CHAPTER 2

Equipment

Chapter Contents

Sec. 2.01 Responsibility and Inventory

It is the responsibility of the State Location and Design Engineer or their representative to secure, assign and keep in good working order all major surveying instruments and equipment.

An Equipment List shall be kept on each survey party of all equipment with a purchase cost of $2,000 or more. In addition, all equipment that is furnished by the Central Office is to be kept on the Equipment List. The list is to be kept up to date and readily available upon request.

All major equipment with a purchase cost of $ 2,000 or more shall be added to the Major Inventory data base via the procurement section and a VDOT property tag is to be attached to the equipment upon receiving said equipment. The Major Equipment database is to be kept up to date with the transfer and disposal of major equipment. Central Office is responsible for the major equipment database.

The assignment of instruments within a district is the responsibility of the District Survey Manager. This should be reported bi-annually to the GeoSpatial Program Manager.

In the event a survey party is disbanded, all instruments and equipment should be returned to District Stock.

Sec. 2.02 Care and Adjustment of Instruments

Electronic Total Station and Data Collector

The electronic total station and the data collector are two of the most important instruments used by the survey party, each representing a considerable monetary investment. The electronic total station may be a robotic instrument, a robotically assisted instrument or a manually operated instrument. Likewise, the data collector may be a traditional handheld electronic field book or a tablet style handheld computer. These are all carefully adjusted scientific instruments constructed to a very fine degree of accuracy and precision. They are necessarily delicate, very sensitive to vibration and subject to being seriously damaged by careless handling. The realization of just what a survey instrument is and how it should be handled is an essential requirement of any competent instrument (survey) technician. Each Total Station and Data Collector has an operator's manual containing instructions on operating procedures. Every operator should read and become familiar with the procedures before attempting to operate these instruments.

When not in use, all instruments should be placed in its carrying case, or protective cover, even when it is necessary to suspend work. Before climbing a fence or similar obstacle, the instrument should be put in the carrying case and, along with the tripod, placed on the other side. **Under no circumstances should an instrument be carried on the tripod**, and under no circumstances should the equipment be positioned in a vehicle so that it could bounce around. If the Total Station or Data Collector have been exposed to inclement weather, they must be wiped dry as soon as possible, in any event, as soon as brought indoors. Drying electronic equipment after use is always required, even if the equipment has been identified by the manufacturer’s IP code as having reasonable protection from inclement weather conditions.

Global Positioning System (GPS) Equipment

Modern GPS or GNSS antennae are typically compact and simple in appearance when compared to the more widely recognized electronic surveying equipment. Nonetheless, a GPS antenna is still a rather complex and intricate piece of electronic hardware which needs to be handled with care to prevent accidental damage. The GPS antenna, sometimes referred to as a receiver, also represents a significant monetary investment and each survey party member should thoroughly familiarize themselves with the operator's manual. GPS antenna typically have multiple communication ports, each designed for a specific purpose. Connections that are incorrectly made, or made using the wrong cable could result in serious and costly damage to the unit.

Levels

Many levels have been assigned to the District Survey offices and other VDOT Divisions and Departments. These instruments also are delicate, very sensitive to vibration and subject to serious damage by careless handling. The Survey Manager should facilitate minor adjustments, in accordance with the manufacturer's recommended procedures, and cleaning when necessary. They should never be disassembled except as authorized by the Survey Manager and then only by an experienced and qualified technician. If these instruments have been exposed to inclement weather, they must be wiped dry as soon as possible, in any event, as soon as brought indoors.

General Care and Cleaning

The Land Surveyor Supervisor is responsible for all equipment and at no time shall a senior technician assign these instruments to the care of a junior technician unless authorized to do so. Electronic equipment should be thoroughly dried and cleaned of any surface dirt/dust prior to being stored away after work is complete. Likewise, the carrying case or protective cover should be dried and cleaned, both inside the case and the outer shell. Extra care should be taken to ensure the batteries and the battery compartments are dry and clean. The lens and eyepiece of an instrument, display windows and touch screens of instruments and data collectors are of particular concern when cleaning and drying the electronic equipment. Drying and cleaning should always be done in accordance with the manufacturer's recommended procedures using only approved cleaning materials and methods.

Electronic survey equipment and survey levels should never be transported loose in the survey vehicle. They should be transported in their product case and properly secured. It may be necessary to provide additional padding for the cased instrument when travelling over rough terrain to prevent damage by excessive vibration or bouncing.

Storage and Shipping

Careful consideration should be given to the location where instruments are stored when not in use, and every possible precaution should be taken to ensure that they are not damaged, vandalized or stolen. Storage areas for electronic equipment and optical survey instruments should be secure, climate controlled, well organized and kept clean at all times.

Under ordinary circumstances, instruments should not be shipped, but carried inside their product case as described above. Should circumstances require that an instrument be shipped, it should be secured in its case and then placed in a sturdy box or shipping container. Packing paper, foam rubber, bubble wrap and/or other suitable materials should be placed carefully and snugly into the box around it. Notify the recipient in advance of sending the instrument to provide them with the shipping details and ensure the package can be properly tracked during shipment.

