General

Geometronics retains ownership of the survey equipment and assigns or loans it to managers of the survey crews along with the trust for its care and maintenance, and the requirement that it will be used in accordance with ODOT's policies.

There are 3 factors that can have an effect on care of survey equipment:

1. Working conditions (such as weather and topography)
2. Workers
3. Public

Besides caring for our survey equipment, if we want reliable, accurate survey results it is necessary to maintain our instruments.

This document will discuss the care and maintenance of tripods, tribrachs, PCMCIA Cards, Instruments, chargers and batteries.

EDM's and plumbing poles will not be discussed in this document though their care and maintenance is also significantly important.

- The survey instrument is the crew chief's responsibility. This includes the care, condition, calibration, safety, security, and the proper operation of the instrument and its supporting survey equipment.

- Instruments should not be left unattended. Be overly cautious of the instrument when surveying using remote control. Never leave the instrument in the vehicle for extended periods of time or overnight when the vehicle is unsecured or in an unsecured or questionable area. Always take the instrument into your room when you are on travel status.

- Take ownership of the equipment you use, but don't permanently mark or engrave it with your name, crew number, or anything else as these markings will remain with the equipment if it becomes someone else's responsibility and/or is transferred.

Care

Tripods

- Geometronics policy is that all tripods must be capped when they are not in use (being stored or transported). The surface of the tripod head is machined for a reason. If it is damaged it can have a detrimental effect on your surveys. Even very small and unnoticeable nicks or gouges can have a negative effect on the instrument operation.

- Legs should be set solidly and wide enough for the site, but set the tripod legs with care, using body weight only. Do not twist them and do not exert excessive pressure on them.

- Tripod leg weights are required to prevent the tripod and its attached equipment from being blown over in high winds, and by wind and snow from passing traffic. Leg weights can also prevent the equipment from moving, or being jostled, or even knocked over in many other situations. Tripods that fall over are a major cause of survey equipment damage and leg weights should be used anytime the setup's stability is in question. Legs should also be set wider apart in these situations.

- Proper positioning of the tripod legs in high wind situations is two legs toward the oncoming wind and one leg away from the high wind (or in the direction the wind is blowing). If possible, it is best to set as many legs as practical in the dirt.

- Proper positioning of the tripod legs in traffic situations is two legs toward the oncoming traffic and one leg away from the oncoming traffic (or in the direction of the traffic flow). If possible, it is best to set as many legs as practical in the dirt.

- Clean the tripods off at the end of the day before they are put away.

Tribrachs

- Transport tribrachs in the vehicles in their proper padded cases - not on the tripods. This helps protect the tribrach from dust, dirt, the weather, and damage (especially to the machined surface contact points).

- Do not overtighten the tribrach mounting screw when attaching the tribrach to the tripod.

- In extreme cold tribrach optics may steam up if taken indoors during non-working periods.

PCMCIA Cards

- Try to keep card in plastic card case when not in use, especially when carrying the card on your person (e.g. in your pockets).
- Avoid exposing the card to possible magnetic and electrical energy sources.
- Connection Pins – Keep pins clean and dry. Blow away any dirt lodged in the pins.
- Keep card dry.
- Operating temperature –20 ºC to +70 ºC.
- Do not bend.
- Do not drop.

Theodolites

- DO NOT POINT THE INSTRUMENT DIRECTLY AT THE SUN or other highly reflective surfaces. The telescope acts as a magnifying lens and can injure your eyes or damage the internal components (diodes) of the EDM, ATR and EGL. "THE ATR WILL NOT LOCK ON THE SUN."
  Solar observations are **not** permitted for total stations and theodolites with attached EDM's. Solar observations are permitted for short periods with a solar eyepiece filter that is marked with a sun symbol.

- Instruments are not suitable for use in aggressive (hostile) or explosive environments not suitable for unprotected humans, though this is normally not an issue in ODOT.

- Allow instruments to acclimatize, before use, to the temperature the instrument will be operating at. A good rule for this is approximately 1minute acclimatization time/ 1º C change in temperature. This formula does not apply to surveyors.

