STP 5-82D12-SM-TG

Topographic Surveyor Soldier's Manual and Trainer's Guide MOS 82D Skill Levels 1/2

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Topographic Surveyor Soldier's Manual and Trainer's Guide MOS 82D Skill Levels 1/2

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This publication supersedes the portions of STP 5-82D14-SM-TG, 3 May 1985, that cover Skill Levels 1 and 2.

Subject Area 5: Differential Global Positioning System

PREFACE

This publication is for skill levels (SLs) 1 and 2 soldiers holding military occupational specialty (MOS) 82D and their trainer or first-line supervisors. It contains standardized training objectives in the form of task summaries that may be used to train and evaluate critical tasks which support unit missions during wartime. Trainers and first-line supervisors should actively plan for soldiers holding MOS 82D to have access to this publication.

Most tasks in this manual are applicable to both the Active and RC soldier. However, some tasks are only for active duty soldiers due to the differences of equipment and missions. Tasks unique to RC soldiers are identified by (RC) following the task title and grouped into RC-unique subject areas.

Users of this publication are encouraged to recommend changes and submit comments for its improvement. Comments should be keyed to a specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to ensure understanding and complete evaluation.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

CHAPTER 1

Introduction

GENERAL

1-1. This manual identifies the individual MOS training requirements for soldiers in MOS 82D. It is designed to be used by commanders, trainers, and soldiers to plan, conduct, and evaluate individual training in units. This manual is the primary reference to support that portion of the Integrated Test/Evaluation Program (ITEP) which requires commanders to routinely evaluate soldiers' ability to perform MOS-specific tasks critical to the unit's mission. Army Regulation (AR) 350-41 describes the ITEP in detail.

1-2. This manual should be used along with Soldier Training Publications (STPs) 21-1-Soldier's Manual of Common Tasks (SMCT) and 21-24-SMCT; Army Training and Evaluation Programs (ARTEPs); and Field Manuals (FMs) 25-4, 25-5, 25-100, and 25-101 to establish effective training plans and programs that integrate individual and collective tasks.

TASK SUMMARIES

1-3. Task summaries contain information necessary to conduct training and evaluate soldiers' proficiency on tasks critical to the MOS. A separate task summary is provided for each critical task. These task summaries are, in effect, standardized training objectives that ensure that soldiers do not have to relearn a task on reassignment to a new unit. The format for the task summaries included in this manual is as follows:

- *Task Title*. The task title identifies the action to be performed.
- *Task Number*. A 10-digit number identifies each task or skill. Include this task number, along with task title, in any correspondence relating to the task.
- *Conditions*. The task conditions identify all the equipment, tools, references, job aids, and supporting personnel that the soldier needs to perform the task in wartime. This section identifies any environmental conditions that can alter task performance, such as visibility, temperature, and wind. This section also identifies any specific cues or events (a chemical attack or identification of a threat vehicle) that trigger task performance.
- *Standards*. The task standards describe how well and to what level you must perform a task under wartime conditions. Standards are typically described in terms of accuracy, completeness, and speed.
- *Training and Evaluation*. This section may contain all or part of the following: training-information outline, evaluation-preparation subsection, and evaluation guide. The training-information outline includes detailed training information. The evaluation-preparation subsection indicates necessary modifications to task performance in order to train and evaluate a task that cannot be trained to the wartime standard under wartime conditions. It may also include special training and evaluation-preparation instructions to accommodate these modifications and any instruction that should be given to the soldier before evaluation. The evaluation guide identifies the specific actions, known as performance measures, that the soldier must do to successfully complete the task. These actions are listed in a *pass/fail* format for easy evaluation. Each evaluation guide contains a feedback statement that indicates the requirements for receiving a *GO* on the evaluation.
- *References*. This section identifies references that provide more detailed and thorough explanations of task-performance requirements than that given in the task-summary description.

1-4. Additionally, some task summaries include safety statements and notes. Safety statements (danger, warning, and caution) alert users to the possibility of immediate death, personal injury, or damage to equipment. Notes provide a small, extra supportive explanation or hint relative to the performance measures.

SOLDIER'S RESPONSIBILITIES

1-5. Each soldier is responsible for performing individual tasks which the first-line supervisor identifies based on the unit's mission essential task list (METL). The soldier must perform the task to the standards listed in the soldier's manual (SM). If a soldier has a question about how to do a task or which tasks in this manual he must perform, it is the soldier's responsibility to ask the first-line supervisor for clarification. The first-line supervisor knows how to perform each task or can direct the soldier to the appropriate training materials.

NONCOMMISSIONED OFFICER SELF-DEVELOPMENT AND THE SOLDIER'S MANUAL

1-6. Self-development is one of the key components of the leader-development program. It is a planned, progressive, and sequential program followed by leaders to enhance and sustain their military competency. It consists of individual study, research, professional reading, practice, and self-assessment. Under the self-development concept, the noncommissioned officer (NCO), as an Army professional, has the responsibility to remain current in all phases of the MOS. The SM is the primary source for the NCO to use in maintaining MOS proficiency.

1-7. Another important resource for NCO self-development is the Army Correspondence Course Program (ACCP). (See Department of the Army [DA] Pamphlet 350-59 for information on enrolling in this program and for a list of courses, or write to: Army Institute for Professional Development, United States [US] Army Training Support Center, ATTN: ATIC-IPS, Newport News, Virginia 23628-0001.)

1-8. Unit learning centers are valuable resources for planning self-development programs. They can help access enlisted career maps, training-support products, and extension-training materials.

TRAINING SUPPORT

1-9. This manual includes the following appendixes and information that provide additional training support information:

- *Appendix A, Department of the Army (DA) Form 5164-R (Hands-On Evaluation)*. This appendix provides an overprinted copy of DA Form 5164-R for the tasks contained in the SM. The NCO trainer can use this form to set up the leader book described in FM 25-101. The use of this form may help preclude writing the soldier tasks associated with the unit's METL and can become a part of the leader book.

- *Appendix B, Department of the Army (DA) Form 5165-R (Field Expedient Squad Book)*. This appendix provides an overprinted copy of DA Form 5164-R for the tasks contained in the SM. The NCO trainer can use this form to set up the leader book described in FM 25-101. The use of this form may help preclude writing the soldier tasks associated with the unit's METL and can become a part of the leader book.

- *Appendix C, Conversion Factors (United States (US) Units and Metric)*. This appendix provides an English to metric measurement conversion chart.

- *Glossary*. This glossary is a single comprehensive list of acronyms, abbreviations, definitions, and letter symbols.

- *References*. This section contains two lists of references, required and related, that support training of all tasks in this SM. Required references are listed in the conditions statement and are

required for the soldier to do the task. Related references are materials that provide more detailed information and a more thorough explanation of task performance.

ENLISTED PERSONNEL MANAGEMENT SYSTEM

1-10. The Enlisted Personnel Management System (EPMS) (AR 614-200) is the Army's overall system to improve the professionalism of the enlisted force. It integrates policies relating to training, evaluation, classification, and promotion into an overall system. It provides the soldier with a means to look to the future and see a realistic, clear, and viable career progression path from private to sergeant major (SGM). However, the EPMS is useless if the soldier does not understand and use it. Part of the trainer's job is to make sure the soldier understands and uses the EPMS. As an aid, Figure 1-1 provides the trainer with a career map for the 82D soldier. Along with information contained in AR 614-200, the soldier can use the career map to develop goals early in his career and plan accordingly.

NCOES	PLDC	BNCOC	ANCOC	USASMA		
Civilian schools	High school, GED diploma	College				
		1 year	2 years	3 years		
		A goal: troop assignments often preclude off-duty education.				
Other schools	Drill Sergeant School Recruiting School Battle Staff Course 1SG Course					
Encouraged assignments	CMF 81 staff assignments Operations/intelligence sergeant Instructor Recruiter/drill sergeant Training developer/writer					
Key leadership assignments	Topographic Surveyor	Team Leader Squad Leader	Squad Leader Section Leader	Operations SGT Section Leader	1SG	CSM
Rank	PVT, PFC SPC, CPL	SGT	SSG	SFC	1SG MSG	SGM CSM
Years of service	1-4	3-8	6-14	10-18	16-22	20+

Figure 1-1. Career Map, Career Management Field (CMF) 81

SKILL-PROGRESSION CHART

1-11. Similar or related education, training, and experience are grouped into CMFs. The career-progression path for MOS 82D, CMF 81, Topographic Surveyor, is shown in Figure 1-2.

E9	00Z50 CSM
SL 5 E8 through E9	81Z50 Senior topographic operations SGT 1SG
SL 4 (E7)	82D40 Section leader Senior survey operations SGT
SL 3 (E6)	82D30 Squad leader
SL 2 (E5)	82D20 Topographic survey SGT Survey operations SGT
SL 1 (E1 through E4)	82D10 Topographic surveyor
	Trainee

Figure 1-2. Career-Progression Sequence for General Engineering (CMF 81)

CHAPTER 2

Training Guide

2-1. General. The MOS Training Plan (MTP) identifies the essential components of a unit training plan for individual training. Units have different training needs and requirements based on differences in environment, location, equipment, dispersion, and similar factors. Therefore, the MTP should be used as a guide for conducting unit training and not a rigid standard. The MTP consists of two parts. Each part is designed to assist the commander in preparing a unit training plan which satisfies integration, cross training, training up, and sustainment training requirements for soldiers in this MOS.

Part One of the MTP shows the relationship of an MOS SL between duty position and critical tasks. These critical tasks are grouped by task commonality into subject areas.

Section I lists subject-area numbers and titles used throughout the MTP. These subject areas are used to define the training requirements for each duty position within an MOS.

Section II identifies the total training requirement for each duty position within an MOS and provides a recommendation for cross training and train-up/merger training.

- **Duty-Position Column**. This column lists the duty positions of the MOS, by SL, which have different training requirements.
- **Subject-Area Column**. This column lists, by numerical key (see Section I), the subject areas a soldier must be proficient in to perform in that duty position.
- **Cross-Train Column**. This column lists the recommended duty position for which soldiers should be cross trained.
- **Train-up/Merger Column**. This column lists the corresponding duty position for the next higher SL or military-occupational-specialty code (MOSC) the soldier will merge into on promotion.

Part Two lists, by general subject areas, the critical tasks to be trained in an MOS and the type of training required (resident, integration, or sustainment).

- **Subject-Area Column**. This column lists the subject-area number and title in the same order as Section I, Part One of the MTP.
- **Task-Number Column**. This column lists the task numbers for all tasks included in the subject area.
- **Title Column**. This column lists the task title for each task in the subject area.
- **Training-Location Column**. This column identifies the training location where the task is first trained to STPs standards. If the task is first trained to standard in the unit, the word “Unit” will be in this column. If the task is first trained to standard in the training base, it will identify, by brevity code (ANCOC, BNCOC, etc.), the resident course where the task was taught. Figure 2-1 contains a list of training locations and their corresponding brevity codes.

AIT	Advanced Individual Training
UNIT	Trained in the Unit

Figure 2-1. Training Locations

Sustainment-Training-Frequency Column. This column indicates the recommended frequency at which the tasks should be trained to ensure soldiers maintain task proficiency. Figure 2-2 identifies the frequency codes used in this column.

BA - Biannually
AN - Annually
SA - Semiannually
QT - Quarterly
MO - Monthly
BW - Bi-weekly
WK - Weekly

Figure 2-2. Sustainment-Training-Frequency Codes

Sustainment-Training SL Column. This column lists the SLs of the MOS for which soldiers must receive sustainment training to ensure they maintain proficiency to SM standards.

2-2. Subject-Area Codes.

Skill Level 1

1 General
2 Automated Integrated Survey Instrument
3 Traverse
4 Level
5 Differential Global Positioning System

Skill Level 2

1 General
2 Automated Integrated Survey Instrument
3 Traverse
4 Level
5 Differential Global Positioning System

2-3. Duty-Position Training Requirements.

2-4. Critical-Tasks List.

MOS TRAINING PLAN
82D12

CRITICAL TASKS

Subject Area	Task Number	Title	Training Location	Sust Tng Freq	Sust Tng SL
Skill Level 1					
1. General	052-260-1116	Emplace a Permanent Survey Control Point	UNIT	AN	1
	052-260-1213	Sketch and Describe the Location of a Survey Control Station	AIT	QT	1
	052-260-1323	Recover Survey Control Stations	AIT	QT	1
	052-260-1333	Perform a Topographic Survey by the Stadia-Transit Method	AIT	AN	1
	052-260-1335	Compute an Intersection	AIT	QT	1
2. Automated Integrated Survey Instrument	052-260-1131	Perform Operator Maintenance on Survey Equipment	AIT	QT	1
	052-260-1134	Operate the Automated Integrated Surveying Instrument (AISI)	AIT	QT	1
	052-260-1336	Perform a Topographic Survey With an Automated Integrated Surveying Instrument (AISI)	AIT	QT	1
	052-260-1337	Perform a Traverse With an Automated Integrated Surveying Instrument (AISI)	AIT	QT	1
	052-260-1338	Perform an Intersection With an Automated Integrated Surveying Instrument (AISI)	AIT	QT	1
3. Traverse	052-260-1122	Set Up a Target Set	AIT	AN	1
	052-260-1225	Record Electronic-Distance-Measuring-Equipment (EDME) Values	AIT	QT	1
	052-260-1226	Record Horizontal Directions for Theodolites	AIT	QT	1
	052-260-1227	Record Vertical Angles (VAs)/Zenith Distances (ZDs) for Theodolites	AIT	QT	1
	052-260-1234	Check Field Notes and Abstracts for Errors	AIT	QT	1
	052-260-1235	Compute a Grid Traverse or Side Shot (SS)	AIT	QT	1
	052-260-1236	Compute Distances	AIT	QT	1

	052-260-1313	Abstract Vertical Angles (VAs)/Zenith Distances (ZDs)	AIT	QT	1
	052-260-1314	Abstract Horizontal Angles (HAs)	AIT	QT	1
	052-260-1326	Measure Distances With Electronic Distance-Measuring Equipment (EDME)	AIT	QT	1
	052-260-1328	Measure Horizontal Directions With Theodolites	AIT	QT	1
	052-260-1329	Measure Vertical Angles (VAs)/Zenith Distances (ZDs) With Theodolites	AIT	QT	1
4. Level	052-260-1109	Determine the Level Error "C"	AIT	QT	1
	052-260-1125	Perform as a Rodman	AIT	QT	1
	052-260-1228	Record Level Data	AIT	QT	1
	052-260-1330	Measure the Difference in Elevation With a Level	AIT	QT	1
	052-260-1340	Compute a Differential Level Line	AIT	QT	1
5. Differential Global Positioning System	052-260-1401	Collect Data With Differential Global-Positioning-System (DGPS) Equipment	AIT	QT	1
	052-260-1406	Collect Site Information for Differential Global-Positioning-System (DGPS) Planning	AIT	QT	1
Skill Level 2					
1. General	052-260-2338	Perform Operator Maintenance on Theodolites	UNIT	QT	2
	052-260-2340	Supervise Operator Maintenance of Survey Equipment	UNIT	QT	2
	052-260-2460	Compute the Instrument Constant for Electronic Distance-Measuring Equipment	UNIT	AN	2
	052-260-2466	Convert Universal Transverse Mercator (UTM) Grid Coordinates to Geodetic Coordinates	UNIT	QT	2
	052-260-2470	Convert Geodetic Coordinates to Universal Transverse Mercator (UTM) Grid Coordinates	UNIT	QT	2
	052-260-2479	Compute the Convergence	UNIT	QT	2
	052-260-2482	Compute Datum Transformations	UNIT	QT	2
	052-260-2491	Check Intersection Computations	UNIT	QT	2
	052-260-2492	Establish a Declination Station	UNIT	AN	2
2. Automated Integrated Survey Instrument	052-260-2486	Postprocess Automated Integrated Surveying-Instrument (AISI) Data	UNIT	QT	2

3. Traverse	052-260-2487	Check Horizontal Field Data	UNIT	QT	2
	052-260-2488	Check Vertical-Angle (VA)/Zenith-Distance (ZD) Field Data	UNIT	QT	2
	052-260-2489	Check Distance Data	UNIT	QT	2
	052-260-2490	Compute a Geodetic Traverse	UNIT	AN	2
4. Level	052-260-2332	Perform Operator Maintenance on a Leveling Instrument	UNIT	QT	2
	052-260-2333	Check Level Data	UNIT	QT	2
5. Differential Global Positioning System	052-260-2334	Download Data From the Differential Global-Positioning-System (DGPS) Receiver	UNIT	QT	2
	052-260-2335	Process Differential Global-Positioning-System (DGPS) Data	UNIT	QT	2
	052-260-2504	Adjust Differential Global-Positioning-System (DGPS) Networks	UNIT	QT	2

CHAPTER 3

MOS/Skill Level Tasks

Skill Level 1

Subject Area 1: General

Emplace a Permanent Survey Control Point
052-260-1116

Conditions: As a topographic surveyor in a field environment, given all the required tools and supplies for the type of monument to be emplaced or marked.