If it is sent in for repairs, **ONLY** the instrument should be sent along with a detailed report of why repairs are needed. Any accessories ordinarily kept in the equipment case should be placed in a safe storage area and kept separate from other supplies so they may be reunited with the instrument once repairs are complete. A record of the equipment sent, complete with all identifying information and serial numbers, and a record of the overall instrument condition shall be kept. The equipment is to be examined for physical damage and then field "checked" to ensure it is working properly prior to be placed back into normal service. Do Not Assume an instrument is fixed and properly calibrated when it returns from shipping and/or service, verification is a must.

Sec. 2.03 Field Controllers and/or Data Collectors

Since field controllers and/or data collectors have become available, various programs have been developed which will help the user solve most routine surveying calculations. This applies mainly to the alphanumeric programmable type collectors with continuous memory. Scheduled firmware and software updates will generally be pushed out from the Central Office. Other available programs, when needed, may be obtained by contacting the Central Office Survey Support Group.

Sec. 2.04 Electronic Distance Meter (EDM) Reflector (Prism) Constants

The direction of a light wave, and thus the speed of a light wave, is influenced by the substance which it passes through, and this is known as a refractive index. Air has a refractive index considered as 1.00, whereas glass can have a refractive index ranging from about 1.5 to almost 2. Meaning light is about 1.5 to 2 times slower when passing through glass than it is when passing through the air. Electronic distance meters (EDM's) that use a retro-reflector (prism) are dependent on measuring a light wave that has passed through glass. Since the composition of glass determines its refractive index, the type of prism used must be considered and the manufacturer's specifications for that prism must be followed.

An EDM Reflector (Prism) Constant must be applied to electronic distance measurements in order to account for the refractive index of the glass and the path of light into and from the prism. The most common prism constants are 0.00 mm and 30.0 mm but some prism manufacturers use prism constants of 17.5 mm, 23.1 mm and 34.4 mm as variant examples. The prism constant, which varies with the different types of reflectors and its holder configuration, is usually noted in the reflector specifications and corrected within the EDM system or applied as a correction (prism constant) within the data collection software. In any case, it must be taken into account, because failure to do so can result in serious errors.

Electronic distance meters are an integral part of an electronic total station, built directly into the instrument's system. Some instruments use both near infrared light waves that are dependent upon having a retro-reflector prism to return the light signal, as well as having a direct reflect capability. Unlike the continuous light wave used with prisms, the direct reflect EDM uses pulsed laser emissions, of a defined duration and rate of repetition, to calculate the time of flight of the reflected signal. The direct reflect or pulsed laser EDM can be used to measure distances to most reflective surfaces without the use of a survey prism. When using a dual EDM type instrument, it is very important to make sure that you are using the correct prism constant for each measurement taken, especially when collecting data using both prism mode and non-prism mode during the same instrument set-up.

Sec. 2.05 Survey and Miscellaneous Supplies

Surveying and miscellaneous supplies shall be obtained through the District Office, either from the District supply or by requisition.

Sec. 2.06 Periodic Checks of Electronic Total Stations and Accessories

A suitable range should be established in each District to check the Electronic Distance Meters and accessories at approximately three (3) month intervals. Adjacent districts may establish a shared testing range upon approval from the State GeoSpatial Program Manager. The periodic equipment test shall include both horizontal and vertical distance checks and also shall include all tribrachs and prism poles. Survey instruments should be serviced and calibrated by a qualified service technician certified by the equipment manufacturer as recommended by the manufacturer. All servicing will be coordinated with the GeoSpatial Program Manager and the Survey Support Supervisors by using the email address of GeoSpatial-info@VDOT.virginia.gov.

Sec. 2.07 Routine Equipment Checks

In addition to the periodic checks of electronic total stations and accessories as described above, it is important to conduct routine equipment checks on a more regular basis. Routine equipment checks may be conducted at the direction of the District Survey Manager and/or initiated by the field personnel that use the equipment on a regular basis. Routine equipment checks should be conducted anytime the field crew members notice a series or a pattern of inconsistencies and/or discrepancies. It is also advisable to check equipment prior to beginning a new project or before beginning any project task requiring a high degree of precision and accuracy. These checks may include, but are not limited to; "peg-test" for survey levels, running self-calibration routines available within internal electronic instrument programs, verifying the height of prism poles by direct measurement of the pole from tip to prism center, checking optical and laser plummets to ensure the instrument is set directly over the point, checking the circular bubble level on prism poles, tightening the legs and tribrach plate on tripods and more. The survey crew should remain vigilant and mindful that significant errors may be introduced into the data measurements by simple, and often easily correctable, issues with un-calibrated instruments/equipment.

Sec. 2.08 GPS

The GPS equipment must be maintained with the utmost care possible. All auxiliary components of the GPS receiver (antenna) must be inventoried and returned to the case after each use. Damage to any of the auxiliary components must be reported immediately to the supervisor and arrangements made to have the damaged parts repaired or replaced. Anytime a GPS receiver is impacted, falls over, is dropped or otherwise damaged in any way it must be reported to the District Survey Manager and an email sent to: GeoSpatial-info@VDOT.virginia.gov. It is important to note, that since most GPS receivers are compact and sealed units, the extent of any possible damage may not be easily observed. If damage is suspected, though not readily apparent, the GPS receiver should be checked by observing a known point.

Repair work shall only be performed by a qualified service technician certified by the equipment manufacturer. Under no circumstance shall the instrument case be opened or field adjustments made. Updates to the onboard firmware shall be coordinated by Central Office Geospatial and installed according to manufacturer's guidelines.