AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

FOR

ENGINEERING

(3E5X1)

MODULE 13

SURVEYING

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MODULE 13

SURVEYING

Career Field Education and Training Plan (CFETP) references from 1 Apr 02 version.

OPR: HQ AFCESA/CEOF
(SMSgt Pat Abbott)
Supersedes AFQTP 3E5X1-12, 1 May 01

Certified by: HQ AFCESA/CEOF
(CMSgt Myrl F. Kibbe)
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AIR FORCE QUALIFICATION TRAINING PACKAGES
FOR
ENGINEERING
(3E5X1)

INTRODUCTION

Before starting this AFQTP, refer to and read the "AFQTP Trainer/Trainee Guide."

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

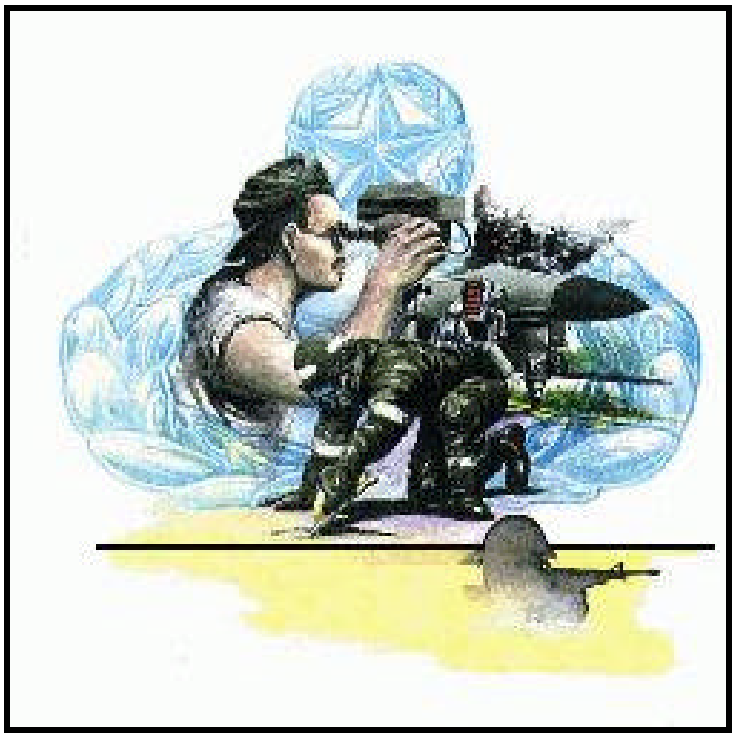
Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location*.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

HQ AFCESA/CEOF
139 Barnes Dr. Suite 1
Tyndall AFB FL 32403-5319
DSN: 523-6322, Comm: (850) 283-6322
Fax: DSN 523-6488
E-mail: ceof.helpdesk@tyndall.af.mil

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.



MANUAL SURVEYING

MODULE 13 AFQTP UNIT 1

ESTABLISH HORIZONTAL CONTROL (13.1.3.)

(MANUALLY) ESTABLISH HORIZONTAL CONTROL

Task Training Guide

STS Reference Number/Title:	13.1.3. – (Manually) establish horizontal control.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Surveying, Fourth Edition by Jack McCormac. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. Army FM 5-233. 2.2. Surveying, Fourth Edition by Jack McCormac. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying.***
Equipment/Tools Required:	1. 100' steel tape. 2. Theodolite. 3. Level. 4. Range pole. 5. Taping arrows. 6. Tension scale and handle. 7. Scissors clamp. 8. Hand or engineer level. 9. Leveling rod. 10. Axes, hatches, or machetes. 11. Plumb bob. 12. Hub. 13. Guard stakes. 14. Thermometer. 15. Traverse computation sheet. 16. Calculator.
Learning Objective:	Given equipment, trainee will be able to establish horizontal control.
Samples of Behavior:	1. The trainee will be able to measure horizontal angles and distances. 2. The trainee will be able to accurately complete an open and closed traverse. 3. The trainee will be able to complete a Traverse Computation Sheet.
Notes:	
1. For training purposes, have trainee re-accomplish previously completed traverses. 2. Use hands-on training to accomplish learning objective. 3. Train to a "Go" level.	

(MANUALLY) ESTABLISH HORIZONTAL CONTROL

1. Background.

1.1. Survey points must be located relative to some type of control system--basic, supplemental, or auxiliary. The position of the point will be established with some degree of permanency. Relative positions of points can be determined within a local control system (state or municipal). If such control is tied into geodetic control, positions of the points can be computed with respect to national or worldwide systems or by the use of a Global Positioning System (GPS). The main control scheme is a network either of triangulation or traverses based on the Compass Rule. These should be near the points to be tied in to reduce supplementary control requirements. Supplementary control consists of short traverse or triangulation lines that run close to or across a project area. These stations must be established to a degree of accuracy required by the survey's purpose. If a main control scheme must be run first, it should be accurate enough for the supplementary survey to furnish proper accuracy for the detail.

1.2. A traverse is classified as either open or closed. The purpose of the traverse will usually govern whether its stations will be marked permanently or temporarily. When you know that a traverse station may be reused for several years, use a permanent station marker, otherwise use temporary marking.

1.2.1. A **closed** traverse means the traverse begins and closes on a known point.

1.2.2. An **open** traverse ends at a station whose relative position is not previously known and provides no checks against mistakes or large errors.

2. To manually establish horizon control, follow these steps:

Step 1: Reconnaissance. Use the best available maps and aerial photographs during both office and field reconnaissance.

1.1. Select start and closing points. Your starting point should be an existing control station that was determined by a survey with order of accuracy equal to or greater than the traverse to be run. A second existing control station, visible from the first, should be used to orient the new traverse. If no nearby station exists, the starting point must be determined by some other method (for example GPS). It may be assigned an assumed position, or you may have to determine the position from observation of stars.

1.2. Route selection. Traverses are usually run to establish new stations (control) in the area. Location of the required stations is specified, at least in terms of vicinity or distance between stations. Clearing for traverse lines should be kept to a minimum. When in a contingency environment, some mass clearing may be acceptable if force protection or speed of survey completion is required. In most peacetime operations where traverse lines are run through private property, indiscriminate tree cutting isn't allowed.

Step 2: Set-up procedures for instrument.

2.1. Set up tripod over starting station.

2.2. Attach instrument to tripod.

2.3. Plumb instrument over station.

2.4. Level instrument.

Step 3: Field procedures.

3.1. Backsight to rear station.

3.2. Initialize the horizontal angle on the rear station.

3.3. Turn angle clockwise to the forward station.

3.4. Record horizontal angle value in field notebook.

3.5. Measure linear distance to forward station.

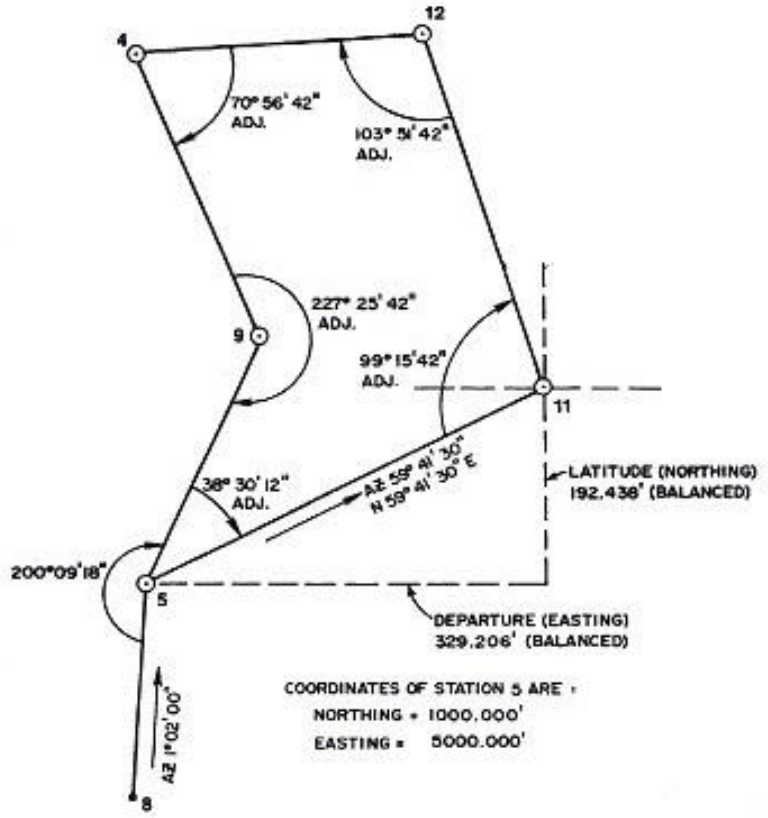
3.6. Record linear distance value in field notebook.

NOTE:
To continue traverse, move to forward station and repeat steps 2 & 3 until reaching closing point.

Step 4: Complete Traverse Computation Sheet (for enlarged version of the sheet, refer to Foldouts 1-3 of the CDC 3E551A Engineering Journeyman, Volume 4, Supplementary Material).

4.1. Sketch the layout of the survey in the area provided at the bottom left hand corner of the transverse computation sheet.

Figure 1. Sketch



4.2. Number the stations on the sketch to correspond with your field notes.

4.3. Record station data in column 1 as per figure 2.

4.4. Record linear distance between stations in column 2.

4.5. Record horizontal angle value, between rear and forward stations, in column 3.

4.6. If a closed traverse has been accomplished, compute the adjusted angles between stations using the following steps and enter adjusted angles in column 4.

4.6.1. Compute the measured sum of the interior angles by adding all angles in column 3.

4.6.2. Compute the mathematical sum of the interior angles by subtracting 2 from the total number of sides in the polygon, then multiply that number by 180º. (N-2) 180

4.6.3. If the measured sum equals 540º 01' 30", subtract 540º 00' 00" to get 0º 01' 30" as our angular error of closure (AEC).

4.6.4. Divide the AEC by the number of interior angles in your polygon.

4.6.5. Since the measured sum is greater than the mathematical sum, subtract the adjustment calculated in step 4 from each angle in column 3 of the worksheet. If the measured sum is less than the mathematical sum, add the adjustment to each angle in column 3. Enter the adjusted angles in column 4.

4.7. Compute the azimuth of each line using the known azimuth from the control points and enter value in column 5.

4.8. Compute the bearing of each line using the azimuth in column 5 and enter the value in column 6.

4.9. Using your calculator, compute the cosine and sine of each bearing angle and enter those values in columns 7 & 8, respectively.

4.10. Calculate the latitude (distance north and south) and departure (distance east and west) by multiplying, respectively, the cosine, and sine of the bearing times the distance of the traverse line. Enter those values in columns 9 through 12.

NOTE:
The latitude N 59º 41' 30" E is North (positive) and the departure is east (positive). South and West directions are negative. Be sure to use the correct column. If you don't, the linear error of closure (LEC) will not compute.