Standards: Emplace a permanent survey control point so that it cannot be destroyed or moved. Make the monument out of concrete and establish an azimuth or a reference mark or a witness post as required by the survey-project work order.

Performance Steps

1. Select the tools that are needed for the monument to be emplaced or marked.

NOTE: The survey-party chief will select the type of monument to be emplaced or marked. While most peacetime project directives specify and fund for a specific monument, there is no standard type of monument required in a combat zone. However, there are several types of locally fabricated or commercially procured monuments that are considered standard based on the location of the zone of operations. Therefore, a knowledge of these types of monuments and their proper construction/installation is needed for this task.

2. Position the survey control point so that it cannot be destroyed or moved.

3. Emplace the survey monument.

NOTE: Only one type of monument should be selected for demonstration. However, each soldier must know the procedures and minimum requirements for setting up each type of monument.

a. Emplace precast-concrete or cut-stone monuments (see Note 1).
   (1) Dig a hole deep enough to accommodate the main monument as well as the subsurface marker, if required. Dig the hole as narrow as possible so that the main monument, when tamped in place, will fit with as little chance of lateral movement as possible.
   (2) Go to step 3a(4) if a subsurface marker is not required. If a subsurface marker is required, emplace the subsurface marker, set up a plumb bench over the hole, mark the plumb position on the horizontal board, and remove one nail and slide the board out of the way, making sure that the stakes are not moved.
   (3) Cover the subsurface marker with 0.06 meters of sand or soil. Whenever a survey marker disk is used (to mark the plumb point and identify the station name), mark the disk before putting it in the monument (see Note 2).
   (4) Insert the permanent monument in the hole and have at least two other people support it until the rest of the hole is filled and tamped, as required. If a subsurface marker is used, align the plumb mark of the stone with the mark on the plumb bench before backfilling the hole. The amount of exposed stone on the surface depends on the type of monument being emplaced and the project or mission directive.
   (5) Establish azimuth and reference marks, as required.

Performance Steps

NOTES:

1. A precast-concrete monument is one that is manufactured by the survey party in a base camp/rear area and transported to the station site. Construct monuments according to standing operating procedures (SOPs) and the project directive. Once the monuments are formed and cured, they are emplaced in the same manner as commercially manufactured, nonmetallic ones.
2. Do not use brass or bronze survey disks or markers stamped "CORPS OF ENGINEERS--U.S. ARMY" outside the United States (US) unless they have been approved by the host nation.

b. Construct on-site concrete monuments.
   (1) Dig a hole 1 to 1.5 meters deep (to extend below the frost line). The width of the hole will be about 30 centimeters wide. A hole any wider requires more concrete. Go to step 3b(6) if a subsurface marker is not required.
   (2) Dig an additional 10 centimeters and fill the extension with concrete for subsurface markers (see Note 3).
   (3) Insert a prestamped survey marker or disk (see Note 2).
   (4) Set up a plumb bench and plumb over the marker.
   (5) Cover the subsurface point with a thin board for protection and backfill the hole with 5 to 7 centimeters of soil.
   (6) Enlarge the hole at the bottom about 5 centimeters in radius, tapering upward for about 30 centimeters.
   (7) Construct the top form.
   (8) Pour and tamp the concrete into the hole until it is 15 centimeters from the top (see Note 3).
   (9) Put the form on top of the hole. Fill and tamp the form with concrete.
   (10) Level off the concrete with the top of the form and insert the prestamped survey marker or disk (see Note 2). If a subsurface marker is used, plumb the disk from a plumb bench.
   (11) Cover the monument with paper, then with soil. Do not use the monument until the concrete has cured (see Note 4).
   (12) Establish azimuth and reference marks, as required.

NOTES:

3. Construct monuments with cement, clean sand, and aggregate (preferably crushed rock) in proportions of 1:2:3, with the top 30 centimeters containing more cement. Where only cement and sand are available, make the lower part one part cement to three parts sand and make the upper part one part cement to two parts sand. Mix the dry material thoroughly and add water cautiously so that the mixture does not get too wet. Then pour and tamp the mixture well into the form (for precast monuments) or the hole. To avoid cracking because of drying too rapidly, cover the monument with paper, cloth, straw, earth, or other material for at least 48 hours.
4. The monument described is the minimum requirement for second-order class II specifications. Monuments used for lower-order surveys may be reduced in size to save time and money.

c. Construct natural monuments.
   (1) Construct natural monuments by permanently marking natural or man-made features such as rocks, boulders, or street curbs. Any object that cannot be easily moved can be made into a natural monument if properly marked.
   (2) Use a star drill or another suitable tool to make a hole 0.06 meters deep to receive the shank of a standard survey marker (see Note 2).
   (3) Insert the survey marker and cement it in place with concrete or masonry mortar.
   (4) Establish azimuth and reference marks, as required.

d. Emplace metallic rods.
   (1) Emplace any type of metallic rod that can be driven to the point of refusal and will accommodate some type of survey disk or marker on top. Metallic rods can either be commercially procured or manufactured from scrap (for example, a used water pipe). Do not use metallic rods when a subsurface marker is required.
   (2) Use a driving device to drive the rod section to a depth of at least 4 meters or to the point of refusal (see Note 5).
   (3) Dig a hole around the rod that is a 25-centimeter square or dig a hole that is 25 centimeters in diameter and at least 20 centimeters deep.

Performance Steps

(4) Pour concrete into the hole until it is level with the top of the rod (see Note 1). Make sure that no more than 2 centimeters of the rod is protruding above ground level.
(5) Set the prestamped survey-marker disk on top of the rod. Make sure that the poured concrete comes up to the underside of the disk (see Note 2).
(6) Establish azimuth and reference marks, as required.

NOTE 5: Metallic rods come in many sizes and shapes. Procedures listed here are common to all rods. Use special tools such as sledgehammers or gasoline-powered impact hammers to drive the rods to the desired depths.

4. Establish an azimuth or reference mark or a witness post for each permanent survey control point.

NOTE: Only one type of monument should be selected. However, each soldier must know the procedures and minimum requirements for setting up each type of monument.

a. Establish at least one azimuth or reference mark or witness post for each permanent survey control point. This mark or post should be as permanent as the principal point, but it does not have to be the same type of material.
b. Add an additional azimuth or reference mark or a witness post if future identification could be a problem or if the project directive requires it.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select one or more points to be permanently marked that are of use in either a miniature garrison survey-training course or as part of a real survey project. If permanent points are not needed in sufficient numbers to allow all skill level (SL) 1 soldiers to assist, demonstrate the task using a few soldiers. Have the others watch the demonstration. In this case, the "brief soldier" section becomes a briefing to the group and the pass or fail ratings are not used on soldiers performing the task.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him the location where the monument is to be emplaced. Tell him if any required azimuth or reference marks or witness posts are needed. Specify the permanent point type to be emplaced at the location and tell him where the required tools and materials are. Tell him that this is a group task and that individual and group evaluations will be done. Tell him to emplace a permanent survey control point.

Performance Measures	**GO**	**NO GO**
1. Selected the tools that were needed for the monument to be emplaced or marked.	____	____
2. Positioned the survey control point so that it could not be destroyed or moved.	____	____
3. Emplaced the survey monument.	____	____
4. Established an azimuth or a reference mark or a witness post for each permanent survey control point.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required

Related
DA FORM 1959
EM 1110-1-1002

Sketch and Describe the Location of a Survey Control Station

052-260-1213

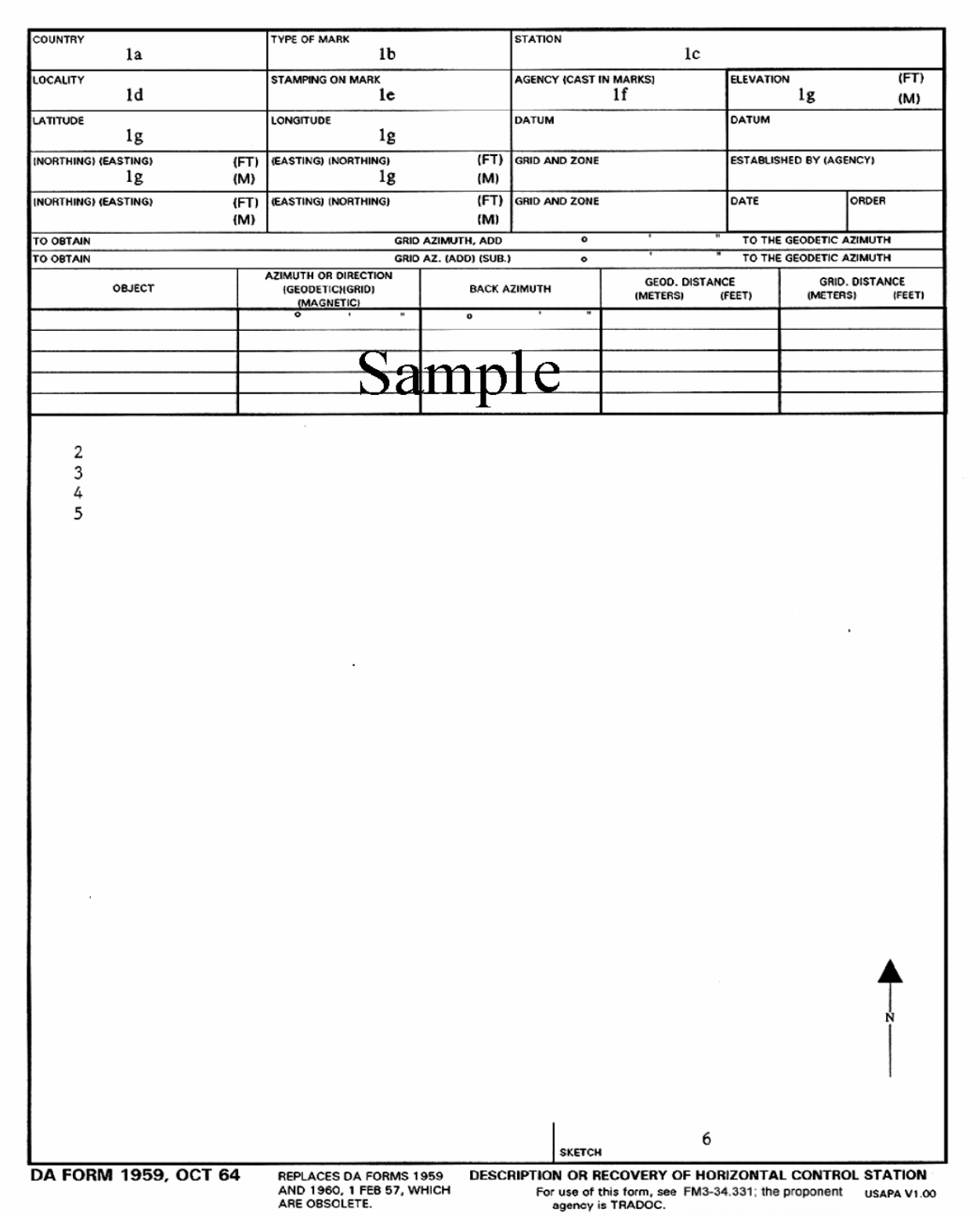
Conditions: As a topographic surveyor in a field environment, given Department of the Army (DA) Form 1958 or 1959, a 1:50,000 map of the area where the control point(s) are located, a plotting scale, a compass, a 30-meter tape measure, a straightedge, and an identified survey control station.

Standards: Sketch and describe the designated station without error, showing its location on DA Form 1958 or 1959. The description must be clear and concise.

Performance Steps

1. Enter administrative data on DA Form 1959 (or DA Form 1958, if needed) (Figures 052-260-1213-1 and 052-260-1213-2).

Performance Steps



COUNTRY 1a	TYPE OF MARK 1b	STATION 1c	
LOCALITY 1d	STAMPING ON MARK 1e	AGENCY (CAST IN MARKS) 1f	ELEVATION 1g (FT) (M)
LATITUDE 1g	LONGITUDE 1g	DATUM	DATUM
(NORTHING) (EASTING) (FT) (M) 1g	(EASTING) (NORTHING) (FT) (M) 1g	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING) (EASTING) (FT) (M)	(EASTING) (NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER

TO OBTAIN GRID AZIMUTH, ADD ° ' " TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ. (ADD) (SUB.) ° ' " TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC) ° ' "	BACK AZIMUTH ° ' "	GEOD. DISTANCE (METERS) (FEET)	GRID. DISTANCE (METERS) (FEET)

Sample

2
3
4
5

N

SKETCH 6

DA FORM 1959, OCT 64 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE.

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see FM3-34.331; the proponent agency is TRADOC.

USAPA V1.00

Figure 052-260-1213-1
Sample of DA Form 1959 With Block Numbers

Performance Steps

NOTES ON COMPLETION OF FORM

1. GENERAL: This form may be used in the field or, as an office form to record and publish positions, descriptions, and related data.

2. FIELD USE OF FORM: The information required should be obtained and recorded AT THE STATION SITE. The field engineer should fill in only the information available and applicable to field use. In general, the geographic and grid positions, azimuths, distances, and elevations should not be filled in at field level except when the information is required for an immediate specific purpose.

a. ORIGINAL DESCRIPTION OF NEW STATION: The type of mark used for the station, reference marks, and azimuth marks, and a description of each must be given in the text of the description. If a disk is used, the identity of the agency whose name is cast in the disk and all of the letters and numbers stamped on the mark which identify the organization establishing or setting the mark should be given. In many areas the use of disks is not desirable because of their loss, due to vandalism or superstition. Less conspicuous marks should be used under these conditions. This requires exact statements of the character of the marks. Information for all marks as to the elevation above or below ground and approximate elevation above or below nearby prominent features is important. At least three measurements within .01 foot should be made from the station to any permanent marks, features, or structures that would permit relocating the spot where an instrument was centered.

Good judgment should be exercised as to how far these measurements should be made. It is recommended that they be made to items which are not in the immediate vicinity of the station. Angles should also be turned to these items, particularly where no azimuth marks have been established.

b. VIEW: Provide information on height of tower or stand used in occupying or establishing the station and information on view from a normal tripod, i.e., a 50-foot tower was used at the station; view from a tripod height is clear to the south and east but is obstructed by rise in ground (by 50 foot trees) to the north and west.

c. PHOTOGRAPHIC IDENTIFICATION: Provide when possible, two measurements from the station to natural or cultural features which might be visible on aerial photography and a description of the terrain. If photographs are available identify the station thereon and note estimated accuracy of the identification.

d. NOTES ON RECOVERED STATIONS: A diligent search should be made for ALL previously established stations in the vicinity and no station should be reported as destroyed unless conclusive evidence of destruction is present. A statement of the diligence of the search and reason for the nonrecovery of a previously established mark is required. If the spot where a station mark was located can be reproduced by measurement given in the description, the station is not destroyed. The reproduced spot should be tied in by azimuth and distance and the estimated accuracy of the reproduced location given. If a new mark is set in the exact location of a previously established but destroyed mark, the designation of the station should be identical with the original with only a new date added to its designation. If a new disk is set in the approximate location of the old station, the name should be preserved but the number "2" and a new date should be added.

