusted. This is quite simple on an automatic level. First, make sure that the tripod is well adjusted; the hinges especially should be snug. Then plant the tripod feet firmly in the ground. Next, attach the level to the tripod and level it up.

(1) Now align the telescope so that it is pointed along a line that passes through one of the three leveling screws and bisects the line connecting the two remaining leveling screws (see Figure 4). (2) Once you've made sure that the bubble is centered, turn the telescope, releasing the horizontal motion screw if necessary, so that the telescope is now pointing 180°. Any movement of the bubble from the center indicates twice the error in the adjustment of the bubble. Now find the adjusting screws (they may be underneath or on top of the vial) and the proper tool for turning them--generally there will be three screws. Using the same principle as when you level the circular bubble with the leveling screws, turn the adjusting screws until you bring the bubble halfway back from its position to the center. Now repeat steps (1) and (2) above to see if the process of adjusting has caused the instrument to move off level. If when

you turn the telescope 180° in step (2), the bubble stays perfectly centered, you've successfully adjusted the bubble. If not, repeat the adjusting process. With experience it will be possible to properly adjust the instrument with just one or two iterations.

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