- Instruments should not, if at all possible, be stored in a room close to a heat source or transported close to a heat source as this will require more acclimatization time. Instruments are best stored in a secure location, at outside temperature, to minimize temperature fluctuation and prevent steaming up of optics and condensation in the instrument.

- When drying or storing a wet instrument, that normally lies down in its case, remove the instrument from the case and stand the instrument upright. Bringing an instrument indoors, from the vehicle, at the end of the day and removing it from its case is recommended to eliminate any possible condensation problems. If an instrument has become wet it should be wiped carefully and the container opened as soon as possible to allow the instrument to dry out completely. Never leave a damp instrument in a closed container. Leave the case open and upside down to dry. Do not apply heat.

- Instruments are water-resistant from the top down – not from the bottom up. The bottom of the instrument is not sealed.

- Dirt and dust should be removed only with a clean soft cloth or with a soft brush. (If a cloth is used it should be a many-times-washed soft cotton.) Water may be used to lightly wash from the top down, but do not clean with air or water pressure. Let the water do the dirt removal. Do not force water up underneath the instrument or in the eyepiece assembly. If necessary, moisten the cloth with pure alcohol (from pharmacists). Use no other liquids; these may attack polymer components.

- Instruments frequently used in dry, dusty areas should be cleaned often. Damage from dust & dirt is not as immediate as with water, but they can be very abrasive and eventually work into the instrument seals over time.

- Inspect cables and plugs occasionally. Plugs and sockets should be kept dry and clean. If a connection-cable plug becomes dirty blow away any dirt lodged in the plug or wash in spirit and allow to dry.

- If you accidentally immerse the instrument in salt water, leave it there and go get a pail of fresh water. Submerse the instrument in the pail of fresh water and take it in to the shop. Exposure to the air, after immersion in salt water, could cause corrosion of the contacts and onboard circuitry.

- Objective, eyepiece and prisms should be treated with particular care.
  Blow dust off lenses and prisms. It is permissible to breathe on the lenses before wiping them, but liquids such as oil, benzine, etc. should never be used for any cleaning. Lenses should never be touched or rubbed with fingers. Use only a clean, soft and lint-free cloth for cleaning. If necessary, moisten the cloth with pure alcohol (from pharmacists). Use no other liquids; these may attack polymer components.

- Fogging of prisms: Reflector prisms that are cooler than the ambient temperature tend to fog. It is not enough simply to wipe them. Keep them for some time inside your jacket or in the vehicle to allow them to adjust to the ambient temperature.

- Use a tarp or cover under/over the instrument case in the field. A small tarp can be carried with the instrument and part of it placed on the ground under the case or backpack to keep it clean and dry. The remainder of the tarp can be pulled over the case to keep it clean and out of the elements. Also, when using the instrument in the field always close the transport case.

- Pad the area in your vehicle where you keep the instrument to protect the instrument from bumping and jarring. Instruments with locking tangent screws should not be jarred. When transporting the equipment in the field always make sure to carry the instrument in its original transport case or backpack. Only the level may be carried on the tripod with its legs splayed across your shoulder keeping the attached instrument upright.

- If the instrument lies down in its case, try to position the case so the instrument will be upright whenever possible. If the instrument is wet this position will allow the water to run away from the areas that are not rainproof. If the instrument has been lying down in its case allow a few minutes for the compensator to acclimatize before setup.

- Motorized instruments should not be manually turned when the motor is engaged.

- Geometronics is recommending instruments, under normal field use, be routinely serviced at no less than18 month intervals. This may be shortened for instruments subjected to use in harsh environments.

Chargers and Batteries

- Keeping the batteries warm will enhance the life of their charge. The lower the operating temperature, the lower the capacity available for measurement tasks (at -20 ºC only about 50% of the nominal capacity).

- Persistent excessively-high temperatures shorten the life of the battery.

- Even when there appears to be no outward signs of damage, dropping batteries can ruin them by loosening them up internally.

- Charge batteries indoors, in dry rooms @ room temperature – not @ extreme temperatures. Protect the chargers from the damp for reasons of electrical safety.

