have an angle encoder which is a greater distance (+/-5mm) from the detector. While there is not the close proximity of a stator and rotor, it doesn't mean that these won't be subject to error due to telescope axis movement; it just means that transport position is less critical.

Back to the carrying case: Instruments with encoders are best transported with the stator and rotor systems on end: that means, for almost all ETSs, face down. You will have to determine the proper positioning of the case for transport. It will probably not be the same position used to hand carry the ETS.

Now that the ETS is face down and the angle reading systems are protected, we must address vibration damage. Do you lock the motions or not? Old school says leave them loose. When loose, the stator and rotor systems are allowed some movement to and away from each other. We feel that the tangent locks should be lightly tightened to prevent the bearings from vibrating, while still allowing the motions to be moved by a hard shock. When snugged up, the movement is limited. Forcing the motions to rotate when the tangents are lightly tightened will not damage the equipment. These instruments are designed so that the angle reading systems are a separate assembly which is independent of the clamping mechanism forces. If the motions are left loose, there can be some movement that can cause bearing and retainer wear in a small area. If this wear occurs, the linearity and repeatability of the instrument can be degraded.

As always, remember ... take care of your equipment and it will serve you well.

If you have any questions about a specific instrument or would like to comment on this article, I can be contacted at The Technical Side, 1562 Linda Way, Sparks, NV 89431, or you may fax correspondence to (702) 359-6671. isto

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The Technical Side
Dual Axis Compensators

By Chris Cothrun, Service Technician, Ingenuity, Inc.

This time around we are discussing dual axis compensators. The HP 3820 was one of the first instruments to incorporate a dual axis compensator. Since then, many total stations offer this feature. In this article we will discuss the benefits and some things to watch out for with a dual axis compensator.

First, I'll provide some background information. When you set up your instrument you use the plat vial, which is usually no more accurate than 30 seconds per division. This typically allows levelling the instrument to within 10 seconds of absolute level. A single axis compensator, found on all but the most inexpensive total stations and theodolites, corrects the vertical angle for variations in levelling. Without it, the zenith angle is no better than the accuracy to which the instrument was levelled. The compensation axis is always in the same direction that the telescope is aimed. A dual axis compensator adds a compensation axis perpendicular to the vertical compensator. This is used to correct the horizontal angle when the instrument is not perfectly level and the telescope is inclined from horizontal. Picture an instrument set up badly out of level. When you transit the telescope the line of sight will not be perpendicular to the level plane. This introduces an error in the horizontal angle that depends on how far out of level the instrument is and how far from horizontal the telescope is. If your instrument is 30" out of level and your telescope is 10 degrees from horizontal the error would be 5". Increase the telescope attitude to 30 degree and the error increases to 17". Double the amount the instrument is mislevelled and the error doubles. The second axis in the compensator corrects for these errors.

This is used to correct the horizontal angle when the instrument is not perfectly level and the telescope is inclined from horizontal.

Sounds good so far, right? It even gets better. With a dual axis compensated instrument, a direct reading of the compensators is available. With this you can easily level the instrument to within five seconds of absolute level. You can also easily check the level to make sure your instrument hasn't changed its position.

What about problems? When the instrument changes level the compensator corrects for the change and affects the horizontal angle displayed. If this happens while you are turning angles and you try to check your backsight the azimuth to the backsight will be different. If you try to re-sight a point previously sighted, the azimuth displayed will not match the one previously measured. When this happens, try re-levelling the instrument. If the error was actually due to the level changing, the azimuth should match again. The actual angle measured from your backsight to a foresight should not change. If the angle is changing, look for errors beyond levelling.

We hope this article helps you understand your equipment better and lets you achieve greater accuracy in your work. Please send any questions to... The Technical Side, 1562 Linda Way, Sparks, NV 89431, or fax them to 702/359-6693. isto