4.11. Apply a correction to the latitudes and departures using the following steps:

4.11.1. Total the values in column 9 through 12 as per figure 2 on page 13-10.

4.11.2. Calculate the difference between columns 9 & 10 ΔY's, and columns 11 & 12 ΔX's.

4.11.3. Calculate the LEC using the formula - LEC = Square Root of (ΔY squared + ΔX squared).

4.11.4. Calculate the Precision using the formula - Precision = total distance in column 2 divided by the LEC.

4.11.5. Calculate the latitude correction per foot by using the formula - Latitude correction = ΔY divided by total distance in column 2.

4.11.6. Calculate the departure correction per foot by using the formula - Departure correction = ΔX divided by the total distance in column 2.

4.12. Balance latitudes using the following steps:

4.12.1. Multiply the correction for latitude times the distance (column 2), and apply this product to the latitude (column 9 or 10) to find the balanced latitude (column 13).

4.12.2. If the total North latitudes are larger than the total south latitudes, subtract corrections from north and add to South.

4.12.3. If the total South latitudes are larger, add corrections to North and subtract from South.

4.13. Balance departures exactly the same as latitudes, multiply the correction for departure times the distance (column 2), and apply this product to the departure (column 11 or 12) to find the balanced departure (column 14). If the total east departures are larger than the total west departures, subtract corrections from the east and add to the West. If total east departures are less than the total West departures, add corrections to the East and subtract from the West.

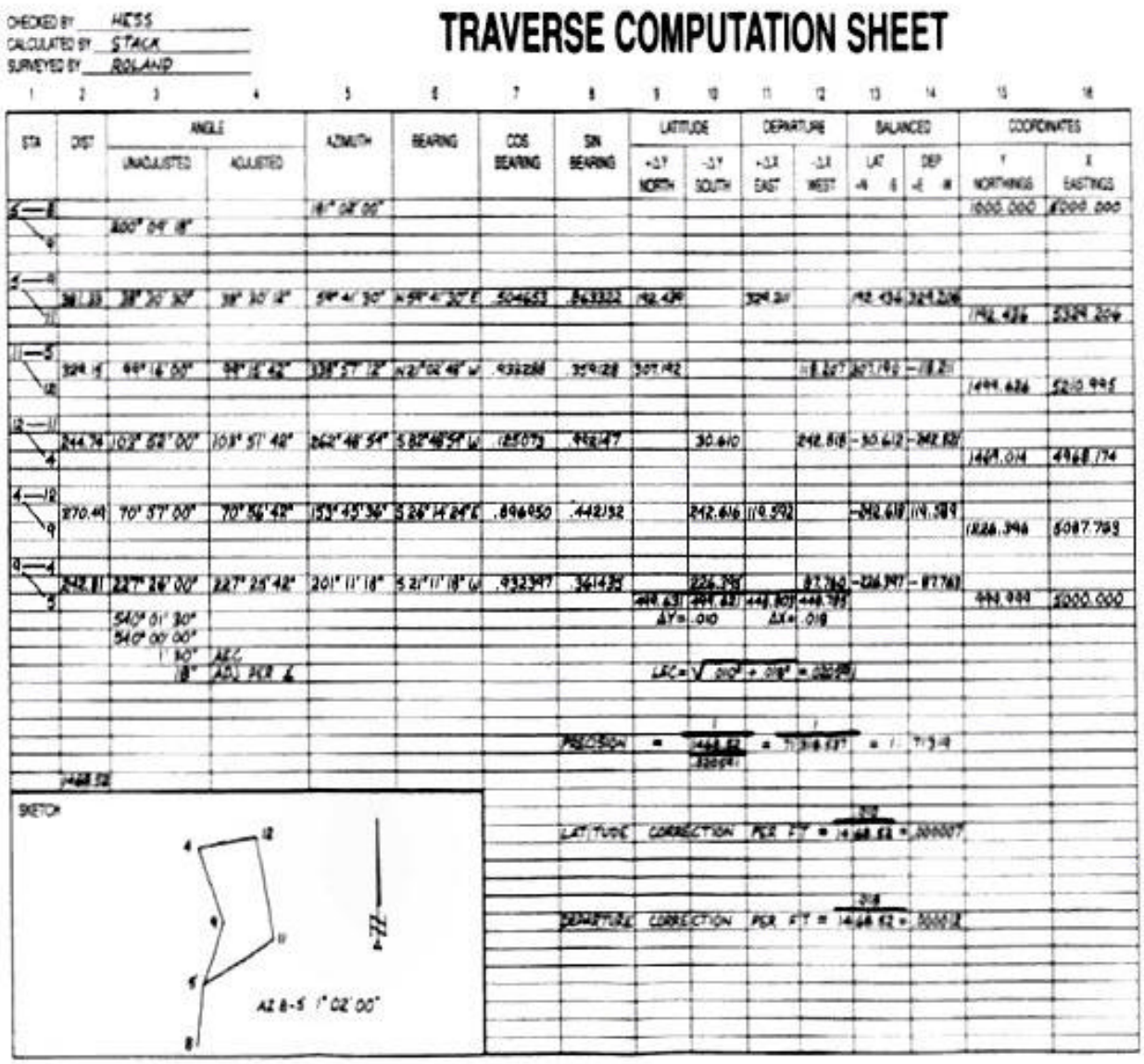
NOTE:
North latitudes are positive and South latitudes are negative. East departures are positive and West departures are negative.

4.14. Using the Northing and Easting from your control point, calculate the new Northings and Eastings using the following steps:

4.14.1. Start with the known or assumed coordinates for your control point and algebraically add the balanced latitudes (column 13) to the Northings.

4.14.2. Algebraically add the balanced departures (column 14) to the Eastings.

Figure 2. Traverse Computation Sheet



REVIEW QUESTIONS
FOR
(MANUALLY) ESTABLISH HORIZONTAL CONTROL

QUESTION	ANSWER
1. What is a traverse?	Written answer.
2. What are the two kinds of traverse?	a. Connecting and Loop. b. Convex and Loop. c. Open and Closed. d. Connect 4 format and Loop.
3. North latitudes are positive and South latitudes are negative.	a. True. b. False.
4. East departures are negative and West departures are positive.	a. True. b. False.
5. What does the term closed traverse mean?	Written answer.
6. A closed traverse provides no checks against mistakes or large errors.	a. True. b. False.

(MANUALLY) ESTABLISH HORIZONTAL CONTROL

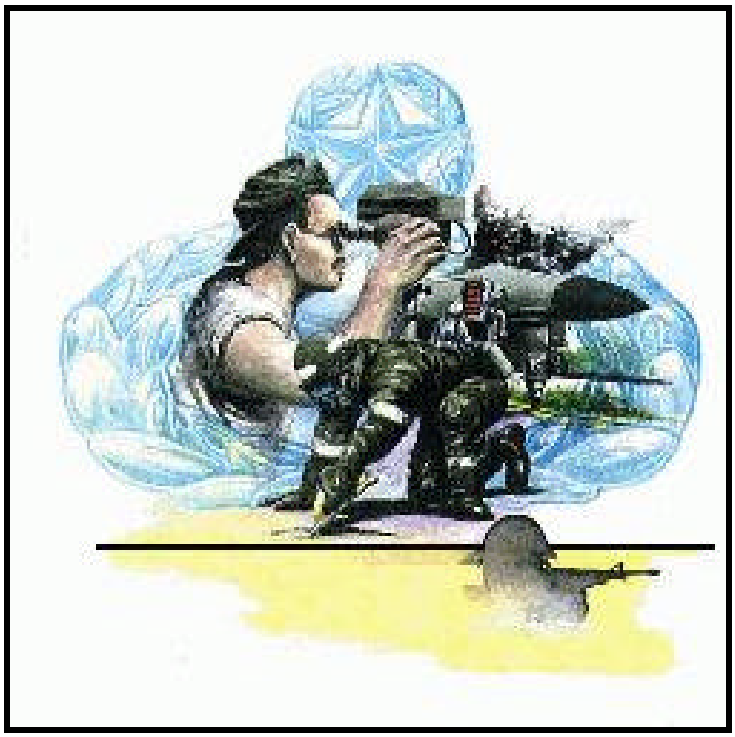
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. while performing reconnaissance: 1.1. select start and closing points? 1.2. select a good route?		
2. while performing instrument setup: 2.1. correctly setup tripod? 2.2. correctly attach instrument? 2.3. correctly level instrument? 2.4. correctly set instrument plumb over starting point?		
3. while performing field procedures: 3.1. initialize instrument on rear station? 3.2. properly read and annotated horizontal angle? 3.3. properly read and annotated linear distance?		
4. while computing traverse computation sheet: 4.1. accurately sketch survey? 4.2. properly transfer information from field notebook to worksheet? 4.3. properly compute adjusted angles? 4.4. properly compute Azimuth of each line? 4.5. properly compute bearing of each line? 4.6. properly compute Sine and Cosine of bearing angle? 4.7. correctly compute Latitude? 4.8. correctly compute Departure? 4.9. properly apply corrections to Latitudes and Departures? 4.10. properly balance Latitudes and Departures? 4.11. properly calculate Northings and Eastings?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



MANUAL SURVEYING

MODULE 13 AFQTP UNIT 1

MEASURE AND COMPUTE HORIZONTAL ANGLES (13.1.4.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL ANGLES

Task Training Guide

STS Reference Number/Title:	13.1.4. – (Manually) measure and compute horizontal angles.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Surveying, Fourth Edition by Jack McCormac. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. Army FM 5-233. 2.2. Surveying, Fourth Edition by Jack McCormac. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.**
Equipment/Tools Required:	1. 100' steel tape. 2. Theodolite. 3. Range pole. 4. Taping arrows. 5. Tension scale. 6. Tension handle. 7. Scissors clamp. 8. Hand or engineer level. 9. Leveling rod. 10. Axes, hatches, or machetes. 11. Plumb bob. 12. Hub. 13. Guard stakes. 14. Thermometer. 15. Traverse computation sheet. 16. Calculator.
Learning Objective:	Given the equipment, trainee will be able to measure and compute horizontal angles.
Samples of Behavior:	The trainee will be able to measure and compute horizontal angles.
Notes:	
1. Use hands-on training to accomplish learning objective. 2. Train to a "Go" level.	

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL ANGLES

1. Background.

1.1. The relative directions of traverse lines are determined from measurements of the horizontal angle formed by the lines at each station. Horizontal angles are measured with a theodolite and are always measured at the occupied station.