- Wherever possible, store batteries in dry rooms at temperatures of between 0 ºC and +20 ºC.

- The permitted temperature range for operation is -20 ºC to +50 ºC.

Maintenance

Tripods

- If the finish on the legs gets chipped or scratched, they should be sealed or touched up with paint, nail polish, or some other sealer to protect the wood from the elements. This can prevent loosening and movement from swelling and shrinking, and other possible damage to the tripod.

- The connections between metal and wood leg components must always be firm and tight. Tighten the Allen screws moderately.

- The tripod shoes (feet) must be tight, the dowels must not twist and each tripod leg must be snug in its connection to the tripod head. There are two tests to check this. Stand the tripod up with the feet apart in the normal fashion and then lift the tripod off the ground by the tripod head. If the legs swing in and slam together, the connections are too loose (or the bushings are in need of replacement). If the legs swing in slightly but do not bang together, the connections are just right. The second test is just as simple. Set up a Theodolite on the tripod and point to a well-defined target. While sighting the target, twist the tripod head (not the tribrach) with your thumb and finger of each hand. The telescope crosshairs should move off the target but return when the tripod head is released. If the crosshairs do not return to the exact point, the connections are in need of adjustment. The tripod head should not twist on the tripod legs.

- If the instrument consistently goes off level slightly, and the leg clamps are tight, replace the shims in the leg clamps to keep them from slipping.

Tribrachs

- Tribrachs should be checked and adjusted before the first use, before each precision survey, and whenever their accuracy and/or reliability is in question. There are two areas of concern on tribrachs, the level bubble (which is not important on the instrument setup) and the Optical Plummet:

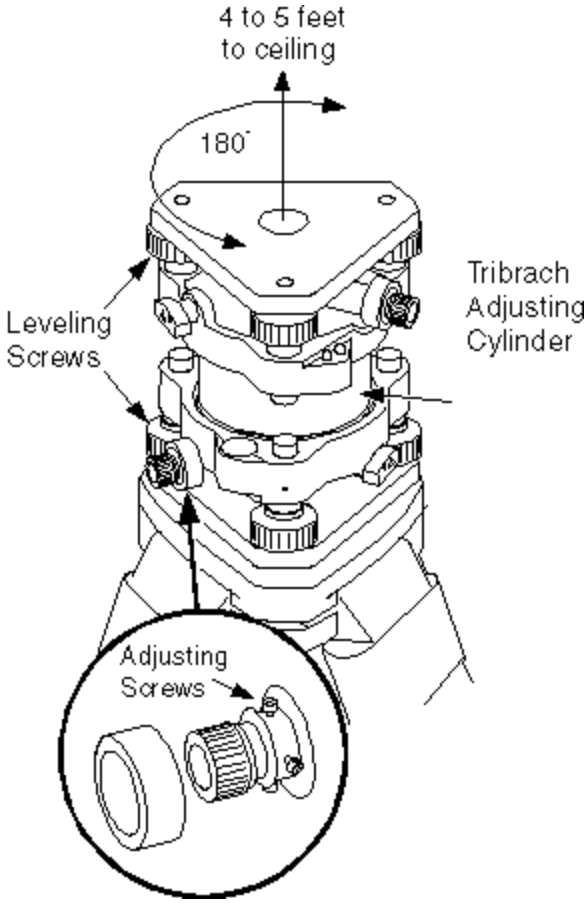
1. To adjust the level bubble, set up a tripod, the tribrach needing adjustment, and a theodolite. Level the theodolite using its plate bubble (or electronics) and then check the tribrach bubble and adjust to the center, if needed.

2. To adjust the Optical Plummet there are several methods that can be used. Shown below is an example of a method using a Tribrach Adjusting Cylinder (or hockey puck).