(DESCRIBED) (RECOVERED) BY 7a	
PROJECT 7b	
DATE 7c	FIELD BOOK

REVERSE OF DA FORM 1959, OCT 64 USAPA V1.00

Figure 052-260-1213-1
Sample of DA Form 1959 With Block Numbers (Continued)

Performance Steps

COUNTRY	TYPE OF MARK	STATION	
Germany	170 Monument	Stone Kamp	
LOCALITY: Illesheim/L6528	STAMPING ON MARK: NA	AGENCY (CAST IN MARKS): NA	ELEVATION (FT) (M): 331.671
LATITUDE: 49°28´10.47467"	LONGITUDE: 10°23´10.925197"	DATUM: WGS 84	DATUM: Amsterdam
(NORTHING) (EASTING) (FT) (M): 5,480,852.200	(EASTING) (NORTHING) (FT) (M): 600.444.268	GRID AND ZONE: 32U	ESTABLISHED BY (AGENCY): 320th Engineer
(NORTHING) (EASTING) (FT) (M):	(EASTING) (NORTHING) (FT) (M):	GRID AND ZONE:	DATE: November 96 / ORDER: Third
TO OBTAIN	GRID AZIMUTH, ADD	° ' "	TO THE GEODETIC AZIMUTH
TO OBTAIN	GRID AZ. (ADD) (SUB.)	° ' "	TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD. DISTANCE (METERS) (FEET)	GRID. DISTANCE (METERS) (FEET)
	° ' "	° ' "		
	Sample			

The station is located on Storch Barracks, Illesheim, Germany.

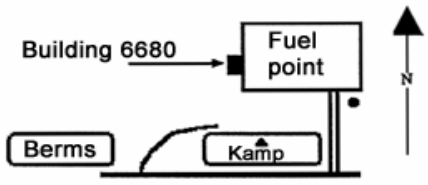
To reach the station front gate of Storch Barracks (Grid 0082) go straight for 0.1 mile to a four-way intersection. Turn right (west) and proceed 0.8 mile to the gate of the access road and a guard shack. Follow the access road around the perimeter of the airfield for 0.9 mile to the station site.

The station is a Type 70 monument protruding 20 centimeters above the ground and is located atop a berm.

The station is located 75.1 meters at an azimuth of 160° from Building 6680, 82.3 meters from the hot fuel point and 67 meters from the fuel point sign.

Horizontal position was established by third-order class I traverse.

Elevation was established by third-order leveling procedures.



SKETCH

DA FORM 1959, OCT 64 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE. DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see FM 3-34.331; the proponent agency is TRADOC. USAPA V1.00

Figure 052-260-1213-2
Completed Sample of DA Form 1959

Performance Steps

NOTE: DA Form 1958 is used when performing a benchmark recovery.

a. The country (block 1a).
b. The type of mark (for example, a bronze disk) (block 1b).
c. The station name (block 1c).
d. The locality designation (for example, state, province, county, or country) (block 1d).
e. The stamping on the mark (inscription on the disk) (block 1e).
f. The agency that established the mark (block 1f).
g. The coordinates or the station, if provided (either the universal transverse Mercator [UTM] or the geodetic) (blocks 1g).

2. Describe the general location of the station (block 2). Provide the general-vicinity information in relation to major landmarks, cities, and cultural or man-made features. Use the following phrase "The station is located. . ."

3. Describe the site location of the station (block 3). Give the location of the station by using a magnetic compass and tape measure. The description will be referenced to the station's reference marks or to prominent durable features such as a road intersection or a building (for example, 30 meters at an azimuth of 45° from the intersection of Main Street and Elm Road). Use the following phrase "The station is located. . ."

4. Describe the station (block 4). Give a description of the station in terms of material used, the configuration and stamping on the mark, the height of the mark in reference to ground level, and whether or not the mark has a subsurface monument. Use the following phrase "The station is marked by a. . ."

5. Describe any reference marks and include the following (block 5):

NOTE: This is not necessary if a reference mark is not present.

a. A reference-mark description.
b. A magnetic azimuth from the main station to the reference mark.
c. The distance from the main station to the reference mark. Measure to the nearest 1 centimeter.
d. An azimuth and approximate distance to any prominent points that may assist in locating the station.

6. Make a sketch of the station in the area provided on the form and include the following (block 6):
   a. The orientation of the station in reference to north.
   b. An adequate coverage area that includes several referenced objects.
   c. Any other marks (in addition to the described reference marks) that may assist in the station's location such as trees, fence lines, roads, sidewalks, or structures.
   d. A quantifiable description for the referenced marks (for example, use the tree type and dimension, road width, building size, and so forth).

7. Complete the back of the form with the following:
   a. The name of the individual completing the form (block 7a).
   b. The project designation (block 7b).
   c. The date of recovery and completion (block 7c).

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting. For the purpose of evaluation and training, either DA Form 1958 or 1959 may be used. An assistant may be provided to determine the distances to referenced objects. However, if the evaluator has made a "master" card/form in advance, an assistant is not necessary. In this case, the soldier would only have to identify the object and the evaluator would provide the distance and azimuth information. Show the soldier the monument to be described and the DA form to be used. Identify the quantity and location of any required reference and/or azimuth marks.

Explain that final position, elevation, and azimuth data are not required because they will be added after the survey is computed and adjusted. Tell him to sketch and describe the location of a survey control station.

Performance Measures	**GO**	**NO GO**
1. Entered administrative data on DA Form 1959 (or DA Form 1958 if it was used).	____	____
2. Described the general location of the station.	____	____
3. Described the site location of the station.	____	____
4. Described the station.	____	____
5. Described any reference marks, if they were used.	____	____
6. Made a sketch of the station in the area provided on the form.	____	____
7. Completed the back of the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1958	
DA FORM 1959	

Recover Survey Control Stations

052-260-1323

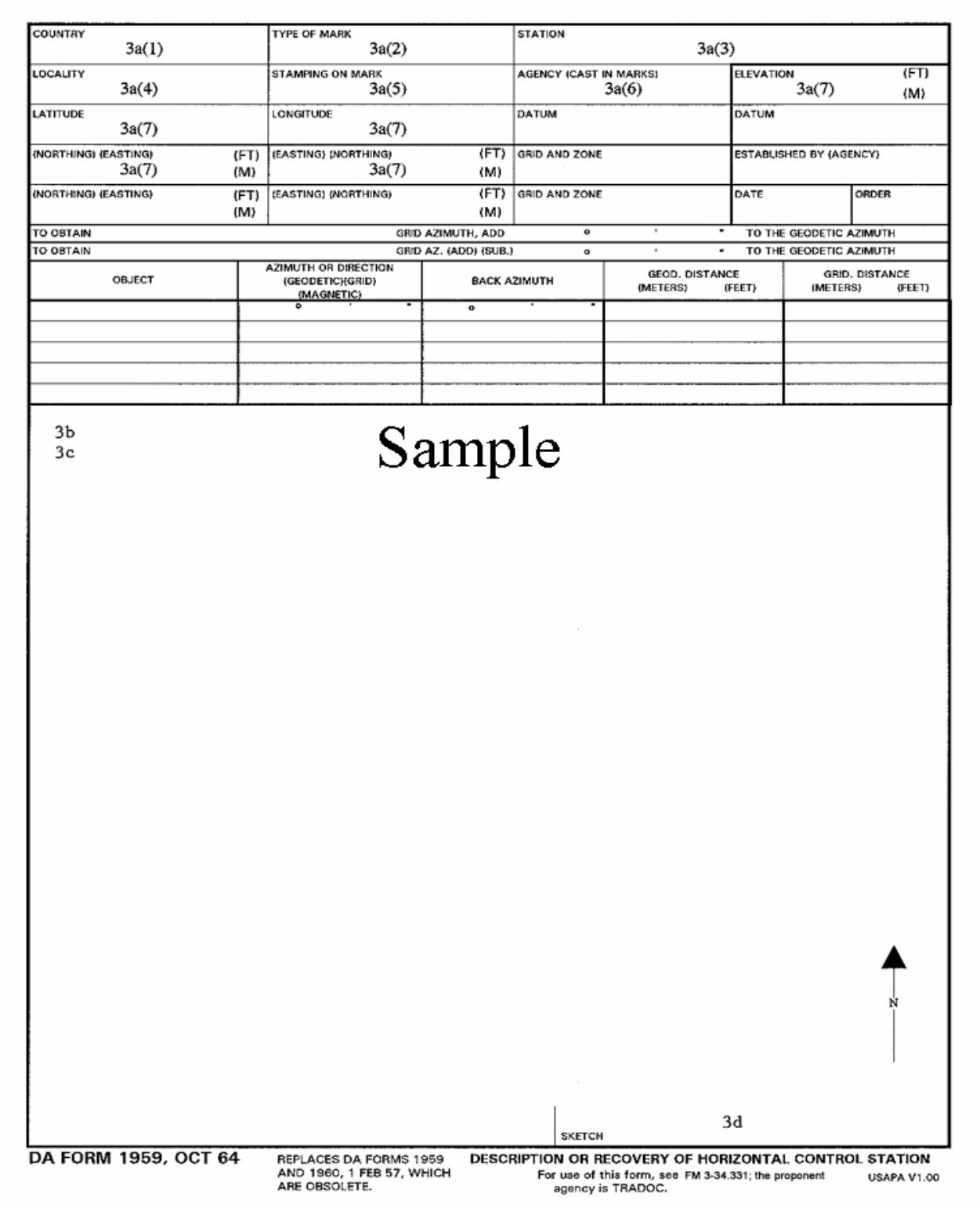
Conditions: As a topographic surveyor in a field environment, given universal transverse Mercator (UTM) coordinates, the survey station's description on Department of the Army (DA) Form 1958 or 1959 for the desired control point(s) and/or the trig list containing the desired control point(s), a hand-held global-positioning-system (GPS) receiver, a 1:50,000 map of the area where the control point(s) are located, a plotting scale, a compass, a 30-meter tape measure, a vehicle with a driver, and blank DA Form 1958 or 1959.

Standards: Recover the designated station. Use the information that is provided on DA Form 1958, DA Form 1959, or the trig list to recover, sketch, and describe the designated station(s). Follow all safety precautions.

Performance Steps

1. Collect the information on the stations to be recovered.
   a. Locate the area where the survey control stations are on the map.
   b. Develop a course of action to navigate safely to the survey control station.
   c. Brief the driver (if necessary) on the route to be used to navigate to the station(s).
2. Locate the survey control station and navigate safely to it.
3. Describe and make a sketch of the survey control station on DA Form 1959 (or DA Form 1958, if used) (Figures 052-260-1323-1 and 052-260-1323-2).

Performance Steps



COUNTRY 3a(1)	TYPE OF MARK 3a(2)	STATION 3a(3)	
LOCALITY 3a(4)	STAMPING ON MARK 3a(5)	AGENCY (CAST IN MARKS) 3a(6)	ELEVATION 3a(7) (FT) (M)
LATITUDE 3a(7)	LONGITUDE 3a(7)	DATUM	DATUM
(NORTHING) (EASTING) 3a(7) (FT) (M)	(EASTING) (NORTHING) 3a(7) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING) (EASTING) (FT) (M)	(EASTING) (NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER
TO OBTAIN	GRID AZIMUTH, ADD	° ' "	TO THE GEODETIC AZIMUTH
TO OBTAIN	GRID AZ. (ADD) (SUB.)	° ' "	TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC) ° ' "	BACK AZIMUTH ° ' "	GEOD. DISTANCE (METERS) (FEET)	GRID. DISTANCE (METERS) (FEET)

3b
3c

Sample

N

SKETCH 3d

DA FORM 1959, OCT 64 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE.

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

USAPA V1.00

Figure 052-260-1323-1
Sample of DA Form 1959 With Block Numbers

Performance Steps

NOTES ON COMPLETION OF FORM

1. GENERAL: This form may be used in the field or, as an office form to record and publish positions, descriptions, and related data.

2. FIELD USE OF FORM: The information required should be obtained and recorded AT THE STATION SITE. The field engineer should fill in only the information available and applicable to field use. In general, the geographic and grid positions, azimuths, distances, and elevations should not be filled in at field level except when the information is required for an immediate specific purpose.

a. ORIGINAL DESCRIPTION OF NEW STATION: The type of mark used for the station, reference marks, and azimuth marks, and a description of each must be given in the text of the description. If a disk is used, the identity of the agency whose name is cast in the disk and all of the letters and numbers stamped on the mark which identify the organization establishing or setting the mark should be given. In many areas the use of disks is not desirable because of their loss, due to vandalism or superstition. Less conspicuous marks should be used under these conditions. This requires exact statements of the character of the marks. Information for all marks as to the elevation above or below ground and approximate elevation above or below nearby prominent features is important. At least three measurements within .01 foot should be made from the station to any permanent marks, features, or structures that would permit relocating the spot where an instrument was centered.

Good judgment should be exercised as to how far these measurements should be made. It is recommended that they be made to items which are not in the immediate vicinity of the station. Angles should also be turned to these items, particularly where no azimuth mark or marks have been established.

b. VIEW: Provide information on height of tower or stand used in occupying or establishing the station and information on view from a normal tripod, i.e., a 50-foot tower was used at the station; view from a tripod height is clear to the south and east but is obstructed by rise in ground (by 50foot trees) to the north and west.

c. PHOTOGRAPHIC IDENTIFICATION: Provide when possible, two measurements from the station to natural or cultural features which might be visible on aerial photography and a description of the terrain. If photographs are available identify the station thereon and note estimated accuracy of the identification.

d. NOTES ON RECOVERED STATIONS: A diligent search should be made for ALL previously established stations in the vicinity and no station should be reported as destroyed unless conclusive evidence of destruction is present. A statement of the diligence of the search and reason for the nonrecovery of a previously established mark is required. If the spot where a station mark was located can be reproduced by measurement given in the description, the station is not destroyed. The reproduced spot should be tied in by azimuth and distance and the estimated accuracy of the reproduced location given. If a new mark is set in the exact location of a previously established but destroyed mark, the designation of the station should be identical with the original with only a new date added to its designation. If a new disk is set in the approximate location of the old station, the name should be preserved but the number "2" and a new date should be added.

(DESCRIBED) (RECOVERED) BY 3e(1)	
PROJECT 3e(2)	
DATE 3e(3)	FIELD BOOK

REVERSE OF DA FORM 1959, OCT 64 USAPA V1.00

Figure 052-260-1323-1
Sample of DA Form 1959 With Block Numbers (Continued)

Performance Steps

COUNTRY	TYPE OF MARK	STATION	
Germany	170 Monument	Stone Kamp	
LOCALITY: Illesheim/L6528	STAMPING ON MARK: NA	AGENCY (CAST IN MARKS): NA	ELEVATION: 331.671 (FT) (M)
LATITUDE: 49°28´10.47467"	LONGITUDE: 10°23´10.925197"	DATUM: WGS 84	DATUM: Amsterdam
(NORTHING) (EASTING) (FT) (M): 5,480,852.200	(EASTING) (NORTHING) (FT) (M): 600.444.268	GRID AND ZONE: 32U	ESTABLISHED BY (AGENCY): 320th Engineer
(NORTHING) (EASTING) (FT) (M):	(EASTING) (NORTHING) (FT) (M):	GRID AND ZONE:	DATE: November 96 / ORDER: Third
TO OBTAIN	GRID AZIMUTH, ADD ° ' "	TO THE GEODETIC AZIMUTH	
TO OBTAIN	GRID AZ. (ADD) (SUB.) ° ' "	TO THE GEODETIC AZIMUTH	

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD. DISTANCE (METERS) (FEET)	GRID. DISTANCE (METERS) (FEET)
	° ' "	° ' "		
	Sample			

The station is located on Storch Barracks, Illesheim, Germany.