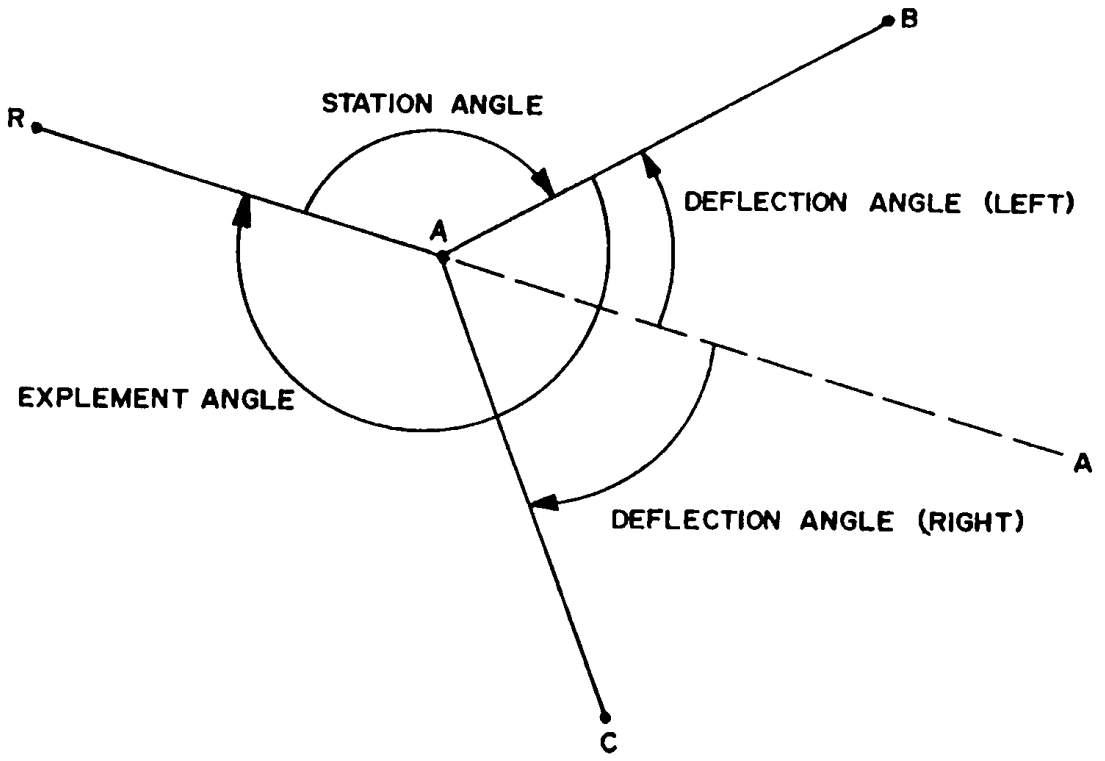
1.2. Types of measured angles. (See Figure 1)

2.2.1. Station angles.

2.2.2. Explement angles.

2.2.3. Deflection angles.

Figure 1. Measured Angles



2. To manually measure and compute horizontal angles, follow these steps:

Step 1: Select start and closing points.

Step 2: Field procedures.

2.1. Sight the instrument on the rear station and turn the angle clockwise to the forward station for the direct angle.

2.2. Record horizontal angle value in field notebook.

2.3. Sight the instrument on the forward station then turn clockwise the rear station for the explement angle.

2.4. Record horizontal angle value in field notebook.

2.5. After sighting on the rear station plunge the instrument. If your station angle is less than 180 degrees turn the angle to the left to get your deflection angle. If your station angle is greater than 180 degrees you would turn the angle right to get your deflection angle.

2.6. Record horizontal angle value in field notebook.

NOTE:

1. To continue traverse, move to forward station and repeat steps 2.1-2.4 until reaching closing point.
2. When sighting on stations, it's good practice to point on the part of the station target that can cause the least amount of error. If you're using a range pole, sight the lowest visible point so any mis-plumbing of the pole will have the least effect on the angle reading. Heat waves rising from the ground can also introduce distortions. Make every effort possible to get the truest pointing.

REVIEW QUESTIONS
FOR
(MANUALLY) MEASURE AND COMPUTE HORIZONTAL ANGLES

QUESTION	ANSWER
1. In what three ways may an angle be observed?	a. Station, Explement, and Exterior. b. Station, Explement, and Deflection. c. Station, Deflection, and Interior.
2. What do we call an angle observed by backsighting a station, then measuring clockwise to forward station?	a. Explement. b. Deflection. c. Station.
3. What two angles equal 360 degrees?	a. Station and Explement. b. Deflection and Station. c. Explement and Deflection.

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL ANGLES

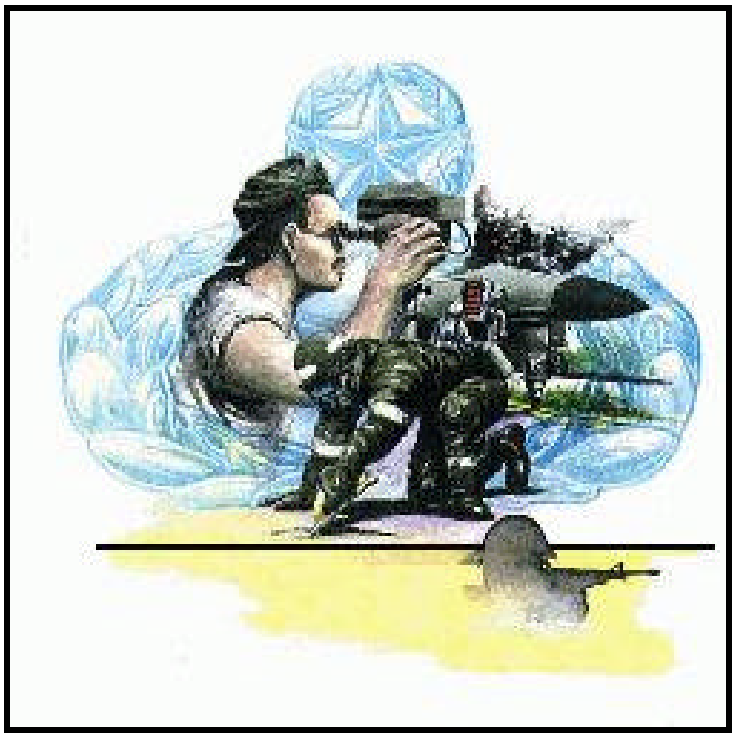
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. understand the three ways to observe an angle?		
2. proficiently turn and record angles?		
3. make every effort possible to get the truest sighting?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



MANUAL SURVEYING

MODULE 13 AFQTP UNIT 1

MEASURE AND COMPUTE HORIZONTAL DISTANCES (13.1.5.)

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL DISTANCES

Task Training Guide

STS Reference Number/Title:	13.1.5. - Manually measure and compute horizontal distances.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Surveying, Fourth Edition by Jack McCormac. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 1, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. Army FM 5-233. 2.2. Surveying, Fourth Edition by Jack McCormac. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 1, *Plane Surveying*.**
Equipment/Tools Required:	1. 100' steel tape. 2. Range pole. 3. Taping arrows. 4. Tension scale. 5. Tension handle. 6. Scissors clamp. 7. Axes, hatches, or machetes. 8. Plumb bob. 9. Hub. 10. Guard stakes. 11. Thermometer. 12. Calculator.
Learning Objective:	Given the equipment, trainee will be able to measure and compute horizontal distances.
Samples of Behavior:	The trainee will be able to measure and compute horizontal distances.
Notes:	
1. Use hands-on training to accomplish learning objective. 2. Train to a "Go" level.	

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL DISTANCES

1. Background. When an Electronic Measuring Device is not available to record distances manual-taping practices must be used. The principles of measuring horizontal distances are generally the same for any order of accuracy. However, the procedures used and the corrections may vary.

2. To manually measure and compute horizontal distances, follow these steps:

Step 1: Review Measuring Principles and Equipment, Career Development Course (CDC) 3E551A Volume 3, Unit 1, Plane Surveying.

Step 2: In the field apply principles reviewed in step 1.

REVIEW QUESTIONS
FOR
(MANUALLY) MEASURE AND COMPUTE HORIZONTAL DISTANCES

QUESTION	ANSWER
1. What is accuracy?	a. Accuracy is the quality of your work. b. Accuracy is the quality of the result.
2. What is precision?	a. Precision is the quality of your work. b. Precision is the quality of the result.
3. How many members are usually on a taping party?	a. 2. b. 3. c. 4.

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL DISTANCES

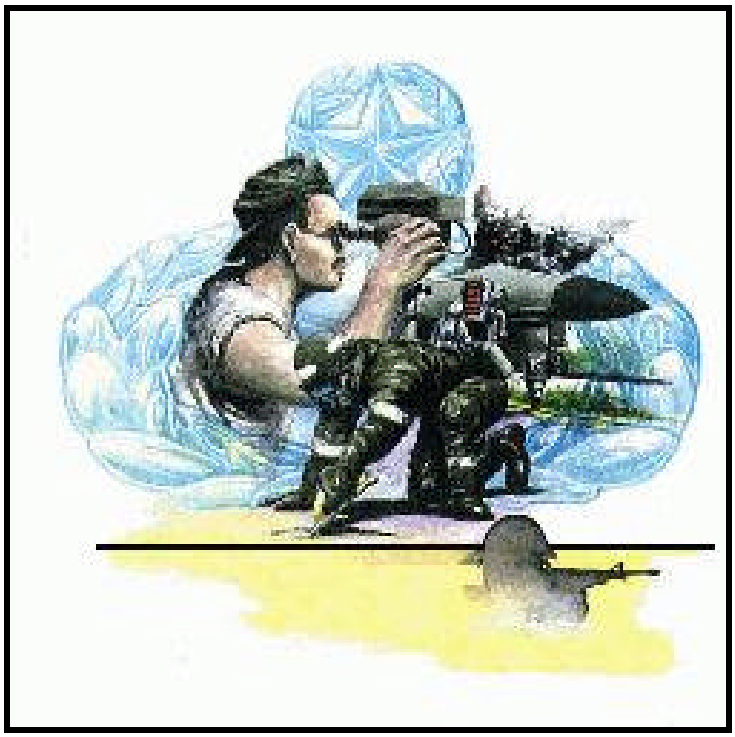
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. tape a distance to a prescribed order of accuracy?		
2. tape a distance using proper procedures?		
3. understand the difference between accuracy and precision?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



MANUAL SURVEYING

MODULE 13 AFQTP UNIT 1

ESTABLISH VERTICAL CONTROL (13.1.7.)

(MANUALLY) ESTABLISH VERTICAL CONTROL

Task Training Guide

STS Reference Number/Title:	13.1.7. – Manually establish vertical control.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*. 3. Surveying, Fourth Edition by Jack McCormac.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. FM 5-233. 2.2. Surveying, Fourth Edition by Jack McCormac. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2**
Equipment/Tools Required:	1. Engineer level. 2. Leveling rod. 3. Axes, hatches, or machetes. 4. Plumb bob. 5. Hub. 6. Guard stakes. 7. Thermometer. 8. Calculator. 9. Field notebook.
Learning Objective:	Given the equipment, trainee will be able to establish vertical control.
Samples of Behavior:	1. The trainee will be able to transfer vertical control from a known point to an unknown point with third order accuracy. 2. The trainee will be able to complete a level circuit.
Notes:	
Train to a “Go” level.	