Optical Plummet Adjustment Using Tribrach Adjusting Cylinder

Equipment Needed: Tribrach Adjusting Cylinder, Tripod, 2 tribrachs, ceiling target

1. Place the tribrach on the tripod. Put the adjuster in the tribrach. Place the tribrach to be adjusted on top of the adjuster so that it is upsidedown looking at the target on the ceiling. The distance between the tribrach and target should be between 4 and 5 feet.
2. Using the leveling screws of the bottom tribrach, point the crosshair of the tribrach being tested to coincide with the target.
3. Rotate the tribrach being tested 180 degrees on the adjuster. Crosshairs will stay on the target of an adjusted tribrach.
4. After 180 degree turn if the crosshair does not stay on the target, half the error should be corrected with the adjusting screws provided by the manufacturer of the tribrach. The remainder should be corrected with the leveling screws of the bottom tribrach.
5. Repeat steps 2, 3 & 4 until the crosshair stays on target at all positions.



PCMCIA Cards

- In CardWizard the card should be stopped before removing it to allow the system to properly process the removal to avoid losing data on the card.
- After inserting a PCMCIA card in the computer it may be necessary to View Refresh in Explorer before the card drive is recognized.
- Always back out to the Main Menu and switch off the instrument before removing the PCMCIA card.
- If, for any reason the card is bad, it could corrupt the instrument onboard programs e.g. if an attempt is made to format the bad card on the instrument instead of on the computer.
- Write protect lock OFF during normal use.
- Battery lock ON during normal use.

Theodolites

- Instrument maintenance involves calibration (or checking and adjusting) of the instrument.

- Calibration is the re-determining of instrument errors.

- Calibration can be done in the field and the new values accepted if the procedures, as stated in the following Leica documents, are followed. These values change due to variables such as weather and operator changes or if something has compromised the instrument.

- Calibration should be done for the reasons stated in the following Leica ' Checking and adjusting ' document, but not necessarily in that order.

- Calibration should be done whenever the adjustment is in question.

- The instrument errors change with temperature, vibration, and after long periods of transport. If you want to measure, with as little error as possible, in just one face, then immediately before the measurements you must determine the instrument errors and store them.

- Shade bubbles. Bubbles always move towards heat.

From Leica TPS - System 1000 manual - page 175

Checking and adjusting

Electronically

In general, the instrument possesses the following mechanical errors:

- (l, t) Index error from the 2-axis compensator
- (i) Index error from the vertical encoding circle
- (c) Line-of-sight error
- (a) Tilting-axis error
- (ATR) Collimation of the target recognition axis (TCA versions only)

The above instrument errors can change over time and with temperature.
They should, therefore, be redetermined in the order shown below:

- before the first use
- before each precision survey
- after long periods of transport
- after long periods of work
- if the temperature alters by more than 20°C

Before determining the instrument errors, level-up the instrument using the electronic bubble. The instrument should be secure and firm, and should be protected from direct sunlight in order to avoid thermal warming on one side only.

CA

The determination of the instrument errors can be started in any telescope face.

Activate the function F2 in the main menu.

From Leica ' Surveying made easy ' document - page 24 & 25

Instrument errors in the total station

Ideally, the total station should meet the following requirements:

a) Line of sight ZZ perpendicular to tilting axis KK
b) Tilting axis KK perpendicular to vertical axis VV
c) Vertical axis VV strictly vertical
d) Vertical-circle reading precisely zero at the zenith

If these conditions are not met, the following terms are used to describe the particular errors:

a) Line-of-sight error, or collimation error c (deviation from the right angle between the line of sight and the tilting axis)
b) Tilting-axis error a (deviation from the right angle between the tilting axis and the vertical axis)
c) Vertical-axis tilt (angle between plumb line and vertical axis).

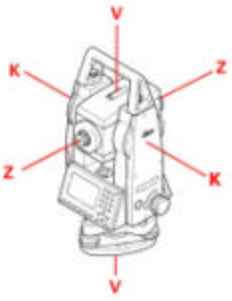
The effects of these three errors on the measurement of horizontal angles increase with the height difference between the target points.