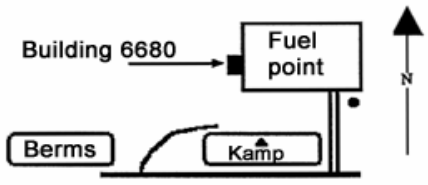
To reach the station front gate of Storch Barracks (Grid 0082) go straight for 0.1 mile to a four-way intersection. Turn right (west) and proceed 0.8 mile to the gate of the access road and a guard shack. Follow the access road around the perimeter of the airfield for 0.9 mile to the station site.

The station is a Type 70 monument protruding 20 centimeters above the ground and is located atop a berm.

The station is located 75.1 meters at an azimuth of 160° from Building 6680, 82.3 meters from the hot fuel point and 67 meters from the fuel point sign.

Horizontal position was established by third-order class I traverse.

Elevation was established by third-order leveling procedures.



SKETCH

DA FORM 1959, OCT 64 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE. DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see FM 3-34.331; the proponent agency is TRADOC. USAPA V1.00

Figure 052-260-1323-2
Completed Sample of DA Form 1959

Performance Steps

NOTE: DA Form 1958 is used when performing a benchmark recovery.

a. Enter administrative data on DA Form 1959 (Figure 052-260-1323-1).
   (1) The country (block 3a[1]).
   (2) The type of mark used (for example, a bronze disk) (block 3a[2]).
   (3) The station name (block 3a[3]).
   (4) The locality designation (for example, state, province, county, or country) (block 3a[4]).
   (5) The stamping on the mark (inscription on the disk) (block 3a[5]).
   (6) The agency that established the mark (block 3a[6]).
   (7) The coordinates or the station (either the UTM or the geodetic) (blocks 3a[7]).

b. Write a station description that includes the following (block 3b):
   (1) A recovery note. The recovery note should be as follows: recovered as described, no change in the sketch and description; recovered, the station was recovered but the description required some changes; not recovered, no evidence of the station was found; disturbed, the station was found but there was evidence that the station had been displaced; destroyed, evidence that the station existed but was unable to be reset within 1 centimeter; reset, the station was found and reset to within 1 centimeter of the original position.
   (2) The general location. Provide the general-vicinity information in relation to major landmarks, cities, and cultural or man-made features. Use the following phrase "The station is located. . ."
   (3) A route description. Describe the route to follow to find the station that starts from a prominent point, such as an intersection or prominent landmark (for example, from town hall, proceed 2.4 miles south on Main Street to the intersection of Main Street and Elm Road). Use tenths of miles or kilometers in the description. Use the following phrase "To reach the station from. . ."
   (4) A site description. Give the location of the station by using a magnetic compass and tape measure. The description will be referenced to the station's reference marks or to prominent durable features such as a road intersection or a building (for example, 30 meters at an azimuth of 45° from the intersection of Main Street and Elm Road). Use the following phrase "The station is located. . ."

NOTE: Do not use natural features in the site description that will change with time (for example, a tree that is 20 centimeters in diameter will not be 20 centimeters in diameter 10 years later. These types of features may be included in the sketch.

   (5) The type of station. Describe the station in terms of material used, the configuration and stamping on the mark, the height of the mark in reference to ground level, and whether or not the mark has a subsurface monument. Use the following phrase "The station is marked by a. . ."

c. Describe any reference marks and include the following (block 3c):

NOTE: This is not necessary if a reference mark is not present.

   (1) A reference-mark description.
   (2) A magnetic azimuth from the main station to the reference mark.
   (3) The distance from the main station to the reference mark. Measure to the nearest 1 centimeter.
   (4) An azimuth and approximate distance to any prominent points that may assist in locating the station.

d. Make a sketch of the station in the area provided on the form and include the following (block 3d):
   (1) The orientation of the station in reference to north.
   (2) An adequate coverage area that includes several referenced objects.
   (3) Any other marks (in addition to the described reference marks) that may assist in the station's location, such as trees, fence lines, roads, sidewalks, or structures.
   (4) A quantifiable description for the referenced marks (for example, use the tree type and dimension, road width, building size, and so forth).

e. Complete the back of the form with the following:
   (1) The name of the individual completing the form (block 3e[1]).

Performance Steps

(2) The project designation (block 3e[2]).
(3) The date of recovery and completion (block 3e[3]).

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. The evaluator will ensure that the stations to be recovered are in place and recoverable.

Brief Soldier: Give the soldier a safety briefing before starting. Tell him to recover survey control stations.

Performance Measures	**GO**	**NO GO**
1. Collected the information on the station to be recovered.	____	____
2. Located the survey control station and navigated safely to it.	____	____
3. Described and made a sketch of the survey control station on DA Form 1959 (or DA Form 1958, if it was used).	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1958	
DA FORM 1959	

Perform a Topographic Survey by the Stadia-Transit Method
052-260-1333

Conditions: As a topographic surveyor in a field environment, during daylight hours with no precipitation, given a theodolite with all accessories, a rodman with a level rod, a recorder with Department of the Army (DA) Form 5818, scratch paper, a plotting scale, a protractor, starting coordinates for two survey stations, and the mission of performing a topographic survey without the benefit of electronic distance measuring equipment (EDME).

Standards: Perform a topographic survey using the stadia-transit method. Produce a topographic map with 0.50-meter contour intervals (accurate to ± 0.35 meters) in the specified time. All details must be complete and legibly plotted to within ± 2.5 millimeters at map scale for the correct relationship.

Performance Steps

1. Set up, plumb, and level the theodolite over a survey station.
2. Determine the height of instrument (HI) above the station.
3. Orient the instrument.
   a. Locate and focus on the target station.
   b. Enter the azimuth from the occupied station to the target station as the initial plate setting.
4. Make point observations.
   a. Sight on the rodman.
   b. Call out the station name.
   c. Read and call out the azimuth reading.
   d. Read and call out the stadia-interval reading.
   e. Read and call out the middle-wire reading.
5. Repeat step 4 until the field-data collection is complete.
6. Check the recorded azimuth, distance, and elevation data.
7. Check the points plotted by the assistant.
8. Ensure that the contours are sketched correctly to represent man-made and natural features.
9. Ensure that the following information is entered on each data sheet--a scale; a title; the name of the observer, recorder, and computer; and other pertinent information.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two survey control points within 100 meters of each other. Identify 10 prominent points within a 50-meter radius of one of the control points. Have a recorder record the azimuth, distance, and difference in elevations. Have an assistant compute the recorded notes and plot the observed points. Provide the computed azimuth from the occupied station to the orientation station.

Brief Soldier: Identify the survey control points, prominent points to be plotted, and equipment and personnel to be used. Explain that scoring will be GO or NO-GO based on the correct plumbing, orienting, observing, and plotting of topographic work. Give the soldier a safety briefing before starting the test. Tell him to perform a topographic survey by the stadia-transit method.

Performance Measures	**GO**	**NO GO**
1. Set up, plumbed, and leveled the theodolite over a survey station.	____	____

Performance Measures	GO	NO GO
2. Determined the HI above the station.	____	____
3. Oriented the instrument.	____	____
4. Made point observations.	____	____
5. Repeated performance step 4 until the field-data collection was complete.	____	____
6. Checked the recorded azimuth, distance, and elevation data.	____	____
7. Checked the points plotted by the assistant.	____	____
8. Ensured that the contours were sketched correctly to represent man-made and natural features.	____	____
9. Ensured that the following information was entered on each data sheet--a scale; a title; the name of the observer, recorder, and computer; and other pertinent information.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 5818	

Compute an Intersection

052-260-1335

Conditions: As a topographic surveyor in a secure field environment, given a sketch of the triangle on Department of the Army (DA) Form 1962, the horizontal angles (HAs) and zenith distances (ZDs) measured from two known stations, the coordinates of the known stations, computation forms, the grid azimuth and grid distance (S) between the two known points, instructions on two-point intersection computations, a scientific calculator, a desktop personal computer (PC) with the National Imagery and Mapping Agency (NIMA) Tables Program, and blank DA Forms 1920, 1938, and 1947.

Standards: Compute the unknown angle, the length of the unknown sides, the northings (N) and eastings (E) of the unknown point, and the elevation of the unknown point. Compute the triangles to one decimal place in seconds, the sine to eight decimal places, and the distances to three decimal places. Compute the positions to two decimal places that agree to within ± 2 in the last decimal place. All entries and computations must be accurate, neat, and legible.

Performance Steps

1. Use the sketch of the triangle on DA Form 1962 (Figure 052-260-1335-1) to label the first unknown point as #1 and the points clockwise as unknown points #2 and #3. Complete the triangle computation on DA Form 1920 (Figures 052-260-1335-2 and 052-260-1335-3).

Performance Steps

PROJECT: 412-101-G-100 SPE 1 Problem #1

TABULATION OF GEODETIC DATA

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

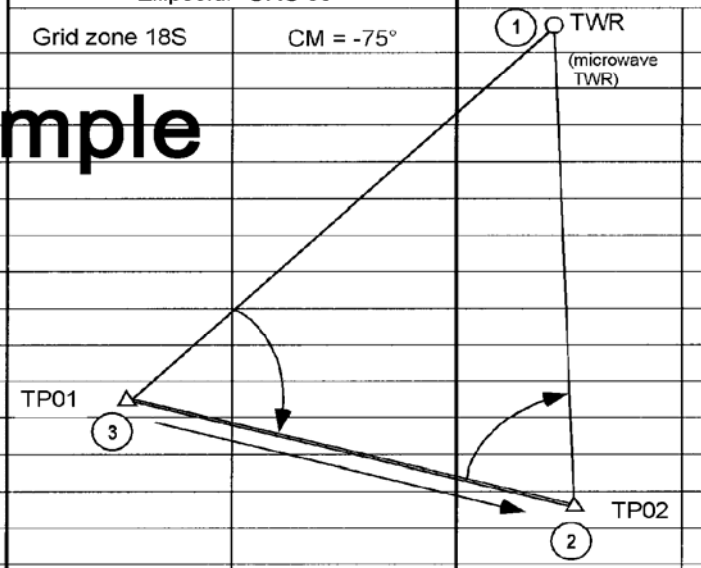
LOCATION: Fort Belvoir, VA

ORGANIZATION: DMS

STATION

Ellipsoid: GRS 80 | Grid zone 18S | CM = -75°

Mean latitude 38°42′



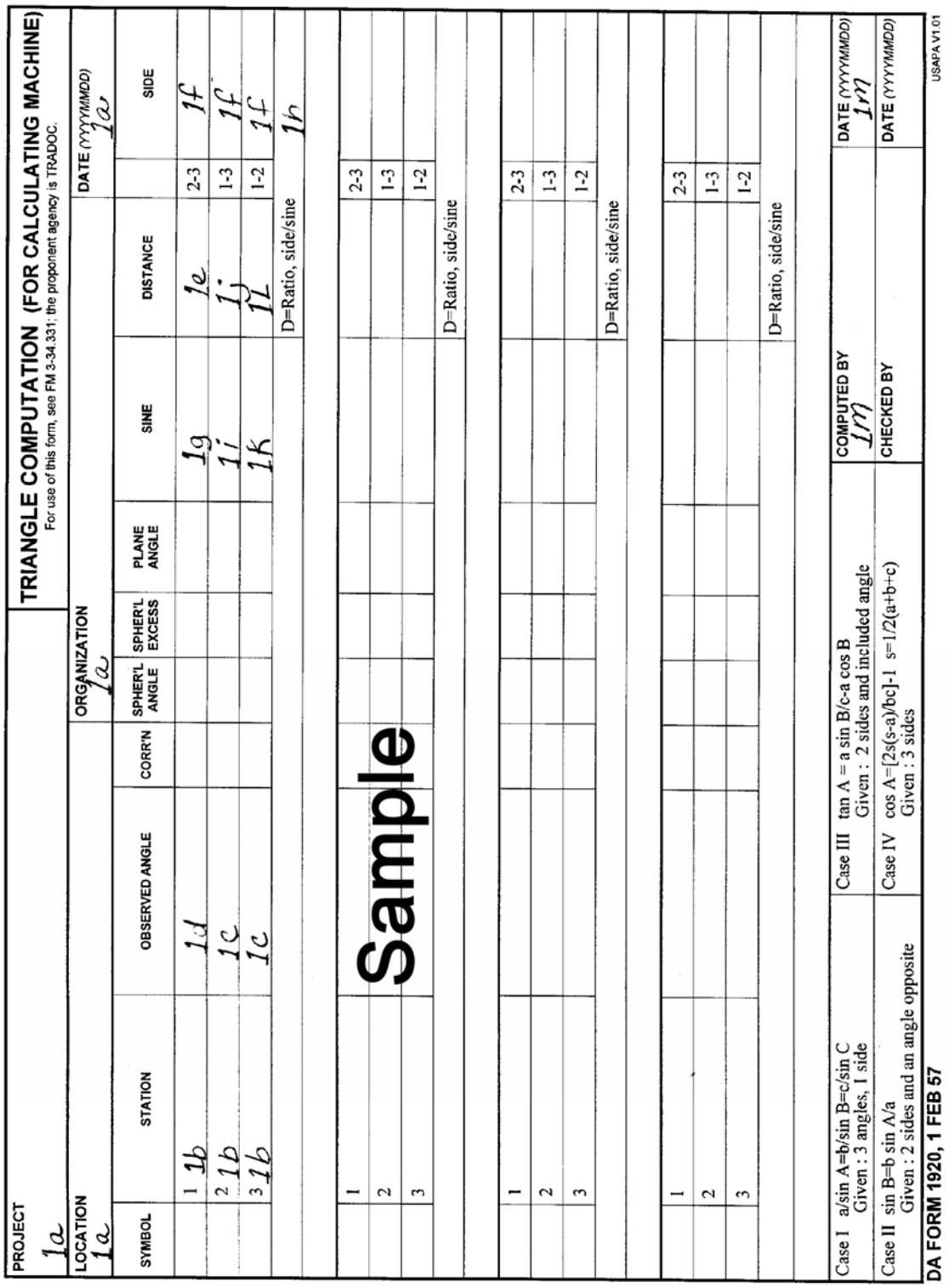
TP01	N	4285228.863		TP02 N	4285184.870
	E	314226.195		E	314411.276
	Elev	40.379 meters		Elev	39.987 meters
AZ TP01 to TP02					
103°22′15.0″					
Observed		Horz ∠ &	ZD to TWR	HI	
TP01		75°25′36.4″	84°35′09.2″	1.581	
TP02		76°26′37.5″	84°30′08.3″	1.556	
		Grid distance			
TP01-TP02		190.238 meters			
		RHO			
TP01-TWR		6365607.5168			
TP02-TWR		6360404.6683			

TABULATED BY: SSG Baker | DATE (YYYYMMDD): 2001/08/14 | CHECKED BY: SFC Whitworth | DATE (YYYYMMDD): 2001/08/14

DA FORM 1962, FEB 57 — EDITION OF FEB 57 IS OBSOLETE. — USAPA V1.01

Figure 052-260-1335-1
Completed Sample of DA Form 1962

Performance Steps



PROJECT 1a

TRIANGLE COMPUTATION (FOR CALCULATING MACHINE)
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION 1a | ORGANIZATION 1a | DATE (YYYYMMDD) 1a