(MANUALLY) ESTABLISH VERTICAL CONTROL

1. Background.

1.1. Very few, if any, construction projects can be completed based on horizontal position only. Vertical positions must also be known. A body of still water will assume a level surface. If changes in the ocean's surface, caused by such influences as tides, currents, winds, atmospheric pressure, and the rotation of the earth could be eliminated, the resulting surface would be level. The ocean's level tidal height observations are determined over a Metonic cycle (approximately 19 calendar years). This average, called mean sea level, is the most common datum for leveling and is usually assigned an elevation of zero. This datum remains in effect until continuing observations show a significant difference, and it becomes worthwhile to change to a new datum. In the United States, the mean sea level datum of 1929 is still in effect.

1.2. Types of Leveling. Leveling is divided into two major categories, direct and indirect.

1.2.1. Direct Leveling is usually referred to as differential or spirit leveling. In this method the difference is elevation between a known elevation and the height of instrument, and then the difference in elevation from the instrument height to an unknown point are determined by measuring the vertical distance with a precise or semi-precise level and leveling rods. This is the only method that will yield accuracy of third or higher order.

1.2.2. Indirect Leveling. There are two methods of doing indirect leveling, trigonometric and barometric.

1.2.2.1. Trigonometric applies the fundamentals of trigonometry to determine the differences in elevation by observing vertical angles (above or below a horizontal plane) and a horizontal distance (measured or computed) to compute the vertical distance between points. This method is generally used for lower order leveling where the terrain is prohibitive to direct leveling.

1.2.2.2. Barometric uses the differences in atmospheric pressure as observed with a barometer or altimeter to determine the differences in elevation between points. This is the least used and least accurate method of determined differences in elevations. This method should only be used in surveys when one of the other methods is unfeasible or would involve great expense in time or money. Generally in surveying, this method is used for small scale mapping projects and field surveys as necessary.

2. To manually establish vertical control, follow these steps:

Step 1: Reconnaissance. Use the best available maps and aerial photographs during both office and field reconnaissance.

1.1. Select start and closing points. Your starting point should be an existing control station that was determined by a survey with order of accuracy equal to or greater than the traverse to be run. A second existing control station, visible from the first, should be used to orient the new traverse. If no nearby station exists, the starting point must be determined by some other method. It may be assigned an assumed position, or you may have to determine the position from observation of stars.

1.2. Route Selection. Traverses are usually run to establish new stations (control) in the area. Location of the required stations is specified, at least in terms of vicinity or distance between stations. Clearing for traverse lines should be kept to a minimum. When in a contingency environment, some mass clearing may be acceptable if force protection or speed of survey completion is required. In most peacetime operations, where traverse lines are run through private property, indiscriminate tree cutting isn't allowed.

Step 2: Set-up procedures for instrument.

2.1. Set up instrument at a point between the start and closing point.

NOTE:
Depending on your equipment this point should be no more than 300 feet from your start point. It also must allow for a clear line of sight to the start point.

2.2. Place auto-level on tripod and secure.

2.3. Level instrument using the leveling screws and circular bubble.

Step 3: Field Procedures.

3.1. Record elevation of starting point in field notebook.

3.2. Rodman holds a rod vertically on the start point with a known elevation.

3.3. Instrument man makes a level reading through the telescope on the Philadelphia rod (this is known as a backsight or BS) also make a stadia distance reading.

NOTE:
To calculate the stadia distance, take a rod reading at the upper and lower (stadia) cross hairs. The difference is the stadia intercept. Multiply the stadia intercept by the stadia interval ratio. 1:100 is the most commonly used ratio. When it is necessary to determine or to check the stadia interval factor, refer to your survey manual.

3.4. Record these readings in the field notebook.

3.5. Add the BS to the known elevation of the starting point; this gives you the height of instrument or HI.

3.6. Rodman now moves to a point between the instrument and the closing point.

NOTE:
This point should be approximately the same distance the instrument was set up from the BS. This procedure should be continued throughout the level circuit. This will prevent possible error in line of sight adjusting.

3.7. Instrument man now rotates instrument to focus on the new rod position and takes a level reading through the telescope (this is known as a foresight FS) also make a stadia distance reading.

3.8. Record these readings in the field notebook.

3.9. Subtract the FS from the HI; this will give you the elevation of the point the rod is setting on.

NOTE:
It is very important to remember backsights are always added and foresights are always subtracted. This will prevent errors in calculating your final elevation.

3.10. After completion of the foresight reading, the instrument man now moves to a new position between the rod and the closing point and repeats the setup procedures in Step 2. The existing rod position now becomes the backsight.

3.11. Repeat the process in Step 3 until the elevation is transferred to the closing point.

NOTE:
It is always good practice to close your survey to a point of known elevation. This may require you to return to your original starting point or continue on to a different point with a known elevation.

Step 4: Determining the adjusted elevation.

4.1. Total the backsight readings in the field notebook.

4.2. Total the foresight readings in the field notebook.

4.3. Find the difference between the BS column and the FS column.

4.4. Find the difference between the beginning known elevation and the ending known elevation.

4.5. Compare the two differences; if they are different, an error has been made in determining the height of instrument or elevations.

4.6. Total the distance column in the field notebook, and convert it to miles using the formula - Distance column total / 5280 ft = xx.xx miles (M).

4.7. Calculate the allowable error of closure (AEC) using the formula - AEC = +/- 0.05 (square root of M).

4.8. Find the difference between the ending point known elevation and your computed ending point elevation.

4.9. If the difference is within the limits of the AEC, the survey meets the accuracy requirements for a third order survey. If the difference is not within the limits of the AEC, the survey must be redone.

4.10. Take the difference and divide it by the number of set-ups; this will give you the adjustment.

4.11. If the computed elevation is too low, add adjustments. If the computed elevation is too high, subtract adjustments.

4.12. Add one fraction of the total error (the computed adjustment) to the first set-up elevation.

4.13. Add two fractions of the total error to the second set-up elevation and three to the third.

4.14. Continue this process until you complete the adjustments to all set-ups, the final set-up should have the entire adjustment added to it.

REVIEW QUESTIONS
FOR
(MANUALLY) ESTABLISH VERTICAL CONTROL

QUESTION	ANSWER
1. What are the two methods for performing indirect leveling?	a. Trigonometric and barometric. b. Trigonometric and geometric. c. Algometric and barometric. d. Thermometric and barometric.
2. What are the two major categories of leveling?	a. Horizontal and vertical. b. Trigonometric and barometric. c. Direct and indirect. d. Vertical and diagonal.
3. Backsights are always subtracted from the known elevation.	a. True. b. False.
4. You should always attempt to balance your backsight and foresight distances.	a. True. b. False.
5. To close a level circuit you may return to your starting point or continue to another point of known elevation.	a. True. b. False.

(MANUALLY) ESTABLISH VERTICAL CONTROL

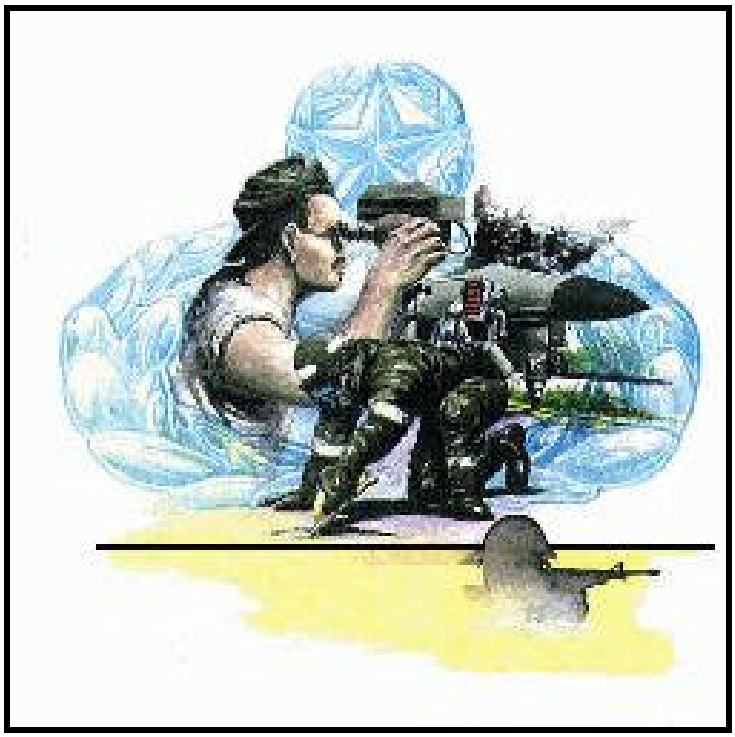
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….?	YES	NO
1. while performing reconnaissance: 1.1. select start and closing points? 1.2. select a good route?		
2. while performing instrument setup: 2.1. properly setup tripod? 2.2. correctly attachment instrument? 2.3. correctly complete leveling procedures?		
3. while performing field procedures: 3.1. properly read backsight? 3.2. properly read stadia? 3.3. properly calculate the height of instrument? 3.4. properly read foresight? 3.5. properly calculate the elevation at the new location? 3.6. properly wave the rod? 3.7. use secure turning points?		
4. while determining the adjusted elevation: 4.1. verify backsight and foresight differences equal the known elevation difference? 4.2. properly convert total distance to miles? 4.3. properly calculate the AEC? 4.4. determine if the survey met third order accuracy? 4.5. properly calculate the adjustment? 4.6. properly apply the adjustment?		

FEEDBACK: Trainer/Certify should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



MANUAL SURVEYING

MODULE 12 AFQTP UNIT 1

PERFORM TOPOGRAPHIC SURVEY (13.1.17.)

(MANUALLY) PERFORM TOPOGRAPHIC SURVEY

Task Training Guide

STS Reference Number/Title:	13.1.17. –Manually perform topographic survey.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Army FM 3-34.230, *Topographic Operations*. 3. Army FM 3-34.331, *Topographic Surveying*. 4. Army Engineer Manual (EM) 1110-1-1005, *Engineering and Design - Topographic Surveying*. 5. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. FM 5-233, 3-34.230, and 3-34.331. 2.2. EM 1110-1-1005. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2.**
Equipment/Tools Required:	1. Calculator. 2. 100’ and 300’ measuring tape. 3. Drawing media (Vellum). 4. Pencil. 5. Triangle. 6. Umbrella. 7. Notebook. 8. Theodolite or level with tripod. 9. Level rods.
Learning Objective:	Given the equipment, trainee will be able to perform a topographic survey.
Samples of Behavior:	The trainee will be able to determine contours through use of the radiation method by stadia observations.
Notes:	
Due to the availability of equipment and shop uniques, use established in-house steps and procedures to accomplish your hands-on training objective. This AFQTP is designed to reacquaint and/or jog your memory prior to initiating training in this area.	