Taking measurements in both telescope faces eliminates line-of-sight errors and tilting-axis errors. The line-of-sight error (and, for highly-precise total stations, also the tilting-axis error, which is generally very small) can also be determined and stored. These errors are then taken into consideration automatically whenever an angle is measured, and then it is possible to take measurements practically free of error even using just one telescope face. The determination of these errors, and their storage, are described in detail in the appropriate user manual. Vertical-axis tilt does not rate as being an instrument error; it arises because the instrument has not been adequately levelled up, and measuring in both telescope faces cannot eliminate it. Its influence on the measurement of the horizontal and vertical angles is automatically corrected by means of a two-axis compensator.

d) Height-index error i (the angle between the zenith direction and the zero reading of the vertical circle, i.e. the vertical-circle reading when using a horizontal line of sight), is not 100 gon (90°), but 100 gon + i.

By measuring in both faces and then averaging, the index error is eliminated; it can also be determined and stored.

Note:
The instrument errors change with temperature, as a result of vibration, and after long periods of transport. If you want to measure in just one face, then immediately before the measurements you must determine the instrument errors and store them.



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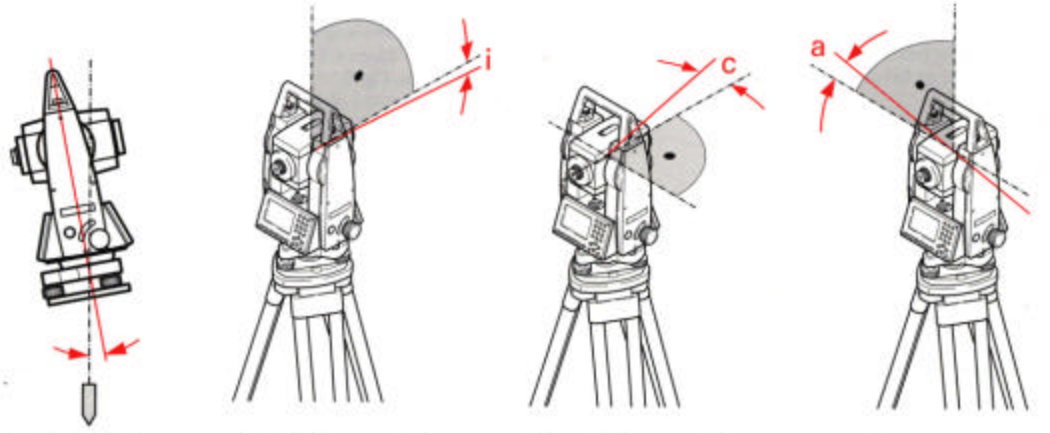
Instrument errors



Vertical-axis tilt

Height-index error (i)
(V index)

Line-of-sight error (c)
(Hz collimation)

Tilting-axis error (a)

Compensator index error for the longitudinal and transverse axes of the compensator

Chargers and Batteries

Charging Procedure:

- The chargers supply a controlled current, which will completely recharge a flat battery in 14 hours.

- The life of a battery is limited largely by the number of times that it is charged and discharged, and so these additional discharge cycles will reduce the battery life considerably.

Charging the batteries:

- New batteries are charged for 14 hours with the appropriate charger. The batteries then reach their full capacity after four or five charge/discharge cycles. To speed up this activation procedure, we recommend you to prolong the period of charging to 20-24 hours on the first occasion. This also applies to batteries which have not been used for several months.

- Flat batteries, and ones the charge of which is not known, are to be charged 14 hours. Charging for longer period with a Leica charger does not damage the battery.

- Batteries may be charged only at temperatures of between +10 ºC and +30 ºC. Habitual charging at temperatures outside this range will shorten the life of the battery. Warning: Charging at temperatures below 0 ºC can irreparably damage the battery.

- The more these type of batteries are used the stronger they seem to be. We recommend using all batteries on a regular basis. If they are not used, their nature is to weaken. Any battery that has not been used for some time probably should be deep cycled once or twice. Normal procedure would be to charge the batteries on a daily basis and discharge or deep cycle batteries every 20 charging cycles or once a month. If using this routine, the batteries need not be completely down before charging, unless they seem to be weakening. If they do weaken, deep cycle the battery.

- To deep cycle a battery, connect battery to charger, disconnect and reconnect to the charger within two seconds. Normal charging, simply connect charger to battery.