SYMBOL	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE	SINE	DISTANCE		SIDE
	1 1b	1d					1g	1e	2-3	1f
	2 1b	1c					1i	1j	1-3	1f
	3 1b	1c					1k	1l	1-2	1f
								D=Ratio, side/sine		1h
	1								2-3	
	2	Sample							1-3	
	3								1-2	
								D=Ratio, side/sine		
	1								2-3	
	2								1-3	
	3								1-2	
								D=Ratio, side/sine		
	1								2-3	
	2								1-3	
	3								1-2	
								D=Ratio, side/sine		

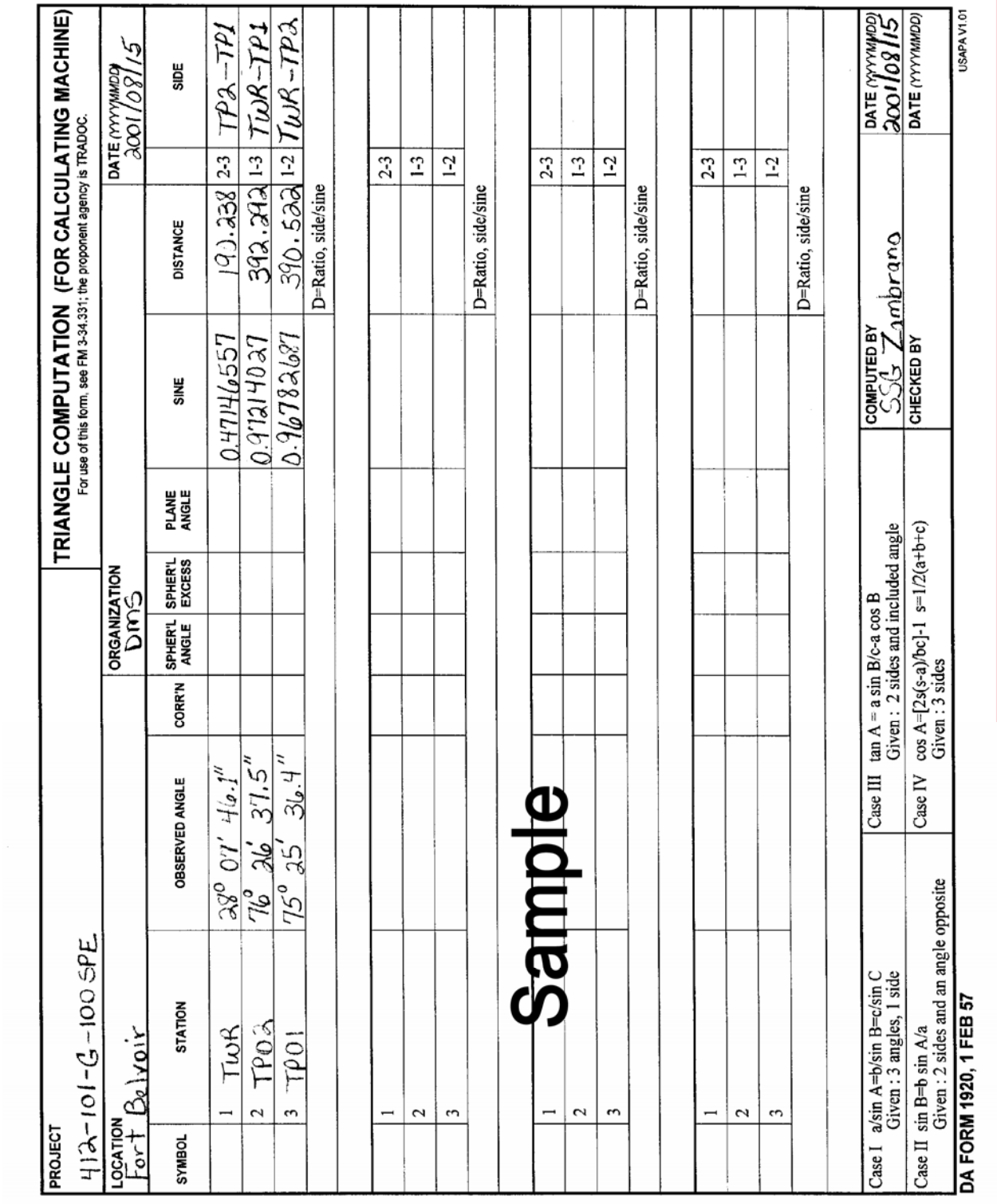
Case I a/sin A=b/sin B=c/sin C Given : 3 angles, 1 side
Case II sin B=b sin A/a Given : 2 sides and an angle opposite
Case III tan A = a sin B/c-a cos B Given : 2 sides and included angle
Case IV cos A=[2s(s-a)/bc]-1 s=1/2(a+b+c) Given : 3 sides

COMPUTED BY 1m | DATE (YYYYMMDD) 1m
CHECKED BY | DATE (YYYYMMDD)

DA FORM 1920, 1 FEB 57 USAPA V1.01

Figure 052-260-1335-2
Sample of DA Form 1920 With Block Numbers

Performance Steps



PROJECT: 412-101-G-100 SPE

TRIANGLE COMPUTATION (FOR CALCULATING MACHINE)
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION: Fort Belvoir
ORGANIZATION: DMS
DATE (YYYYMMDD): 20011108/15

SYMBOL	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE	SINE	DISTANCE		SIDE
1	TWR	28° 01' 46.1"					0.47146557	190.238	2-3	TP2-TP1
2	TP02	76° 26' 37.5"					0.97121402 7	392.292	1-3	TWR-TP1
3	TP01	75° 25' 36.4"					0.96782687	390.522	1-2	TWR-TP2
								D=Ratio, side/sine		
1									2-3	
2									1-3	
3									1-2	
								D=Ratio, side/sine		
1									2-3	
2									1-3	
3									1-2	
								D=Ratio, side/sine		
1									2-3	
2									1-3	
3									1-2	
								D=Ratio, side/sine		

Sample

Case I a/sin A=b/sin B=c/sin C Given : 3 angles, 1 side
Case II sin B=b sin A/a Given : 2 sides and an angle opposite
Case III tan A = a sin B/c-a cos B Given : 2 sides and included angle
Case IV cos A=[2s(s-a)/bc]-1 s=1/2(a+b+c) Given : 3 sides

COMPUTED BY: SSG Zambrano — DATE (YYYYMMDD): 20011108/15
CHECKED BY — DATE (YYYYMMDD)

DA FORM 1920, 1 FEB 57 — USAPA V1.01

Figure 052-260-1335-3
Completed Sample of DA Form 1920

Performance Steps

a. Fill in the administrative headings in blocks 1a.
b. Enter the station names opposite their respective numbers in blocks 1b.
c. Enter the observed angles opposite their respective numbers in blocks 1c.
d. Compute the unknown angle #1 by subtracting the two observed angles from 180° and enter this information in block 1d.
e. Enter the given side 2-3 that serves as the baseline in block 1e.
f. Enter the station names that correspond to each side in blocks 1f.
g. Determine the sine of angle #1 and enter to eight decimal places in block 1g.
h. Divide the given side 2-3 by the sine of angle #1 to determine the ratio (D) and enter to eight decimal places in block 1h.
i. Determine the sine of angle #2 and enter to eight decimal places in block 1i.
j. Determine side 1-3 by multiplying the sine of angle #2 by ratio (D) and enter to three decimal places in block 1j.
k. Determine the sine of angle #3 and enter to eight decimal places in block 1k.
l. Determine side 1-2 by multiplying the sine of angle #3 by ratio (D) and enter to three decimal places in block 1l
m. Sign and date the form in blocks 1m.

2. Complete the universal transverse Mercator (UTM) grid-position computation on DA Form 1938 (Figures 052-260-1335-4 and 052-260-1353-5).

Performance Steps

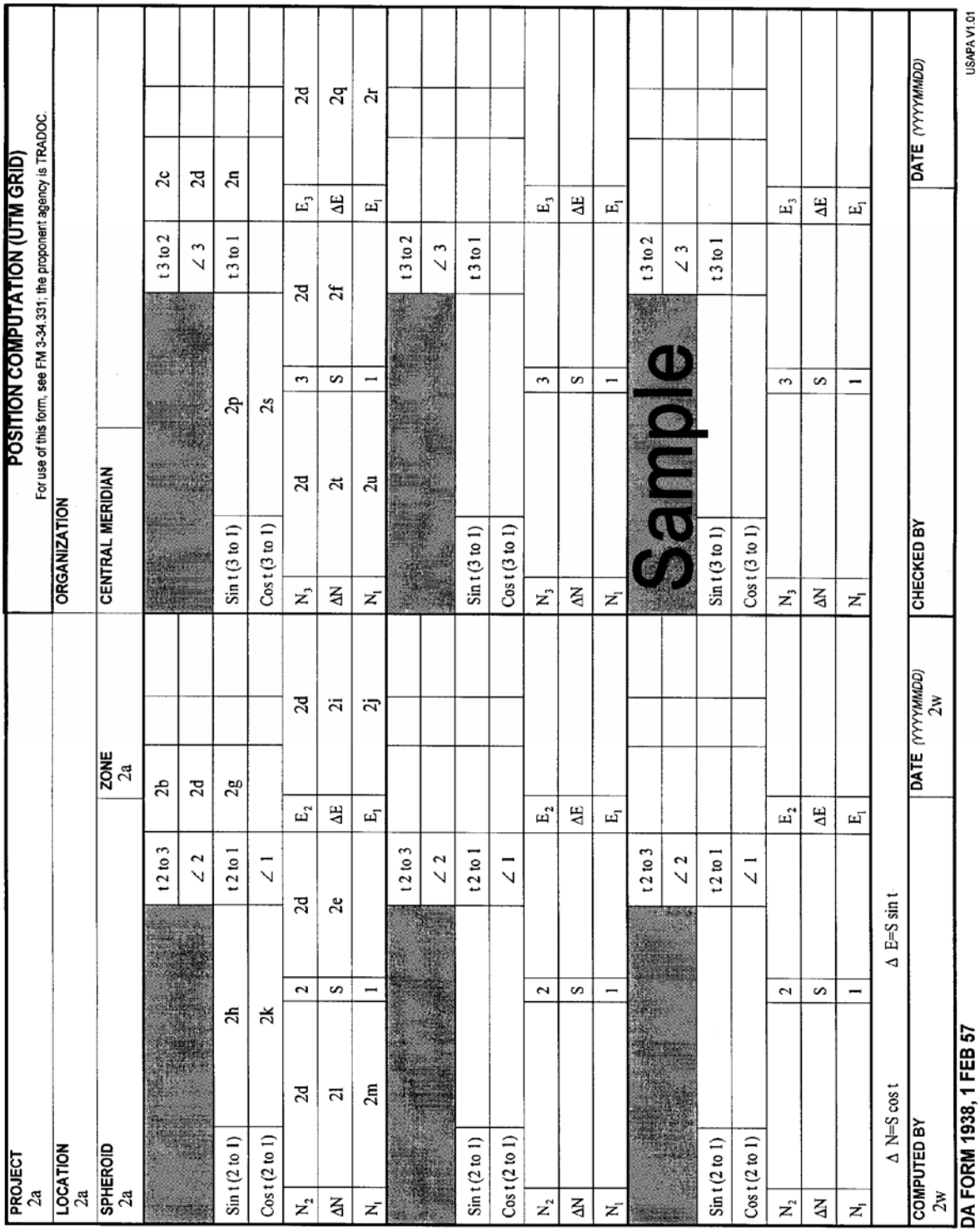
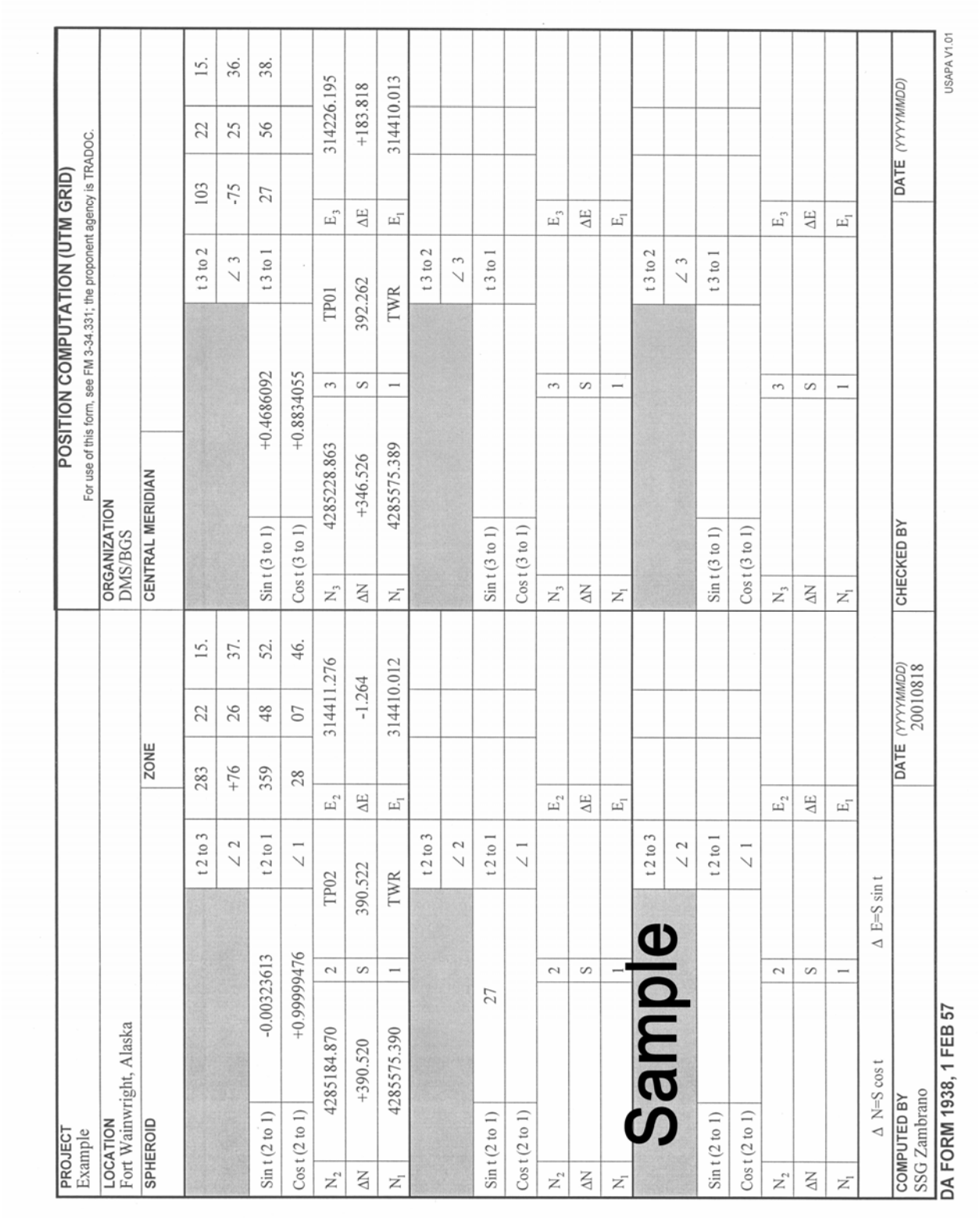


Figure 052-260-1335-4
Sample of DA Form 1938 With Block Numbers

Performance Steps



POSITION COMPUTATION (UTM GRID)