(MANUALLY) PERFORM TOPOGRAPHIC SURVEY

1. Background.

1.1. The purpose of a topographical survey is to document the shape, configuration, relief, roughness, or three-dimensional quality of the earth's surface. Topographical maps are made to show this information, together with the location of artificial and natural features of the earth including buildings, roads, bodies of water, vegetation, and so forth. Topographical maps are a critical part of any construction endeavor and is the basis of performing many forms of reconnaissance such as bare base planning and aircraft crash surveys. Resection, intersection, and radiation are commonly used forms of topographical surveying however, regardless of the type used, your results will be a direct reflection of you abilities to apply systemic procedures. Stadia is used to establish horizontal distances since high order accuracy is not required.

1.2. The next unit will cover the actual plotting of the data. For now we'll focus on the procedures for gathering the actual data.

2. To manually perform topographic survey, follow these steps:

Step 1: Make map. Draw a 200' x 200' detail map of the area to be used to perform the topographic survey.

Step 2: Select topographic equipment. Obtain the necessary equipment to perform the survey.

Step 3: Layout grid. Set up a total dimension grid of 200' x 200' with grid points marked at 25' x 25' inside this grid.

Step 4: Establish baseline. Select any two points in the area of the survey. One should be a benchmark with a known elevation.

Step 5: Set-up instrument. Set up the tripod and instrument and level instrument.

Step 6: Observe backsight. Read backsight station.

Step 7: Compute height of instrument. Add the backsight reading to the known elevation of the station.

Step 8: Observe grid points.

8.1. Read foresight at all grid and key points.

8.2. Read top wire reading, center wiring reading, and bottom wire reading if telescope is level measure vertical angle.

8.3. Record values.

8.4. Radiate level rod out to all points encompassing the complete grid.

8.5. Read horizontal angle for any point of detail object.

REVIEW QUESTIONS
FOR
(MANUALLY) PERFORM TOPOGRAPHIC SURVEY

QUESTION	ANSWER
1. Resection, intersection, and radiation are three methods you can use to locate points in the field.	a. True. b. False.
2. What types of reconnaissance can be performed with topographical surveying?	a. Written Answer.
3. Tapes and stadia measure horizontal distances.	a. True. b. False.
4. What accuracy can be expected from stadia distance measurement?	a. 0.1-foot. b. Right foot. c. 3rd order accuracy. d. 1 metric foot per day.

(MANUALLY) PERFORM TOPOGRAPHIC SURVEY

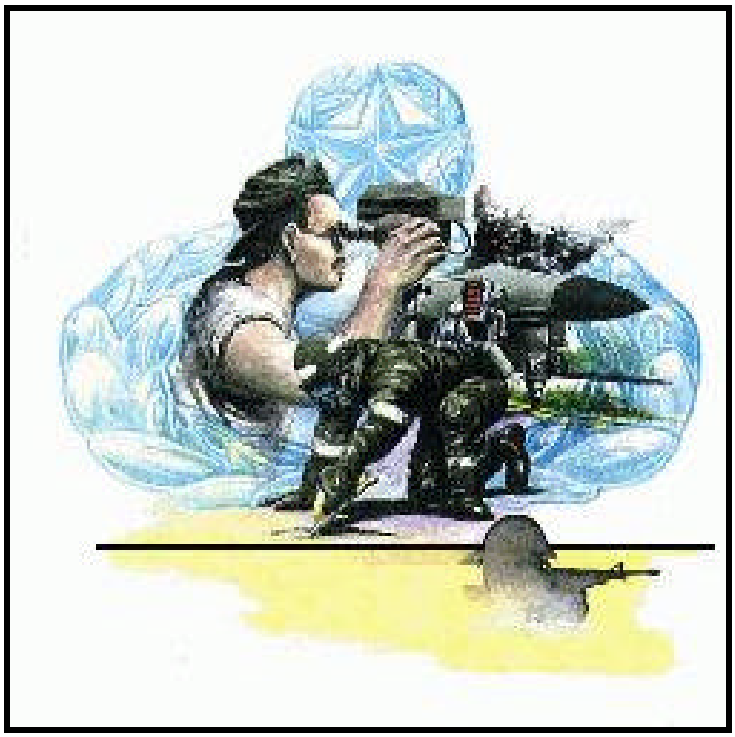
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. make a map of the area?		
2. select correct topographic equipment?		
3. lay out grid?		
4. set up and level instrument correctly?		
5. observe back sight?		
6. compute height of instrument?		
7. observe grid points?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



MANUAL SURVEYING

MODULE 13 AFQTP UNIT 1

PRODUCE TOPOGRAPHIC MAP (13.1.18.)

(MANUALLY) PRODUCE TOPOGRAPHIC MAP

Task Training Guide

STS Reference Number/Title:	13.1.18. – Manually produce topographic map.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the FM 5-233.** 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2.**
Equipment/Tools Required:	1. Calculator. 2. Drawing media (vellum). 3. Pencils. 4. Scales. 5. Large triangle. 6. Field notes.
Learning Objective:	Given the equipment, trainee will be able produce a topographic map.
Samples of Behavior:	1. The trainee will be able to plot contour lines. 2. The trainee will be able to interpolate values.
Notes:	
Due to the availability of equipment and shop uniques, use established in-house steps and procedures to accomplish your hands-on training objective. This AFQTP is designed to reacquaint and/or jog your memory prior to initiating training in this area.	

(MANUALLY) PRODUCE TOPOGRAPHIC MAP

1. Background. The topographic map establishes enough relief and planimetric detail within the prescribed area to locate any obstacles and allow preparation of rough profiles and cross sections. A topographic map can be accomplished in either the *field* or *office*. Topographic mapping plays an important part in any construction operation. The resulting map that you or your subordinates create will affect the operation of the construction force in a beneficial way or a detrimental way, so care must be taken in the proper location of all natural and artificial feature and identification of elevations. For mapping large areas, modern photogrammetrical methods have almost entirely replaced field topographic surveying methods. Photogrammetric topographic maps are usually made for reproduction in large quantities at scales of 1:25,000 or smaller, with contour intervals of 10-feet or more. Regardless of modern advancements, small areas must often be mapped to a larger scale, and with a smaller contour interval by field topographic surveying methods

2. To manually produce topographic map, follow these steps:

Step 1: Determine map scale.

1.1. Given a 17” x 22” paper size for a 200’ x 200’ site size.

1.2. Compute map scale in inches to feet for an engineer scale.

1.3. Length of project divided by length of paper.

1.4. Width of project divided by width of project.

Step 2: Obtain drawing of area. Use the drawing you produced during the topographic survey.

Step 3: Transfer data. Transfer observed data from the field notebook to your drawing.

Step 4: Choose contour. A contour interval of 0.5-foot will be used for map.

Step 5: Interpolation. Interpolate between grid points to locate contour elevations.

Step 6: Produce contours.

6.1. Connect equal elevations with smooth curve (hand drawn).

6.2. Darken index contour.

REVIEW QUESTIONS
FOR
(MANUALLY) PRODUCE TOPOGRAPHIC MAP

QUESTION	ANSWER
1. Topographic maps can be accomplished in the field and office.	a. True. b. False.
2. Photogrammetric topographic maps are usually made for reproduction in large quantities at scales of?	a. 1:5,000. b. 1:10,000. c. 1:20,000. d. 1:25,000.
3. What contour line needs to be darkened?	a. Initial. b. Intermediate. c. Index. d. None.

(MANUALLY) PRODUCE TOPOGRAPHIC MAP

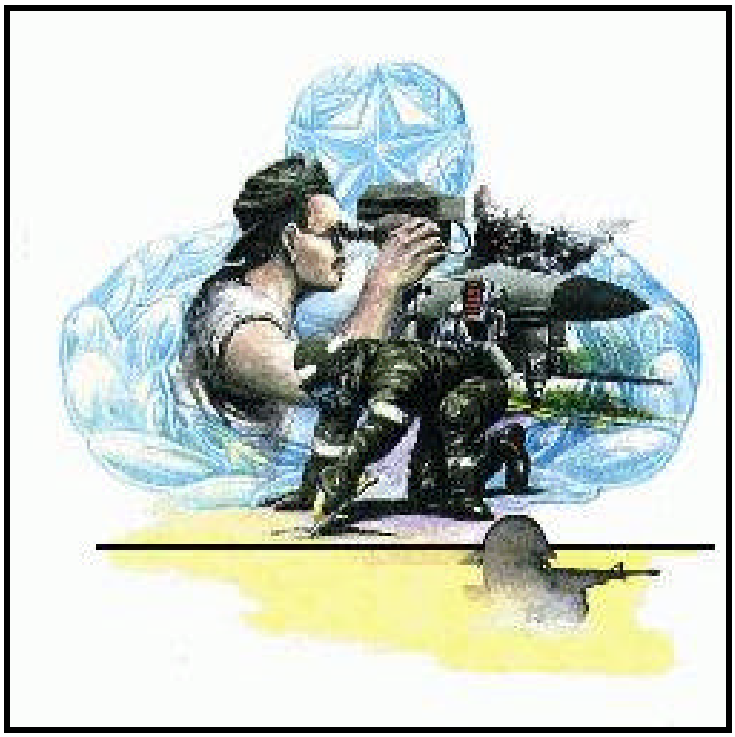
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. determine map scale?		
2. obtain drawing?		
3. transfer data?		
4. choose contour?		
5. interpolate?		
6. produced contours?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the minds of both the trainee and trainer/certifier.



AUTOMATED SURVEYING

MODULE 13 AFQTP UNIT 2

ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN AUTOMATED TRAVERSE SURVEY (13.2.3.)

ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN (AUTOMATED) TRAVERSE SURVEY

Task Training Guide

STS Reference Number/Title:	13.2.3. - Establish horizontal and vertical control by performing an automated traverse survey.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Surveying, Fourth Edition by Jack McCormac. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. Army FM 5-233. 2.2. Surveying, Fourth Edition by Jack McCormac. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2.**
Equipment/Tools Required:	1. Total station with data collector. 2. Tri-pod. 3. Prism. 4. Staff/pole. 5. Measuring tape.
Learning Objective:	Given the equipment, trainee will be able to establish an automated horizontal and vertical control.
Samples of Behavior:	The trainee will be able to establish an automated horizontal and vertical control.
Notes:	
This AFQTP is based on the Geodimeter total station instrument, model 608, which is in all Prime BEEF 4F9EA Team Kits.	

ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN (AUTOMATED) TRAVERSE SURVEY

1. Background. The same principals apply for establishing horizontal and vertical control manually as it does for the automated traverse survey. However, the steps established with the automated survey are streamlined and the end result is stored in an electronic format.

2. After reviewing the following information, see your Unit Education and Training Manager to take the mandatory CerTest # 8176, *Establish Horizontal & Vertical Control - Automated*. Trainee must score at least 80% to meet the minimum completion requirement for diamond tasks.

3. If the equipment is available, follow these steps to establish horizontal and vertical control by performing an automated traverse survey.

Step 1: Reconnaissance. Use the best available maps and aerial photographs during both office and field reconnaissance.