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT: Example

LOCATION: Fort Wainwright, Alaska

SPHEROID

ZONE

ORGANIZATION: DMS/BGS

CENTRAL MERIDIAN

			t 2 to 3	283	22	15.										t 3 to 2	103	22	15.						
			∠ 2	+76	26	37.										∠ 3	-75	25	36.						
Sin t (2 to 1)	-0.00323613		t 2 to 1	359	48	52.							Sin t (3 to 1)	+0.4686092		t 3 to 1	27	56	38.						
Cos t (2 to 1)	+0.99999476		∠ 1	28	07	46.							Cos t (3 to 1)	+0.8834055											
N_2	4285184.870	2	TP02	E_2	314411.276								N_3	4285228.863	3	TP01	E_3	314226.195							
ΔN	+390.520	S	390.522	ΔE	-1.264								ΔN	+346.526	S	392.262	ΔE	+183.818							
N_1	4285575.390	1	TWR	E_1	314410.012								N_1	4285575.389	1	TWR	E_1	314410.013							
			t 2 to 3													t 3 to 2									
			∠ 2													∠ 3									
Sin t (2 to 1)	27		t 2 to 1										Sin t (3 to 1)			t 3 to 1									
Cos t (2 to 1)			∠ 1										Cos t (3 to 1)												
N_2		2		E_2									N_3		3		E_3								
ΔN		S		ΔE									ΔN		S		ΔE								
N_1		1		E_1									N_1		1		E_1								
			t 2 to 3													t 3 to 2									
			∠ 2													∠ 3									
Sin t (2 to 1)			t 2 to 1										Sin t (3 to 1)			t 3 to 1									
Cos t (2 to 1)			∠ 1										Cos t (3 to 1)												
N_2		2		E_2									N_3		3		E_3								
ΔN		S		ΔE									ΔN		S		ΔE								
N_1		1		E_1									N_1		1		E_1								

Sample

Δ N=S cos t Δ E=S sin t

COMPUTED BY: SSG Zambrano

DATE (YYYYMMDD): 20010818

CHECKED BY

DATE (YYYYMMDD)

DA FORM 1938, 1 FEB 57

USAPA V1.01

Figure 052-260-1335-5
Completed Sample of DA Form 1938

Performance Steps

a. Fill in the administrative headings in blocks 2a.
b. Enter the grid azimuth for side 2-3 in block 2b (get this information from DA Form 1962).
c. Enter the grid azimuth for side 3-2 in block 2c (get this information from DA Form 1962).
d. Enter the angles at stations 2 and 3, the station names opposite their appropriate numbers, and the coordinates for stations 2 and 3 in blocks 2d.
e. Enter the grid distance for side 1-2 in block 2e (get this information from DA Form 1920).
f. Enter the grid distance for side 1-3 in block 2f (get this information from DA Form 1920).
g. Compute the grid azimuth for side 2-1 by adding angle #2 to the azimuth for side 2-3. If the sum exceeds 360°, subtract 360°. Enter this amount in block 2g.
h. Determine the sine of the azimuth for side 2-1 and enter it in block 2h.
i. Compute the difference in easting (dE) by multiplying the sine of the azimuth for side 2-1 by the grid distance for side 2-1 and enter it in block 2i.
j. Compute E1 by adding the dE to E2 and enter it in block 2j.
k. Determine the cosine of the azimuth for side 2-1 and enter it in block 2k.
l. Compute the difference in northing (dN) by multiplying the cosine of the azimuth for side 2-1 by the grid distance for side 2-1 and enter it in block 2l.
m. Compute N1 by adding the dN to N2 and enter it in block 2m.
n. Compute the grid azimuth for side 3-1 by subtracting angle #3 from the azimuth for side 3-2. If angle #3 is larger than the azimuth for side 3-1, add 360° to it before subtracting and enter this amount in block 2n.
o. Add angle #1 to the azimuth for side 2-1 for a math check. This should equal the azimuth for side 3-1. It is not necessary to record this value.
p. Determine the sine of the azimuth for side 3-1 and enter it in block 2p.
q. Compute the dE by multiplying the sine of the azimuth for side 3-1 by the grid distance for side 3-1 and enter it in block 2q.
r. Determine E1 by adding the dE to E3 and enter it in block 2r.
s. Determine the cosine of the azimuth for side 3-1 and enter it in block 2s.
t. Compute the dN by multiplying the cosine of the azimuth for side 3-1 by the grid distance for side 3-1 and enter it in block 2t.
u. Determine N1 by adding the dN to N3 and enter it in block 2u.
v. Compare the two sets of N1 and E1 (the coordinates should agree to within 0.001). If they do not, an error was made in the computation.
w. Sign and date the form in blocks 2w.

3. Complete the computation of elevations from the nonreciprocal observations on DA Form 1947 (Figures 052-260-1335-6 and 052-260-1335-7).

Performance Steps

PROJECT 3a						COMPUTATION OF ELEVATIONS FROM NONRECIPROCAL OBSERVATIONS (By calculating machine) For use of this form, see FM 3-34.331 the proponent agency is TRADOC.
LOCATION 3a						
ORGANIZATION 3a			DATE (YYYYMMDD) 3a			
Station 1, occ.	3b					
Station 2, obs.	3c					
Object sighted	3d					
ζ_1	3e					
α and mean ϕ	3f/3g					
(0.5 - m)	3h					
s	3i					
p sin 1"	3k					
k in secs.	3l					
(90° - ζ_1 + k)	3m					
tan (90° - ζ_1 + k)	3n					
A						
B						
C						
$h_2 - h_1$	3o					
h_1	3p					
$i - o$	3q					
Corrected elevation	3r					
$\frac{1}{s^2} = p$ of ($h_2 - h_1$)						
Weighted mass elevation of sta. obs.						
$h_2 - h_1 = s \tan (90° - \zeta_1 + k) A B C$				k in secs. $= \frac{(0.5 - m)s}{p \sin 1''}$		
COMPUTED BY 3t		DATE (YYYYMMDD) 3t	CHECKED BY		DATE (YYYYMMDD)	

Sample

DA FORM 1947, 1 FEB 57 USAPA V1.01

Figure 052-260-1335-6
Sample of DA Form 1947 With Block Numbers

Performance Steps

PROJECT: Example
LOCATION: Fort Wainwright, Alaska
ORGANIZATION: DMS
DATE (YYYYMMDD): 20010818

COMPUTATION OF ELEVATIONS FROM NONRECIPROCAL OBSERVATIONS
(By calculating machine)
For use of this form, see FM 3-34.331 the proponent agency is TRADOC.

Station 1, occ.	TP01	TP02			TP01	TP02
Station 2, obs.	TWR	TWR			TWR	TWR
Object sighted	OL	OL			OL	OL
ζ_1	84°35'09.2"	84°30'08.3"			84°35'09.2"	84°30'08.3"
α and mean ϕ	27°57' / 38°42'	359°47' / 38°42'			27°57' / 38°42'	359°47' / 38°42'
(0.5 - m)	0.4290	0.4290			0.4290	0.4290
s (Grid) S	392.262	390.522		(Geodetic) s	392.253	390.513
p sin 1"	30.864	30.836			30.864	30.836
k in secs.	+05.5"	+05.4"			+05.5"	+05.4"
(90° - ζ_1 + k)	+5°24'56.3"	+5°29'57.1"			+5°24'56.3"	+5°29'57.1"
tan (90° - ζ_1 + k)	0.09480323	0.09627486			0.09480323	0.09627486
A					1.00000634	1.00000629
B					1.00000292	1.00000296
C					1.00000000	1.00000000
$h_2 - h_1$	37.188	37.597			37.187	37.597
h_1	40.379	39.987			40.379	39.987
i - o	1.581	1.556			1.581	1.556
Corrected elevation	79.148	79.140			79.147	79.140
	Δ = 0.008 m				Δ = 0.007 m	
$\frac{1}{s^2}$ = p of ($h_2 - h_1$)						
Weighted mass elevation of sta. obs.						

Sample

$h_2 - h_1 = s \tan(90° - \zeta_1 + k) A B C$

$k \text{ in secs.} = \frac{(0.5 - m)s}{p \sin 1''}$

COMPUTED BY	DATE (YYYYMMDD)	CHECKED BY	DATE (YYYYMMDD)
SSG Zambrano	20010818		

DA FORM 1947, 1 FEB 57 USAPA V1.01

Figure 052-260-1335-7
Completed Sample of DA Form 1947

Performance Steps

a. Fill in the administrative headings in blocks 3a.
b. Enter the name of the station whose elevation is known (station 1, occupied) in block 3b.
c. Enter the name of the station whose elevation is unknown (station 2, observed) in block 3c.
d. Enter the object sighted (for example, target or obstruction light) in block 3d.
e. Enter the mean observed ZD in block 3e.
f. Enter the azimuth of the line to the nearest minute (get this information from DA Form 1938) and enter it in block 3f.
g. Enter the mean latitude of the line to the nearest minute in block 3g (this is obtained by converting the northings and eastings computed on DA Form 1938 to geographic positions then taking the mean of the latitudes).
h. Record the weighted mean coefficient of refraction (when not observed use 0.4290) and enter it in block 3h.
i. Enter the grid distance (S) in block 3i (the grid distance (S) is obtained from DA Form 1938).
j. Determine the mean radius of curvature (r) from the following formula. The values R and N are obtained from the NIMA Tables Program.

   r = RN divided by (R sin2 (alpha)) + (N cos2 (alpha)).

   where--
   R = Radius of curvature in the plane of the meridian.
   N = Radius of curvature in the plane of the prime vertical.

   (1) Enter the NIMA Tables Program.
   (2) Type any letter from a to z to continue the program.
   (3) Select the "LONG PROMPTS" option.
   (4) Enter the station name.
   (5) Select the ellipsoid.
   (6) Select the "INDIVIDUAL POINT" option.
   (7) Enter the latitude of the station in the degrees, minutes, and seconds (DDD.MMSS) format (for example, 38 41 00).
   (8) Select the "RADIUS OF CURVATURE IN THE MERIDIAN (N) AND PRIME VERTICAL (R) VALUES" option. The N and R values will be displayed on the top of the screen.
   (9) Exit the program and enter 99 twice then 0 at the prompts.
k. Compute the rho (detonated by "p") sine of 1" and enter it in block 3k.
l. Compute k in seconds from the following formula and enter it in block 3l:

   k in seconds = (0.5-m)s divided by the value (p sine of 1")

   where--
   s = Slope distance
   m = Mean coefficient of refraction (when this is not observed, use 0.4290).
m. Compute (90° - z1 + k) and enter it in block 3m.

   where--
   z1 = Zenith distance.
   K = A factor that takes in consideration of refraction and the curvature of the earth.
n. Compute the tangent (tan) of (90° - z1 + k) and enter it in block 3n.

   where--
   Z1 = Zenith distance.
   K = A factor that takes in consideration of refraction and the curvature of the earth.

Performance Steps

o. Compute h2 -h1 = s[tan(90° - z1 + k)] and enter it in block 3o.

where--
h2 = Unknown elevation.
h1 = Known elevation.
z1 = Zenith distance
K = A factor that takes in consideration of refraction and the curvature of the earth.

p. Enter the elevation for the occupied station (h1) in block 3p.
q. Enter the height of instrument (HI) at the occupied station in block 3q.
r. Determine the elevation of the observed station by adding h2-h1, h1, and HI and enter it in block 3r.
s. Repeat steps 3b through r for observations taken from the other end of the baseline.
t. Sign and date the form in blocks 3t.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to compute an intersection.

Performance Measures	**GO**	**NO GO**
1. Used the sketch of the triangle on DA Form 1962 to label the first unknown point as #1 and the points clockwise as unknown points #2 and #3. Completed the triangle computation on DA Form 1920.	____	____
2. Completed the UTM grid-position computation on DA Form 1938.	____	____
3. Completed the computation of elevations from the nonreciprocal observations on DA Form 1947.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1920	
DA FORM 1938	
DA FORM 1947	
DA FORM 1962	

Subject Area 2: Automated Integrated Survey Instrument

Perform Operator Maintenance on Survey Equipment

052-260-1131

Conditions: As a topographic surveyor in a secure field environment, given topographic survey equipment (with all accessories and applicable technical manuals [TMs]) and appropriate cleaning materials.

Standards: Perform operator maintenance on the survey equipment according to the applicable TM.

Performance Steps

1. Inventory all equipment components and accessories.
2. Wipe the dirt and dust from all components with a dry cloth.
3. Clean all glass surfaces with lens cleaning tissue.
4. Inspect the exterior of the equipment for damage, cracks, and wear.
5. Ensure that the motion locks and controls rotate freely and function properly.
6. Inspect the tribrach and the tribrach's leveling screws for damage and clean them, as required.
7. Inspect the tripod, bayonet screw, and other screws and nuts for damage and clean and tighten them, as required.
8. Inspect the transport case.
   a. Open and remove the instrument.
   b. Turn the case over and shake out any loose dust and dirt.
   c. Check the exterior for damage.
   d. Clean the case, as required.
9. Store the equipment in its transport case.
10. Notify the supervisor of any uncorrectable faults.

Evaluation Preparation: Setup: Provide the soldier with the items that listed in the conditions statement. The evaluator will prepare the area and equipment in advance to ensure that the task standards can be met. Ensure that all safety precautions are followed.

Brief Soldier: Give the soldier a safety briefing. Identify the survey equipment (automated integrated surveying instrument [AISI], level, global-positioning-system [GPS] receiver, and so forth), accessories, and cleaning materials to be maintained. Tell him to perform operator maintenance on survey equipment.

Performance Measures	**GO**	**NO GO**
1. Inventoried all the equipment components and accessories.	____	____
2. Wiped the dirt and dust from all components with a clean dry cloth.	____	____
3. Cleaned all glass surfaces with lens cleaning tissue.	____	____
4. Inspected the exterior of the equipment for damage, cracks, and wear.	____	____
5. Ensured that the motion locks and controls rotated freely and functioned properly.	____	____

Performance Measures	GO	NO GO
6. Inspected the tribrach and the tribrach's leveling screws for damage and cleaned them, if it was required.	____	____
7. Inspected the tripod, bayonet screw, and other screws and nuts for damage and cleaned and tightened them, if it was required.	____	____
8. Inspected the transport case.	____	____
9. Stored the equipment in its transport case.	____	____
10. Notified the supervisor of any uncorrectable faults.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
	TM 5-6675-332-10

Operate the Automated Integrated Surveying Instrument (AISI)

052-260-1134

Conditions: As a topographic surveyor in a field environment, given a complete AISI set, a survey station to set up over, a tripod, a plumb bob, a 2-meter tape measure, two visible survey stations with targets, and the AISI operator's manual.

Standards: Operate the AISI. Measure the horizontal and vertical directions to both targets to the nearest second, measure the distances to the nearest millimeter, perform calibration checks, and properly take down and secure the instrument. The tripod must provide a stable setup and allow the operator to measure angles without straddling the legs. The tripod head must be horizontal and the legs must be set in relation to the terrain. The instrument must be plumb to ± 2 millimeters of the station mark.

Performance Steps

1. Set up and plumb the instrument over the designated point.
    a. Open the tripod and, with the cover on, attach the plumb bob.
    b. Place the tripod over the survey control station and ensure that it is plumb over the survey mark. Imbed the tripod legs firmly in the ground.
    c. Adjust the tripod legs until the tripod head is horizontal. Ensure that the plumb bob is still plumb over the survey mark. If it is not, repeat steps 1a through c.
    d. Remove the tripod cover and attach the AISI to the tripod.
    e. Move the AISI on the head of the tripod to bring the plumb bob directly over the survey mark. The base of the AISI will not overhang the tripod head. Firmly tighten the AISI to the tripod.
    f. Ensure that the internal battery is fully charged and attached to the AISI. If it is not attached to the AISI, attach it under the eyepiece.
    g. Level the tribrach's bull's-eye bubble using the tribrach's foot screws.
2. Level the instrument using the dual-axis compensator.
    a. Remove the lens cover and eyepiece cover.
    b. Place the face of the instrument parallel to the two foot screws.
    c. Press the power (PWR) button on the lower left corner of the AISI. The instrument will automatically go to the "coarse-level" mode. (If a message to continue appears, answer NO by pressing the NO button.)
    d. Level both bubbles by using the left-thumb rule to adjust the front two foot screws for the lower bubble and the rear foot screw for the upper bubble. Rotate the instrument 180°.
    e. Press the angle measure (A/M) button on the rear of the instrument. The instrument will beep. About 5 seconds later, the instrument will beep twice. Rotate the instrument 180° again until the display is "PRESS A/M."
    f. Press the A/M button on the front of the instrument.
    g. Enter the values for temperature, pressure, offset, and horizontal-angle reference (HA REF) (HA setting).
    h. Ensure that the face of the instrument is still parallel to the two foot screws and press the LEVEL button to enter the "fine-level" mode.
    i. Level both bubbles by using the left-thumb rule to adjust the front two foot screws for the lower bubble and the rear foot screw for the upper bubble.
    j. Press the bubble button to exit the level display.
3. Set the proper units of measure, time, and date.
    a. Press the menu (MNU) button and enter 17.
    b. Press the YES button to accept or the NO button to change the units at the display prompts.
    c. Press the MNU button and enter 15.
    d. Press 1 to set the date.
    e. Enter the correct date in the year, month, and day (YYY.MMDD) format.
    f. Press the enter (ENT) button to accept the change.
    g. Enter the correct time in the hour, minutes, and seconds (HH.MMSS) format.

Performance Steps

h. Press the ENT button to accept the entered time or press the ENT button at a precise time signal (WWV) to synchronize the instrument clock.

NOTE: Use the CLEAR (CL) button to back the cursor to the proper position.

4. Aim the instrument correctly at a target.
   a. Point the instrument toward the sky and rotate the eyepiece until the crosshairs appear very sharp and intensely black.
   b. Point the instrument toward the target using the coarse sight under the telescope in the direct position (over the telescope in the reverse position) or the rifle sight over the telescope in the direct position (under the telescope in the reverse position).
   c. Look through the eyepiece and rotate the focusing ring to focus the target.
   d. Look through the eyepiece and fine tune the instrument pointing by using the two-speed vertical- and horizontal-motion controls.

NOTE: Use the vertical wire for HAs and the horizontal wire for vertical angles (VAs). Use the center of the crosshairs for simultaneous observations.

5. Perform the horizontal/vertical collimation-test measurements.
   a. Ensure that the instrument is in the standard (STD) mode by pressing the STD button.
   b. Press the MNU button and enter 51.
   c. Rotate the instrument to the reverse position.
   d. Aim the center of the crosshair accurately at a well-defined target at least 100 meters away (both horizontally and vertically).
   e. Press the A/M button in front. A beep will sound.
   f. Use the motion screws to move the crosshairs off the target.
   g. Reaim the instrument by approaching the target from another direction.
   h. Press the A/M button.
   i. Repeat steps 5d through h with the instrument in the direct position.
   j. Check the correction shown on the display.
   k. Press the YES and register (REG) buttons to accept and store the corrections, if acceptable.

NOTE: A minimum of two pointings must be made, and the same number of pointings must be made in the direct and reverse positions.

6. Perform the tilt-axis-test measurements.

NOTE: The collimation test must be performed before the tilt-axis test.

   a. Press the YES button at the "TILT AXIS?" prompt.
   b. Rotate the instrument to the reverse position.
   c. Aim the center of the crosshair at a well-defined point that is at least 13.5° (zenith distance (ZD): 76.5°) above the horizon.
   d. Press the A/M button. A beep will sound.

NOTE: A continuous beep will sound if the sighting exceeds the limit. If it does, reaim the crosshair and press the A/M button again.

   e. Reaim the crosshair by approaching the target from another direction.
   f. Press the A/M button.
   g. Repeat steps 6c through f in the direct position.

NOTE: A minimum of two pointings must be made, and the same number of pointings must be made in the direct and reverse positions.

   h. Press the YES button at the "STORE?" prompt, which will be displayed if the correction factor just determined is within ± 00°01'.
   i. Press the YES button at the "FAIL REMEASURE?" prompt if the correction factor exceeds ± 00°01' to repeat the test.

NOTE: If the test continuously fails, bad sightings are being made, the target is too close, or the instrument needs to be readjusted by the manufacturer.

7. Set the horizontal plates.
   a. Point the instrument at a target.
   b. Press F21 to set the HA.

Performance Steps

c. Enter the plate setting in the degrees, minutes, and seconds (DDD.MMSS) format.
d. Press the ENT button.

8. Read the horizontal and vertical directions.
   a. Ensure that the instrument is in Program 0 (P0). P0 will be displayed on the top line of the display.
   b. Aim the instrument at a different target and observe the horizontal and vertical directions. The horizontal angle will be displayed as HA. The vertical angle will be displayed as VA.

9. Obtain the distance measurement.
   a. Point the instrument at a prism and adjust the horizontal and vertical positions until there is a constant clear beep.
   b. Determine the appropriate distance-measuring mode.

NOTE: A prism must be mounted on the target to measure a distance and the AISI will only measure a distance in the direct position.

(1) The STD mode is used during control surveys (for a traverse).
    (a) Press the STD button to enter the standard mode.
    (b) Press the A/M button for each measurement.
(2) The D-BAR mode automatically repeats measurements and determines the arithmetic mean value (for high-accuracy surveys).
    (a) Press the D-BAR button to enter the D-BAR mode.
    (b) Select 1 for the normal mode or 2 for the high-resolution mode.
    (c) Press the A/M button to start and stop the measurements.
(3) The tracking (TRK) mode is used to find a certain distance (for topographic surveys).
    (a) Press the TRK button to start the measurements.
    (b) Press the button for the appropriate mode.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to operate the AISI.

Performance Measures	**GO**	**NO GO**
1. Set up and plumbed the instrument over the designated point.	____	____
2. Leveled the instrument using the dual-axis compensator.	____	____
3. Set the proper units of measure, time, and date.	____	____
4. Aimed the instrument correctly at a target.	____	____
5. Performed the horizontal/vertical collimation-test measurements.	____	____
6. Performed the tilt-axis-test measurements.	____	____
7. Set the horizontal plates.	____	____
8. Read the horizontal and vertical directions.	____	____
9. Obtained the distance measurement.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
AISI OPERATOR´S MANUAL	DMS ST 648
	TM 5-6675-332-10

Perform a Topographic Survey With an Automated Integrated Surveying Instrument (AISI)
052-260-1336

Conditions: As a topographic surveyor in a field environment, given a complete AISI set, a tripod, a plumb bob, a 2-meter tape measure, coordinates for the occupied and backsight (BS) stations, personnel to operate the targets, a recorder, a recording sheet, procedures for collecting data by means of a topographic survey with an AISI, Defense Mapping School (DMS) Special Text (ST) 648, and the AISI operator's manual.

Standards: Perform a topographic survey with an AISI. Collect topographic-survey data for three survey targets, "prism poles." Perform observations according to the guidelines and procedures set forth in the AISI operator's manual. Observations must meet the specifications contained in the unit's standing operating procedure (SOP) or the recommended procedures in DMS ST 648.

Performance Steps

1. Perform the indoor procedure.
    a. Disable the dual-axis compensator.
        (1) Place the instrument on the desk and press the power (PWR) button.
        (2) Press F22 and set the compensator to 0.
        (3) Press the enter (ENT) button.
    b. Set the units of measure, time, and date.
        (1) Press the menu (MNU) button and enter 17.
        (2) Press the YES button to accept or the NO button to change the units at the display prompts.
        (3) Press the MNU button and enter 15.
        (4) Press 1 to set the date.
        (5) Enter the correct date in the year, month, and day (YYY.MMDD) format.
        (6) Press the ENT button to accept the change.
        (7) Enter the correct time in the hour, minutes, and seconds (HH.MMSS) format.
        (8) Press the ENT button to accept the entered time or press the ENT button at a precise time signal (WWV) to synchronize the instrument clock.

NOTE: Use the clear (CL) button to back the cursor to the proper position.

    c. Define the point code (P-CODE).
        (1) Press the program (PRG) button, enter 45, and press the ENT button.
        (2) Enter the P-CODE at the "P-CODE?" prompt (for example, enter 1 and press the ENT button).
        (3) Enter the P-CODE identifier at the "TEXT?" prompt (for example, enter tree).
        (4) Press the ENT button at the "P-CODE?" prompt to exit.
    d. Create a user-defined sequence (UDS) for topographic surveys. Refer to Table 052-260-1336-1.

Performance Steps

Program Number/Name: 1/Station Input 2/Topographic				
Developer: DMS				**Date: 08/18/2001**
Step	Prompts Used in UDS	Label Number	Label Type	Remarks
	LOGON			Logon of job file number and memory device, **answer yes**
1	CALL	79	9/19	Calls Program 19 (admin data)
2	STN#	2	1	Prompts for station number
3	P-CODE	4	1	Prompts for station P-CODE
4	IH	3	1	Prompts for instrument height
5	BS#	62	1	Prompts for backsight point number
6	P-CODE	4	1	Prompts for P-CODE
7	HA REF	21	1	Prompts for horizontal reference **(00.0030)**
8	END	79	7/2	Links to program 2
	LOGON			Logon of job file number and memory device, answer **no**
1	PNO	5	4	Prompts for point number increments **(use auto increment)**
2	P-CODE	4	3	Prompts for P-CODE
3	TH	6	3	Prompts for target height **(use duplicate)**
4	HA	7	0	Stores horizontal angle
5	VA	8	0	Stores vertical angle
6	SD	9	0	Stores slope distance
7	N	37	8	Displays northing
8	E	38	8	Displays easting
9	ELEV	39	8	Displays elevation
10	END	79	5	Loop
Note: P-CODES can be alphanumeric names, such as windsock, TP1, or GPS5				

Table 052-260-1336-1
Programs 1 and 2 for the AISI

Performance Steps

(1) Press the PRG button, enter 40, and press the ENT button.
(2) Enter the program number at the "PROG NO?" prompt. If a program exists, the "VIEW?" prompt will appear. If it does not, go to step (4).
(3) Press the YES button to view the program or the NO button to delete the program and then the YES button to confirm the deletion.
(4) Enter the program number at the "PROG NO?" prompt.
(5) Enter the program name at the "NAME?" prompt. Press the letter "a" for the alpha mode.
(6) Press the YES button at the "LOGON?" prompt. Respond with YES to the "LOGON?" prompt for Program 1 and respond with NO to the "LOGON?" prompt for Program 2.
(7) Enter the label number from the label list in the AISI operator's manual for step 1 (for example, enter 79).
(8) Enter the label type from the UDS label-type list from the AISI operator's manual (for example, enter 9 and press the ENT button, then enter 19 and press the ENT button).
(9) Press the YES or NO button to the "QUESTION?" prompt .
(10) Enter the other labels according to Table 052-260-1336-1.

2. Perform the field procedure.
   a. Set up and plumb the instrument.
      (1) Open the tripod, and with the cover on, attach the plumb bob.
      (2) Place the tripod over the survey control station and ensure that it is plumb over the survey mark. Imbed the tripod legs firmly in the ground.
      (3) Adjust the tripod legs until the tripod head is horizontal. Ensure that the plumb bob is still plumb over the survey mark. If it is not, repeat steps 2a through c.
      (4) Remove the tripod cover and attach the AISI to the tripod.
      (5) Move the AISI on the head of the tripod to bring the plumb bob directly over the survey mark. The base of the AISI will not overhang the tripod head. Firmly tighten the AISI to the tripod.
      (6) Ensure that the internal battery is fully charged and attached to the AISI. If it is not attached to the AISI, attach it under the eyepiece.
      (7) Level the tribrach's bull's-eye bubble.
   b. Level the instrument using the dual-axis compensator.
      (1) Remove the lens cover and eyepiece cover.
      (2) Place the face of the instrument parallel to the two foot screws.
      (3) Press the PWR button on the lower left corner of the AISI. The instrument will automatically go to the "coarse-level" mode. If a message to continue appears, answer NO by pressing the NO button.
      (4) Level both bubbles by using the left-thumb rule to adjust the front two foot screws for the lower bubble and the rear foot screw for the upper bubble. Rotate the instrument 180°.
      (5) Press the angle measure (A/M) button on the rear of the instrument. The instrument will beep. About 5 seconds later, the instrument will beep twice. Rotate the instrument 180° again until the display reads "Press A/M".
      (6) Press the A/M button on the front of the instrument.
      (7) Enter the values for temperature, pressure, offset, and horizontal-angle reference (HA REF) (HA setting).
      (8) Ensure that the face of the instrument is still parallel to the two foot screws and press the LEVEL button to enter the "fine-level" mode.
      (9) Level both bubbles by using the left-thumb rule to adjust the front two foot screws for the lower bubble and the rear foot screw for the upper bubble.
      (10) Press the bubble button to exit the level display.
   c. Execute Program 43 and enter the known coordinates.
      (1) Press the PRG button, enter 43, and press the ENT button.
      (2) Press 2 for internal memory (IMEM).
      (3) Enter the area file for point storage.
      (4) Press the YES button for the target height (TH) measure.
      (5) Enter the point number (PNO).

Performance Steps

(6) Enter the P-CODE for the station (for example, Belvoir).
(7) Enter the station coordinates.

NOTE: Enter both the occupied station and the BS station.

d. Execute Program 20 for station establishment.
(1) Press 1 for the known station.
(2) Enter a job number for data storage.
(3) Ensure that the external memory (XMEM) is off and the IMEM is on and press the ENT button.
(4) Enter the station number (STN#).
(5) Enter the area file.
(6) Enter 2 for the IMEM.
(7) Answer YES or NO for "STN OK?"
(8) Answer YES for the TH measure and enter 0.
(9) Enter the PNO for the BS.
(10) Enter the area file for the BS.
(11) Answer YES or NO for "REF OK?"
(12) Aim the instrument at the reference object and press the A/M button.
(13) Press the register (REG) button to exit the program.

NOTE: If not entering the area file and entering the coordinates manually, leave the space blank.

e. Execute the Topographic-Survey Program.
(1) Press the PRG button, enter 1, and press the ENT button (starts Program 1).
(2) Enter the job number.
(3) Select the memory device to be used.
(4) Enter the project number.
(5) Enter the name of the operator.
(6) Press the REG button to store admin data.
(7) Enter the occupied STN#.
(8) Enter the P-CODE and press the ENT button.
(9) Enter the instrument height (IH).
(10) Enter the BS STN#.
(11) Enter the BS station P-CODE and press the ENT button.

NOTE: Do not change the HA REF if you ran Program 20 and want to measure northings (N) and eastings (E) in the field. Just press the ENT button and go to the next step.

(12) Enter 0.0030 when the AISI prompts for the HA REF=_ setting. Aim the instrument at the BS before pushing the ENT button. The HA for the first BS must be recorded on the recording sheet.

NOTE: The AISI is already referenced to the project coordinates if Program 20 was run.

(13) Enter the PNO for the first topographic shot when the instrument displays PNO=_.

NOTE: The first shot should be on the BS station. Remember that PNOs can only be used once in each project.

(14) Enter the P-CODE.
(15) Enter the TH.
(16) Ensure that the instrument is in the STD mode. The letters STD will appear on the upper left hand of the AISI screen. If the instrument is in the tracking (TRK) mode or the D-BAR mode, press the STD button.
(17) Sight in on the target as soon as the measuring beam acquires the prism. The AISI displays the slope distance (SD) in addition to the HA and vertical angle (VA). To see the display of N, E, and elevation [ELEV]), press the ENT button before pressing the REG button. The N, E, and ELEV are not stored in the job file.
(18) Press the REG button to store data. If measuring in the STD mode, it will be necessary to press the A/M button to start the measurement of the distance.

NOTE: The AISI will increment to the next PNO after pressing the REG button. To change any data such as the PNO, P-CODE, and TH before data registration, use the following function [F] buttons: F5 = PNO, F4 = P-CODE, and F6 = TH.

(19) Press the ENT button.

Performance Steps

(20) Change the P-CODE and the TH, if necessary.
(21) Aim the instrument at the next point.
(22) Press the REG button once and the SD is displayed on the bottom of the display.
(23) Repeat steps 2e(14) through (18) for additional measurements.