1.1. Select start and closing points. Your starting point should be an existing control station determined by a survey with order of accuracy equal to or greater than the traverse to be run. A second existing control station, visible from the first, should be used to orient the new traverse. If no nearby station exists, the starting point must be determined by some other method (for example GPS). It may be assigned an assumed position, or you may have to determine the position from observation of stars.

1.2. Route selection. Traverses are usually run to establish new stations (control) in the area. Location of the required stations is specified, at least in terms of vicinity or distance between stations. Clearing for traverse lines should be kept to a minimum. When in a contingency environment, some mass clearing may be acceptable if force protection or speed of survey completion is required. In most peacetime operations where traverse lines are run through private property, indiscriminate tree cutting isn't allowed.

Step 2: Field procedures using the Geodimeter total station.

NOTE:

The Geodimeter total station instrument, model 608, has a detachable faceplate, which contains the program you will need to perform a traverse. The program involved will be Program 10-11 (Dbar Traverse). Dbar allows Terramodel to perform a least squares adjustment and produce control coordinates. Dbar is used when several control points are needed or the surveyors choose to use double angles to tighten the traverse. All points in the traverse must be observed at least twice. The PCODE for these points is **RO** (reference object).

2.1. Set up instrument over known point. Use program 20 with a control area file for station establishment (use the same job name throughout the traverse).

2.2. Press the Prg key. Enter 10 and your display will show DBAR TRAV ID.

2.3. At the job No. prompt, enter the job name, either numeric or Alphanumeric and press ENT.

2.4. Check the instrument memory settings and press ENT if they are OK.

2.5. At the STA= prompt, it is asking for your occupied point number and press ENT.

2.6. At the Pcode= prompt, it is asking for the Pcode of your occupied point. It is recommended you use a Pcode of RO (reference object) for each station to help RDE know that everything will be traverse stations, but is not required. Enter the Pcode and press ENT.

2.7. At the IH= prompt, enter your Instrument Height as the distance from your control point to the optical center of the instrument. I.E.: 5.00 ENT.

2.8. You will hear beep, then be transferred automatically to Prg11.

2.9. At the *Pno*= prompt, enter the point number of the observed point and press (RO) and press ENT.

2.10. At the *Pcode*= prompt, enter the desired point code (RO) and press ENT.

2.11. For the TH= prompt, enter the target height and press ENT.

NOTE:

Put the instrument in Dbar mode by pressing the **Dbar key (D with a line over it, below the alpha letter Q).**

2.12. Carefully check your observed point. Once sited, press the " Bow Tie" button (below the alpha letter A), and the instrument servos will turn the instrument to the reverse position. Check and correct the pointing of the instrument on the target. There should be very small adjustments, if any.

2.13. Press the **A/M** (aim and measure) key with a short press, or the button in the reverse position to make the first observation. Use the horizontal and vertical motion screws to move the instrument off the point then back on. This helps RDE the mathematically split the pointing errors. Press the **A/M** key again for each observation. If you look at the display it should show you the number of measurements made in Face 2 and Face 1. The number of Face 2 observations **MUST** be the same as the Face 1 observations. For each exercise, you will make 2 Face, then 2 Face 1 observation.

2.14. After completing your Face 2 observations (reverse position), press the **A/M** key for more than 2 seconds (long press) and the instrument servos will turn the instrument to the direct position (Face 1).

2.15. Check your pointing, then press the A/M key.

2.16. Repeat the above step as many times as necessary to match the number of observations in step 2.13. This will "double" your angles.

2.17. When the number of observations for Face 1 and Face 2 are equal, you will see the "angle split" for both the horizontal and vertical measurements. Now press **A/M** to measure the distance.

2.18. The display will show the data for the observed point. Press **REG** to register the shot.

2.19. To observe other points from the same occupied point, simply enter the new point number at the **Pno=**prompt, and the pcode at the **Pcode** prompt, starting again at step #10 above.

2.20. If you are finished, press **ENT** at the **Pno=**prompt and turn off the instrument. If you move to another occupied station, when you turn the instrument back on, answer **NO** when it asks if you want to continue. You can then go thru Prg10 again for a new station establishment and make additional observations.

REVIEW QUESTIONS
FOR
ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN (AUTOMATED) TRAVERSE SURVEY

QUESTION	ANSWER
1. Where is the best place to make sure you have entered the correct control data into the data collector?	a. Office. b. Field.
2. Ideally the occupied station and back sight station should be what type of points?	a. Known. b. Assumed.

ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN (AUTOMATED) TRAVERSE SURVEY

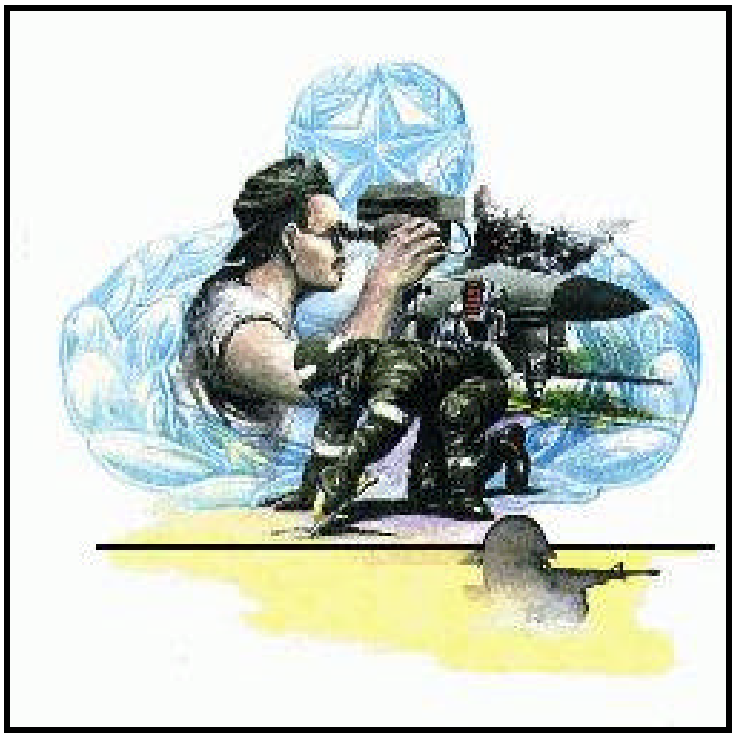
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. load correct control data into the data collector?		
2. ensure the correct occupied point, back sight point, height of instrument, and height of target were entered correctly?		
3. understand the principles and procedures to collect the horizontal and vertical data?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



AUTOMATED SURVEYING

(THIS UNIT IS OPTIONAL)

MODULE 13 **AFQTP UNIT 2**

DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE (13.2.4.)

DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE

Task Training Guide

STS Reference Number/Title:	13.2.4. - Download electronic survey data to a civil software package.
Training References:	1. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*. 2. Geodimeter software tools manual.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the Geodimeter software tools manual.** 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.**
Equipment/Tools Required:	1. Geodimeter total station. 2. Laptop/personal computer. 3. Geodimeter software tools and manual, and proper cables.
Learning Objective:	Given the equipment, trainee will be able to download electronic survey data to a civil software package.
Samples of Behavior:	The trainee will be able to electronic survey data from a Geodimeter total station to a civil software package.
Notes:	
1. This AFQTP is based on the Geodimeter total station instrument, model 608, which is in all Prime BEEF 4F9EA team kits. 2. Recommend the trainee completed this unit in order to finish the automated traverse survey task.	

DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE

1. Background. The electronic file stored in the data collector has assigned horizontal and vertical control to each point. Back in the office with the correct software the data can be downloaded to a civil software package. Once the data is downloaded you can manipulate the data to meet just about any of your requirements**.**

2. After reviewing the following information, see your Unit Education and Training Manager to take the optional CerTest # 8177, *Download Electronic Survey Data to Civil Package*. Trainee must score at least 80% to meet the minimum completion requirement for diamond tasks.

3. If the equipment is available, follow these steps to download electronic survey data to a civil software package.

Step 1: Downloading a file: To be able to properly use the Geodimeter total station, the user must be able to interact with the faceplate while it is attached to the computer. To do this, the Geodimeter Software Tools must be loaded on the PC. This includes two software programs: Geotool, located in the Gst_1 directory on the CD-ROM drive, and Geotool, located in the root directory on the CD-ROM drive.

1.1. The Geodimeter Software Tools software must be loaded on the computer workstation.

1.2. Attach the data link adapter to a COM port on the computer.

1.3. Attach the power supply, and the download cable to the data link adapter. The download cable goes on the bottom, and the power cable goes on the top.

1.4. Attach the download cable to the faceplate.

1.5. Turn faceplate on. It should say local mode.

1.6. Once the faceplate is turned on, go to the Geodimeter Software Tools (GST) by selecting it from the programs menu in Windows. To do this, go to Spectra Precision, and then Geodimeter Software Tools.

1.7. Once GST has started, select the red “Open Instrument” button.

1.8. The EOT setting on the faceplate must be changed to match the GST setting. This is done by pressing F 79 on the faceplate. This will allow you to change your EOT character to 62, to match the software.

1.9. Once the common settings are correct, press OK. The faceplate will beep, letting you know that the PC is communicating with the faceplate.

1.10. You will now be able to download files from the faceplate into a directory on the computer. On the menu, go to File > Upload/Download.

1.11. Click the Browse button on the source side. Browse to the data collector, toward the bottom of the list. Check all of the check boxes, and all of the files on the faceplate will be shown.

1.12. Click the browse button on the target side, and select the directory that you would like to download the file into.

1.13. On the source side, select the file you want to download.

1.14. Click Transfer, and the file will be transferred to the target directory.

1.15. When a file from the PC needs to be uploaded to the faceplate, the same procedures are followed, except the source and target directories are reversed.

Step 2: How to delete a file.

2.1. The Geotool software must be loaded on the computer workstation.

2.2. To begin Geotool, go to Start > Programs > Geotool > Geotool.

2.3. To see the files on the faceplate, go to Transfer > Instrument Directory/Delete Files.

2.4. Select the file you want to delete, and press the delete button. The instrument should beep, letting you know communication happened, and the file will be deleted from the screen.

2.5. When all of the desired files are deleted, press the close button, and then close the software.

NOTE:
It is a good idea to keep the faceplate as clean as possible. There is not a lot of memory on the faceplate. Create a survey files directory on your computer, and save all of your job and area files into that directory. Once you have the file safely downloaded, delete it from the faceplate to conserve memory.

REVIEW QUESTIONS
FOR
DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE

QUESTION	ANSWER
1. Once file is safely downloaded, delete it from the faceplate to conserve memory.	a. True. b. False.
2. What software tools must be loaded on the computer?	a. Microstation. b. Geodimeter Software Tools software. c. Microsoft Word. d. Auto CAD.
3. Where do you attach the data link adapter?	a. Do not attach it to anything. b. COM port on computer. c. Total station.
4. What mode should the faceplate stay in?	a. Local mode. b. Off mode. c. Survey mode.
5. Where should the power supply and download cable be attached to?	a. Data link adapter. b. COM port on computer. c. Total station.
6. On the data link adapter where does the download cable go?	a. Top. b. Bottom.

DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE

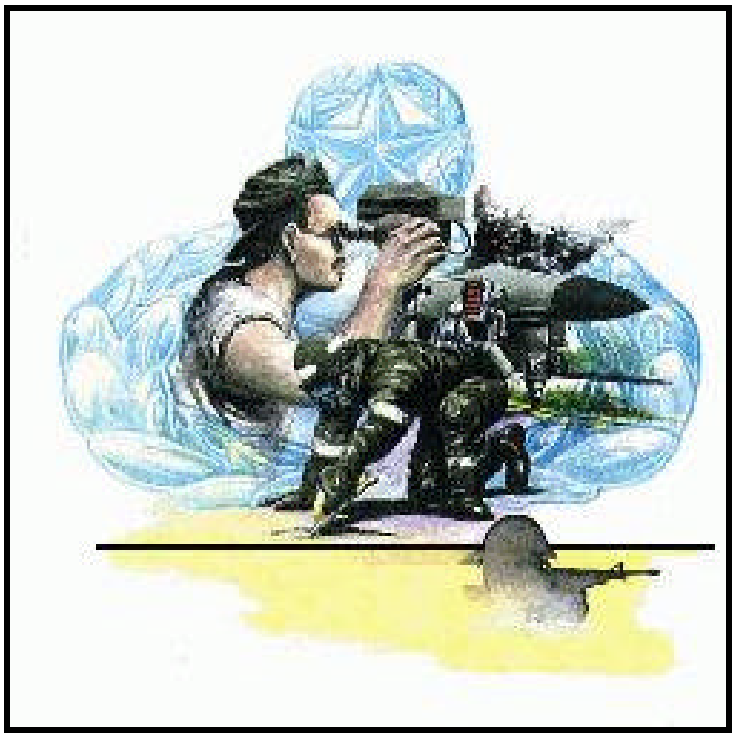
PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….	YES	NO
1. ensure they had the proper equipment and software?		
2. understand the procedures to download the electronic survey data?		
3. once file was safely downloaded, delete it from the faceplate to conserve memory.		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.



AUTOMATED SURVEYING

MODULE 13 AFQTP UNIT 2

PERFORM AN TOPOGRAPHIC SURVEY (13.2.12.)

PERFORM AN (AUTOMATED) TOPOGRAPHIC SURVEY

Task Training Guide

STS Reference Number/Title:	13.2.12. - Perform an automated topographic survey.
Training References:	1. Army Field Manual (FM) 5-233, *Construction Surveying*. 2. Surveying, Fourth Edition by Jack McCormac. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.
Prerequisites:	1. **Possess as a minimum a 3E531 AFSC**. 2. **Review the following references:** 2.1. FM 5-233. 2.2. Surveying, Fourth Edition. 3. **Complete CDC 3E551A Engineering Journeyman, Volume 3, Unit 2, *Plane Surveying*.**
Equipment/Tools Required:	1. Total station with data collector. 2. Tri-pod. 3. Prism. 4. Staff/pole. 5. Measuring tape.
Learning Objective:	Given the equipment, trainee will be able to perform an automated topographic survey.
Samples of Behavior:	The trainee will be able to perform an automated topographic survey.
Notes:	
This AFQTP is based on the Geodimeter total station instrument, model 608, which is in all Prime BEEF 4F9EA team kits.	

PERFORM AN (AUTOMATED) TOPOGRAPHIC SURVEY

1. Background. Topography can be defined as the study of the earth's shape. Characteristics include relief, natural features, and artificial (manmade) features. Relief is a representation of the earth's surface to include features such as hills, valleys, plains, summits, depressions and other natural features. Natural features include trees, streams and lakes to name a few. Manmade features include highways, bridges, dams, wharfs, buildings, etc.

2. After reviewing the following information, see your Unit Education and Training Manager to take the mandatory CerTest # 8178, *Perform an Automated Topographic Survey*. Trainee must score at least 80% to meet the minimum completion requirement for diamond tasks.

3. If the equipment is available, follow these steps to an automated topographic survey.

Step 1: Office Procedures. The first step is to upload the adjusted traverse points from TERRAMODEL to the Geodimeter. Once this is accomplished you can go out and set-up over any of the traverse points and backsight any other visible point on the traverse to establish control.

Step 2: Field Procedures Fast Topo Data Collection

2.1. After you have run Program 20 (Station establishment), go into Program 3.

2.2. Review your *Job No.* and press **ENT** if it is correct.

2.3. Review your *Mem Settings* and press **ENT** if they are okay.

2.4. At the *Pno* = prompt, input the pint number for your first topo shot.

2.5. At the *Pcode* = prompt, use your Point Code list and input the point code for your first topo shot.

2.6. At the *TH* = prompt, input the target height for your rod (which will be used for collecting data at your topo points). You will now be transferred automatically to Program 4.

NOTE:

Before storing a shot (pressing the Reg key) you can:

1. Change your *Pcode* at any time before you store a shot (or press the **Reg** button), by using **F4** (press the **F** key and **4**).
2. Change your Pno by using **F5** (press the **F** key and **5**).
3. Change your *TH* (Target Height) by using **F6** (press the **F** key and **6**).

2.7. Aim at the target on your first topo point and press the **A/M** button.

2.8. Press the **Reg** key to store (register) the data for your topo point.

2.9. Repeat Step #7 and Step #8 until you have collected all topo data for your current occupied point. If you wish to move to another setup point, make sure you know its points number, turn the instrument off, move to the new point, and repeat the following procedures: Set up the Tripod; Attach and Level the Geodimeter Instrument; (note that when you turn the instrument on at the next point, you must answer **no** to the question on the display, "*Powered off by operator, do you wish to continue?"* Run Program 20 or 2 for station establishment. Then use Program 3 and 4 as above.

Note:

Before moving instrument, remember the point number you are on and be sure the next set of point's starts at a higher number. **Example** - If you stopped on 196, you might start again on 200.

2.10. Continue on with your topo or sideshot data collection. You should only be prompted for Pcodes when running UDS programs 3&4; all other data should be automatically incremented or duplicated and displayed. If you decide you need to use Pcode Topo mode (for example, if the point descriptor or Pcode is changing at each shot), press the **Prg** key and enter **5** for the program number.

Step 3: Reinitialize Pno, Pcode, or SH prompts.

3.1. Rerun Program **2** or **20**, and at the *Pno* = prompt, retype the displayed point number. You will get the prompt *Dup*.?; press the **No** key. You will get the prompt *Decr*.?; press the **No** key. You will get the prompt *Auto Dup*.?; press the **Yes** key. This will automatically increment the point number without showing it on the display.

3.2. At the *Pcode* prompt, type in the same Pcode. You will get the prompt *Dup*.?; press the **No** key. You will get the prompt *Decr*.?; press the **No** key. You will get the prompt *Auto Dup*.?; press the **Yes** key. This will hold the Pcode until it is changed with **F4**.

3.3. At the *TH* prompt, type in the same Target Height. You will get the *Dup*.? Prompt. Respond by pressing the **No** key. At the *Auto Dup*.? Prompt, respond by pressing the **Yes** key. This will hold the Target Height until it is changed with **F6**.

Step 4: Orient the instrument on a known point, using 1 additional known station (Program 20).

4.1. Set up the Geodimeter on a known point, with another known point in view.

4.2. Turn the Geodimeter on. If the instrument asks if you want to continue, say No.

4.3. You should be at the level screen. Make the faceplate parallel to the front two screws. The front two screws level the bottom level, and the back screw levels the top level. Once the instrument is level, press the Enter key. The instrument will make a 180-degree turn, stop, and make another 180 degree turn.

4.4. You will now be in program zero. Input the correct answers to the questions it asks you. When you get to the HA Ref screen, press the Enter key.

4.5. The instrument should now be roughly level and ready for operation. You may now fine level the instrument by pressing the fine level key (looks like an envelope). Once the instrument is fine leveled, press the fine level key again.

4.6. You are now ready to orient the Geodimeter. Go into program 20 by pressing PRG, and then inputting 20.

4.7. Press 1 for known station. You can make up a new job number, and press enter.

4.8. On the next screen, you will see Imem, Xmem, and Serial. Imem should say on, Xmem should say off, and Serial should say off. If you need to change any of these, press the number that is associated with it, and it will toggle to the opposite value. Once the settings are correct, press the enter key.

4.9. The faceplate will now ask you for your station. Put in your station number or name. At the area file prompt, press enter.

4.10. Punch in the northing, easting, and elevation, and press enter.

4.11. If you want to store elevations, press enter (yes) at the HT measure prompt.

4.12. At the Refobj prompt, put in the name or number of the reference object (backsight).

4.13. Press enter at the area file prompt, and type in the northing, easting and elevation, and press enter.

4.14. At the aim at Refobj screen, aim the instrument at the backsight point, and press the aim/measure key.

4.15. The instrument should now display the azimuth to the reference point. Press REG if it looks correct.

4.16. You will now be put back into program 0, and the instrument is oriented properly.

4.17. If you are ready to start collecting, refer to the last process in this packet, which covers collecting topographic data in program 30.

Step 5: Orient the instrument on an unknown point, between two or three known points.

5.1. Set up the Geodimeter on an unknown point, with two or three known points in view.

5.2. Turn the Geodimeter on. If the instrument asks if you want to continue, say No.

5.3. You should be at the level screen. Make the faceplate parallel to the front two screws. The front two screws level the bottom level, and the back screw levels the top level. Once the instrument is level, press the Enter key. The instrument will make a 180 degree turn, stop, and make another 180 degree turn.

5.4. You will now be in program zero. Input the correct answers to the questions it asks you. When you get to the HA Ref screen, press the Enter key.

5.5. The instrument should now be roughly level and ready for operation. You may now fine level the instrument by pressing the fine level key (looks like an envelope). Once the instrument is fine leveled, press the fine level key again.

5.6. To perform a free station establishment, or resection, you will have to have an area file in the instrument that will be used to establish the free station. This area file will consist of the points that will be used to establish the free station. To create an area file, go into program 43 by pressing Prg, and then 43.

5.7. Press 1 to select internal memory. If you were using an external data collector, you would press 2.

5.8. At the area file prompt, enter the name of the new area file.

5.9. At the HT measure prompt, press yes if you want to measure elevations.

5.10. Now enter the point numbers, pcodes, northings, eastings, and elevations for each point that will be used to establish the free station. When you have entered all points, press enter.

5.11. Accept the defaults if they haven't changed in program 0.

5.12. You are now ready to orient the Geodimeter. Go into program 20 by pressing PRG, and then inputting 20.

5.13. You will now be at the selection screen. Select 2; for free station. This is sometimes also referred to as a resection.

5.14. Punch in the new job number.

5.15. On the next screen, you will see Imem, Xmem, and Serial. Imem should say on, Xmem should say off, and Serial should say off. If you need to change any of these, press the number that is associated with it, and it will toggle to the opposite value. Once the settings are correct, press the enter key.

5.16. The faceplate will now ask you for your station. Punch in the name of your station. A suggestion for the name of this point would be OC, for occupied station.

5.17. HT measure refers to whether or not you want to measure elevations. If you do, press the enter (yes) key.

5.18. Put in the instrument height.

5.19. At the area file prompt; type in the name or number of the area file that you created.

5.20. Select internal or external memory.

5.21. Put in the number of the first point you will sight.

5.22. The coordinates will come up. If they are correct, press enter.

5.23. Put in the prism height, or signal height.

5.24. You are now in angle and distance mode. Aim at the first reference point, and press the aim/measure key. Press the REG key to accept this measurement.

5.25. Enter the point number for the second reference point. The coordinates will come up. If they are correct, press enter.

5.26. Aim at the second reference point, and press the aim/measure key.

5.27. Accept this measurement by pressing the REG key.

5.28. 5.28. If you have a third point for the free station, press yes to shoot the third point.

5.29. When all reference points have been sighted and observed, you will punch no.

5.30. The coordinates of the occupied point will be displayed, along with the standard deviation of the measurements. If the standard deviation is too large, you will have to redo the measurements.

5.31. Continue to press enter, all the way through the store question. This will store the coordinate for the point you are occupied on.

5.32. When the program asks you for an area file, give a new area file name. This will leave the original area file unaffected.

5.33. The Geodimeter is now set up at a known location, and its horizontal angle reference is referenced properly. If you are ready to start collecting data, go to program 30, which is covered in the next portion of instructions.

Step 6: Downloading. To be able to properly use the Geodimeter total station, the user must be able to interact with the faceplate while it is attached to the computer. To do this, the Geodimeter Software Tools must be loaded on the PC. This includes two software programs: Geotool, located in the Gst_1 directory on the CD-ROM drive, and Geotool, located in the root directory on the CD-ROM drive.

6.1. The Geodimeter Software Tools software must be loaded on the computer workstation.

6.2. Attach the data link adapter to a COM port on the computer.

6.3. Attach the power supply, and the download cable to the data link adapter. The download cable goes on the bottom, and the power cable goes on the top.

6.4. Attach the download cable to the faceplate.

6.5. Turn faceplate on. It should say local mode.

6.6. Once the faceplate is turned on, go to the Geodimeter Software Tools (GST) by selecting it from the programs menu in Windows. To do this, go to Spectra Precision, and then Geodimeter Software Tools.

6.7. Once GST has started, select the red "Open Instrument" button.

6.8. The EOT setting on the faceplate must be changed to match the GST setting. This is done by pressing F 79 on the faceplate. This will allow you to change your EOT character to 62, to match the software.

6.9. Once the comm settings are correct, press OK. The faceplate will beep, letting you know that the PC is communicating with the faceplate.

6.10. We will now be able to download files from the faceplate into a directory on the computer. On the menu, go to File > Upload/Download.

6.11. Click the Browse button on the source side. Browse to the data collector, toward the bottom of the list. Check all of the check boxes, and all of the files on the faceplate will be shown.

6.12. Click the browse button on the target side, and select the directory that you would like to download the file into.

6.13. On the source side, select the file you want to download.

6.14. Click Transfer, and the file will be transferred to the target directory.

6.15. When a file from the PC needs to be uploaded to the faceplate, the same procedures are followed, except the source and target directories are reversed.

REVIEW QUESTIONS
FOR
PERFORM AN (AUTOMATED) TOPOGRAPHIC SURVEY

QUESTION	ANSWER
1. Where is the best place to make sure you have entered the correct control data into the data collector?	a. Office. b. Field.
2. It is import to orientate the instrument by putting in the correct occupied point, correct back sight, height of instrument, and height of target.	a. True. b. False.

PERFORM AN (AUTOMATED) TOPOGRAPHIC SURVEY

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

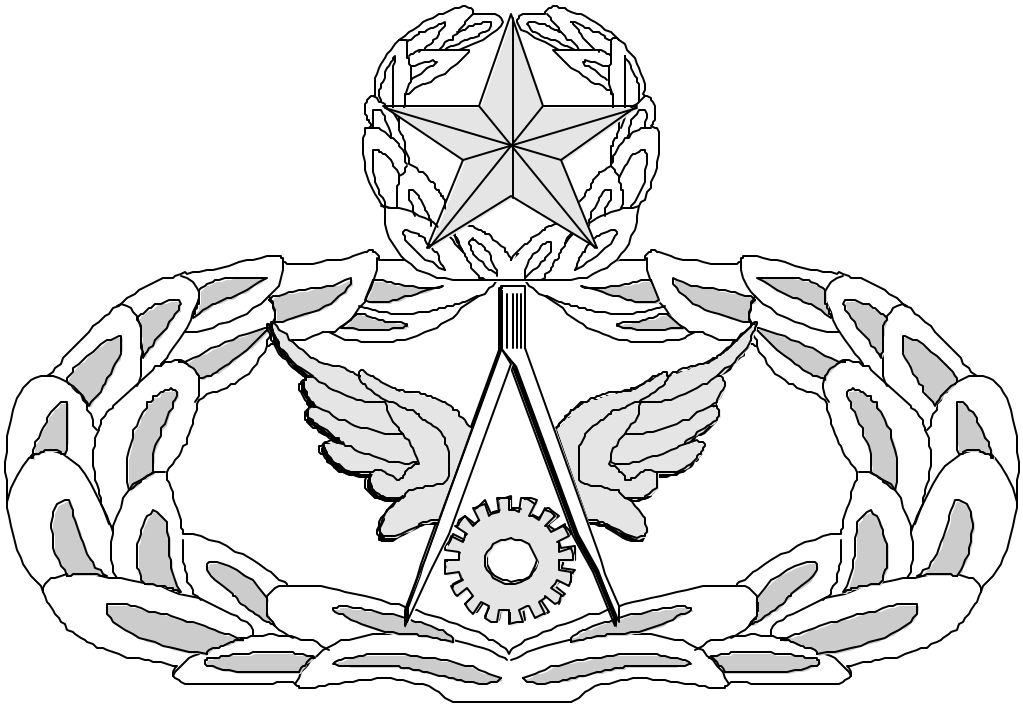
DID THE TRAINEE….	YES	NO
1. load the correct control points into the data collector?		
2. orientate the instrument with back sight?		
3. enter the correct height of instrument and height of the target?		
4. understand the principles and procedures to collect the horizontal and vertical control?		

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



FOR

ENGINEERING

(3E5X1)

MODULE 13

SURVEYING

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

(MANUALLY) ESTABLISH HORIZONTAL CONTROL
(3E5X1-13.1.3.)

QUESTION	ANSWER
1. What is a traverse?	The measurement of lengths and directions of a series of straight lines.
2. What are the two kinds of traverse?	c. Open and Closed.
3. North latitudes are positive and south latitudes are negative.	a. True.
4. East departures are negative and west departures are positive.	b. False.
5. What does the term closed traverse mean?	The end of the traverse closes on a known point.
6. A closed traverse provides no checks against mistakes or large errors.	b. False

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL ANGLES
(3E5X1-13.1.4.)

QUESTION	ANSWER
1. In what three ways may an angle be observed?	b. Station, Explement, and Deflection.
2. What do we call an angle observed by backsighting a station, then measuring clockwise to forward station?	c. Station angle.
3. What two angles equal 360 degrees?	a. Station and explement.

(MANUALLY) MEASURE AND COMPUTE HORIZONTAL DISTANCES
(3E5X1-13.1.5.)

QUESTION	ANSWER
1. What is accuracy?	b. Accuracy is the quality of the result.
2. What is precision?	a. Precision is the quality of your work.
3. How many members are usually on a taping party?	b. 3.

(MANUALLY) ESTABLISH VERTICAL CONTROL
(3E5X1-13.1.7.)

QUESTION	ANSWER
1. What are the two methods for performing indirect leveling?	a. Trigonometric and barometric.
2. What are the two major categories of leveling?	c. Direct and indirect.
3. Backsights are always subtracted from the known elevation.	b. False.
4. You should always attempt to balance your backsight and foresight distances.	a. True.
5. To close a level circuit you may return to your starting point or continue to another point of known elevation.	a. True.

(MANUALLY) PERFORM TOPOGRAPHIC SURVEY
(3E5X1-13.1.17.)

QUESTION	ANSWER
1. Resection, intersection, and radiation are three methods you can use to locate points in the field.	a. True.
2. What types of reconnaissance can be performed with topographical surveying?	Identifies details within the prescribed area to locate any obstacle or drainage problems. This directly affects the operation and planning of construction.-
3. Tapes and stadia measure horizontal distances.	a. True.
4. What accuracy can be expected from stadia distance measurement?	a. 0.1-foot.

(MANUALLY) PRODUCE TOPOGRAPHIC MAP
(3E5X1-13.1.18.)

QUESTION	ANSWER
1. Topographic maps can be accomplished in the field and office.	a. True.
2. Photogrammetric topographic maps are usually made for reproduction in large quantities at scales of?	d. 1:25,000.
3. What contour line needs to be darkened?	c. Index.

ESTABLISH HORIZONTAL AND VERTICAL CONTROL BY PERFORMING AN (AUTOMATED) TRAVERSE SURVEY
(3E5X1-13.2.3.)

QUESTION	ANSWER
1. Where is the best place to make sure you have entered the correct control data into the data collector?	a. Office.
2. Ideally the occupied station and back sight station should be what types of points?	a. Known.

(OPTIONAL)
DOWNLOAD ELECTRONIC SURVEY DATA TO A CIVIL SOFTWARE PACKAGE
(3E5X1-13.2.4.)

QUESTION	ANSWER
1. Once file is safely downloaded, delete it from the faceplate to conserve memory.	a. True.
2. What software tools must be loaded on the computer?	b. Geodimeter Software Tools software.
3. Where do you attach the data link adapter?	b. COM port on computer.
4. What mode should the faceplate stay in?	a. Local mode.
5. Where should the power supply and download cable be attached to?	a. Data link adapter.
6. On the data link adapter where does the download cable go?	b. Bottom.

PERFORM AN (AUTOMATED) TOPOGRAPHIC SURVEY (3E5X1-13.2.12.)

QUESTION	ANSWER
1. Where is the best place to make sure you have entered the correct control data into the data collector?	a. Office.
2. It is important to orientate the instrument by putting in the correct occupied point, correct back sight, height of instrument, and height of target.	a. True.

MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Qualification Training Package Improvement

1. Identify module.

   Module # and title_____

2. Identify improvement/correction section(s):

   _____ STS Task Reference
   _____ Training Reference
   _____ Evaluation Instructions
   _____ Performance Resources
   _____ Steps in Task Performance
   _____ Performance Checklist
   _____ Feedback
   _____ Format
   _____ Other

3. Recommended changes--use a continuation sheet if necessary.

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

4. You may choose to call in your recommendations to DSN 523-6322 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.

5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position