NOTE: Shoot the BS at the end of each setup for a check. The final HA must be recorded on the recording sheet.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the starting and ending survey stations. Tell him to perform a topographic survey with an AISI.

Performance Measures	**GO**	**NO GO**
1. Performed the indoor procedure. a. Disabled the dual-axis compensator. b. Set the units of measure, time, and date. c. Defined the P-CODE. d. Created a UDS for a topographic survey.	____	____
2. Performed the field procedure. a. Set up and plumbed the instrument. b. Leveled the instrument using the dual-axis compensator. c. Executed Program 43 and entered the known stations. d. Executed Program 20 for station establishment. e. Executed the Topographic-Survey Program.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
AISI OPERATOR´S MANUAL	TM 5-6675-332-10
DMS ST 648	

Perform a Traverse With an Automated Integrated Surveying Instrument (AISI)

052-260-1337

Conditions: As a topographic surveyor in a field environment, given a complete AISI set, a tripod, a plumb bob, a 2-meter tape measure, starting and ending survey stations, personnel to tend the targets, instructions on how to do a traverse with the AISI, Technical Manual (TM) 5-6675-332-10 or the AISI operator's manual, and Defense Mapping School (DMS) Special Text (ST) 031

Standards: Perform a traverse with an AISI. Set up the instrument according to task 052-260-1134 and use AISI Program 27 to collect traverse data. Perform observations according to the guidelines and procedures set forth in Technical Manual (TM) 5-6675-332-10 or the AISI operator's manual. Observations must meet the specifications contained in the unit's standing operating procedure (SOP) or the recommended procedures in DMS ST 031.

Performance Steps

1. Set up the AISI over the initial traverse point.

NOTE: Refer to TM 5-6675-332-10 or the AISI operator's manual.

   a. Set up the instrument.
   b. Perform an instrument calibration or a quick check.
   c. Enter the precomputed K* (scale factor) to be used to reduce the distances to the universal transverse Mercator (UTM) grid.
      (1) Press F43.
      (2) Enter the scale factor.

2. Execute Program 27.
   a. Press the program (PRG) button and enter 27 to start the traverse program.
   b. Select new for a new traverse.
   c. Enter the number or name of the job file in which to store the traverse data (new only).
   d. Select the memory unit (1, 2, or 3) in which to store the traverse data (new only).
   e. Enter the occupied station number (STN#).
   f. Enter the occupied station point code (P-CODE) or name and press the enter (ENT) button. To leave the blank empty, press the ENT button again.
   g. Enter the name of the area file in which the known station coordinates are stored or press the ENT button to enter the data manually.
   h. Enter the station coordinates. Leave the elevation (ELEV =) line blank if running a 2-D traverse by pressing the ENT button.
   i. Press the YES or ENT button if the station coordinates were entered correctly and the NO button to make corrections.
   j. Press the YES button at the target height "(TH) MEASURE?" prompt if running a 3-D traverse or the NO button if running a 2-D traverse.

NOTE: Only the TH measure is shown if the coordinates include ELEV.

   k. Enter the instrument height (IH).
   l. Enter the point number (PNO) of the backsight (BS) station.
   m. Enter the name of the area file in which the BS data was stored or press the ENT button to enter the data manually.
   n. Verify the entered coordinates and press the ENT button to accept or the NO button to make corrections.
   o. Aim the instrument at the BS and press the angle measure (A/M) button.

NOTE: All the initial BSs must be made in the direct mode.

   p. Ensure that the horizontal-angle reference (HA REF) (calculated azimuth between the point and BS) is displayed.

Performance Steps

q. Press the register (REG) button. The instrument will beep twice. The display will appear as follows:

Display: STD__ _ _ _ P27_14:51
1-FORESIGHT
2-BACKSIGHT
3-OTHER

3. Make observation measurements at the initial station.
   a. Enter 1 for the foresight (FS) measurement
   b. Enter the FS PNO.
   c. Enter the P-CODE or the point name twice.
   d. Enter the TH. The display will appear as follows:

Display: STD - - - P27_14.53
HA: - - - -317.3502
VA:- - - - - 89.5747

   e. Select the D-BAR mode with normal resolution.
   f. Aim the instrument at the FS in the reverse mode and press the A/M button. Perform this step four times.
   g. Aim the instrument at the FS in the direct mode and press the A/M button. Perform this step four times.

NOTE: For later reference, this is a "Two-face point."

   h. Check the difference in the horizontal aim (dH) and the difference in the vertical aim (dV). The display will appear as follows:

Display: D-BAR - - P27_14.53
HA: - - - -317.3502
VA:- - - - - 89.5747
dH: 02
dV: 05

NOTE: These values are seconds from the mean. They should be below 05 for horizontal and below 10 for vertical. If the values are too high, repeat the reverse and direct pointings. If the values are still too high, perform the collimation test.

   i. Press the A/M button again to measure the distance. The display will appear as follows:

Display: D-BAR- - - -P27-14.55*
HA:- - - - -226.2035
VA:- - - - - -86.5716
SD:- - - - -105.319

NOTE: Count 10 cycles before pushing the REG button.

   j. Press the REG button. The display will appear as follows:

Display: D-BAR- - - -P27-15:01
"MORE?"

NOTE: This completes one set of measurements (BS and FS pair).

   k. Press the YES button to measure additional BS and FS pairs. The display will appear as follows:

Display: D-BAR- - - - -P27-15:03
1-FORESIGHT
2-BACKSIGHT
3-OTHER

   l. Enter 2 to measure the BS.
   m. Enter the PNO and P-CODE and press the ENT button.

Performance Steps

NOTE: The information for the initial BSs is not remembered in the program; however, subsequent stations will be remembered.

n. Enter the TH. The display will appear as follows:

Display: D-BAR- - - -P27-15:04
HA:- - - - -231.1444
VA:- - - - - -86.5715

o. Make a two-face pointing on the BS target.

NOTE: Reciprocal distances ensure a better closure.

p. Press the REG button once the distance is displayed and measured the appropriate number of times.
q. Press the YES button to answer the "MORE?" prompt.
r. Enter 1 for the FS measurement. The AISI will beep three to five times. The display will appear as follows:

Display: D-BAR- - - -P27-15:07
INFO:- - - - 55.0
NEW: - - - -FORESIGHT?

s. Press the YES button.
t. Enter the FS PNO. (Should already be present.)
u. Enter the P-CODE. (Should already be present.)
v. Enter the TH. (Should already be present.) The display will appear as follows:

Display: D-BAR - - -P27-15:10*
HA:- - - - -317.3456
VA:- - - - -89.4404

w. Make the two-face pointings on the FS.
x. Press the REG button once the distance measurement is complete.
y. Repeat steps 3k through x to meet the angle-number requirements.

4. Move to the forward station.
   a. Press the NO button at the "MORE?" prompt.
   b. Press the NO button at the "END-OF-TRAVERSE?" prompt.
   c. Press the power (PWR) button to turn the AISI off and move to the next station.

5. Make the observation measurements at the forward station.
   a. Press the PWR button to turn the AISI on. The "CONTINUE?-YES/NO?" prompt will appear.
   b. Press the NO button.
   c. Level the electronic level and press the A/M button for level calibration.
   d. Enter the temperature and pressure.
   e. Press the PRG button and enter 27.
   f. Enter 2 to continue the traverse.
   g. Aim the AISI at the BS and press the A/M button.
   h. Press the A/M button to measure the distance back to the BS, if required.
   i. Press the REG button once the distances are measured.
   j. Press the YES button at the "MORE?" prompt and press the YES button. The display will appear as follows:

Display: STD- - - - -15.23
1 - FORESIGHT
2 - BACKSIGHT
3 - OTHER

   k. Repeat all of step 3.
   l. Press the YES button at the "MORE?" prompt if shooting side shots (SSs).

6. Make the SS observations and continue the traverse.

Performance Steps

a. Enter 3 to select "OTHER." The display will appear as follows:

Display: STD- - - - - -15.23
1 - FORESIGHT
2 - BACKSIGHT
3 - OTHER

b. Enter 3 for the SSs.
c. Enter SS at the "ACTIVE?" prompt.
d. Enter the PNO, P-CODE, and TH.
e. Aim the AISI at the point and press the A/M button.
f. Press the REG button and the "MORE?" prompt will be displayed.
g. Press the YES button for more SSs or multiple measurements for the same object.
h. Press the NO button at the "MORE?" prompt.
i. Press the NO button at the "END-OF-TRAVERSE?" prompt.
j. Move to the next point.
k. Repeat steps 2 through 6 for additional traverse points.

7. Make observations to close the traverse.

NOTE: Perform this routine on the last set of BS and FS pairs at the last station. This routine will end the traverse, so ensure that all measurements are completed before closing the traverse. This routine is not necessary if at the "END-OF-TRAVERSE?" prompt the user presses the YES button.

a. Make a two-face pointing at the BS and press the A/M button to measure the distance again, if required.
   (1) Press the REG button and then the YES button at the "MORE?" prompt. The display will appear as follows:

   Display: STD- - - - - - -16:12
   1 - FORESIGHT
   2 - BACKSIGHT
   3 - OTHER

   (2) Enter 3 to select "OTHER." The display will appear as follows:

   Display: STD- - - - - - -16:13
   1 - BENCHMARK
   2 - CLOSE
   3 - SIDE SHOT

   (3) Enter 2 to select "CLOSE." The display will appear as follows:

   Display: STD - - - - - - - -16:14
   1 - EXTERNAL-(CE)
   2 - INTERNAL-(CI)
   3 - OTHER

b. Select one of the following:
   1 - FOR CLOSE EXTERNAL TRAVERSE
   2 - FOR CLOSE INTERNAL TRAVERSE
   3 - FOR OTHER (POINT TO POINT)
c. Enter the PNO, P-CODE, and TH.
d. Make a two-face pointing at the closing point and press the A/M button.
e. Press the REG button when the measurement of the distance is complete.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to perform a traverse with an AISI.

Performance Measures	**GO**	**NO GO**
1. Set up the AISI over the initial traverse point.	____	____
2. Executed Program 27.	____	____
3. Made the observation measurements at the initial station.	____	____
4. Moved to the forward station.	____	____
5. Made the observation measurements at the forward station.	____	____
6. Made the SS observations and continued the traverse.	____	____
7. Made observations to close the traverse.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
AISI OPERATOR´S MANUAL	DMS ST 648
DMS ST 031	
TM 5-6675-332-10	

Perform an Intersection With an Automated Integrated Surveying Instrument (AISI)

052-260-1338

Conditions: As a topographic surveyor in a secure field environment, given a complete AISI set, a tripod, a plumb bob, a 2-meter tape measure, coordinates for the occupied and backsight (BS) stations, personnel to operate the targets, procedures for collecting data by means of a topographic survey with an AISI, Defense Mapping School (DMS) Special Text (ST) 031, and the AISI operator's manual or Technical Manual (TM) 5-6675-332-10.

Standards: Perform an intersection with an AISI. Collect intersection data for three survey targets, "prism poles." Perform observations according to the guidelines and procedures set forth in the AISI operator's manual or TM 5-6675-332-10. Observations must meet the specifications contained in the unit's standing operating procedure (SOP) or the recommended procedures in the DMS ST 031.

Performance Steps

1. Set up the instrument for an intersection.
   a. Set up and level the AISI over the point.
   b. Place the AISI in the D-BAR mode and enter 1 for standard (STD) resolution.
   c. Place the AISI in the direct (Face I) position.
   d. Enter F21 (horizontal-angle reference [HA REF]) to set the azimuth. Enter 0.0000 degrees.

NOTE: Do not press the enter (ENT) button after entering 0.0000.

   e. Aim at the BS using both the horizontal and vertical crosshairs.
   f. Press the angle measure (A/M) button carefully as not to disturb the pointing.

2. Execute Program 11 and enter the administrative data.
   a. Press the program (PRG) button, enter 11/12, and press the ENT button. The AISI displays the program name and prompts for job number (JOB NO = _).
   b. Enter the job number. The display will appear as follows:

      UDS P11 21:51
      1 - XMEN OFF
      2 - IMEM ON
      3 - SERIAL OFF

   c. Select the memory device to record data by entering the appropriate number. The display will appear as follows:

      UDS P11 21:57
      STEP 1 - STORE
      STN# =_

   d. Enter the occupied station number (SNT#). The display will appear as follows:

      UDS P11 21:59
      STEP 2 - STORE
      P-CODE=_

   e. Enter the P-CODE (name) of the occupied station (for example, P-CODE = TP), then press the enter (ENT) button. The display will appear as follows:

      UDS P11 22:04
      STEP 3 - STORE
      IH=0.000

   f. Enter the instrument height IH. The display will appear as follows:

      UDS P11 22:07
      STEP 4 - STORE
      BS# =_

Performance Steps

g. Enter the BS point number. The display will appear as follows:

```
UDS   P11 22:09
STEP 5 - STORE
P-CODE =
```

h. Enter the BS P-CODE. The display will appear as follows:

```
UDS   P11 22:09
STEP 6 - STORE
TH =
```

i. Enter the target height (TH). The display will appear as follows:

```
D  P11 22:13
HA:    180.0001
VA:    272.0243
```

NOTE: The numbers and times displayed are examples only.

3. Make the reverse (Face II) measurements for the BS target.
   a. Rotate the AISI to the reverse face and check the BS pointing.
   b. Press the A/M button. The AISI beeps and the display appears as follows:

```
D  P11 22:15
HA:    180.0001
VA:    272.0243
II:1     I:0
```

   c. Take the crosshairs slightly off the target then back on by using the slow-motion screws.
   d. Press the A/M button. The AISI beeps and displays II:2 I:0 on the last line.

NOTE: This completes the second pointing to the BS as indicated on the display by II:2 I:0.

   e. Repeat steps 3c and d for the appropriate number of positions.

4. Make the direct (Face I) measurements for the BS target.

NOTE: If the difference in the horizontal aim (dH) and the difference in the vertical aim (dV) values are not acceptable, then repeat steps 3 and 4 again. If they are still unacceptable, the AISI may need to be calibrated.

   a. Place the AISI in the direct (Face I) position after the reverse (Face II) pointings are completed.
   b. Aim the AISI at the target.
   c. Press the A/M button. The AISI beeps and displays II:4 I:1 on the last line.

NOTE: This completes one BS observation in the "Face I" position as indicated on the display by II:4 I:1.

   d. Repeat steps 4b and c for the appropriate number of positions.
   e. Press the register (REG) button to store values. The AISI beeps and goes into Program 12. This program records the foresight (FS) information for the intersection target.

5. Collect the data for the FS targets (object being intersected). The display will appear as follows:

```
UDS   P12 22:19
STEP 1 - STORE
P-CODE =_
```

   a. Enter a P-CODE at the "P-CODE =_?" prompt. This should be the name of the object sighted. This is your first FS. Press the ENT button.

NOTE: A well-defined point should be identified and a sketch of the obstruction should be drawn.

   b. Enter the TH at the "TH =_?" prompt. This will be 0.00 for most obstructions. The display will appear as follows:

```
UDS  P12 22:20
HA:    0.0002
VA:   92.0244
```

   c. Place the AISI in the reverse (Face II) position.

Performance Steps

d. Aim the AISI at the first point and press the A/M button. The AISI beeps.
e. Repeat the observation procedure for steps 3 and 4 for the required number of pointings in the Face II and I positions until the AISI displays the dH:00 and dV:00 values.

NOTE: If the dH is above 05 and the dV is above 10, then repeat steps 3 and 4.

f. Press the REG button to store the values, if acceptable.
g. Repeat steps 5a through f for additional intersection points.

6. Perform a check on the BS station before leaving it.
   a. Aim the AISI at the BS station and press the A/M button.
   b. Press the REG button to store the value.

7. Reobserve any bad measurements, as necessary.

NOTE: Reobserve any bad measurements using the same P-CODE.

8. Check and/or edit the stored data.
   a. Press the menu (MNU) button.
   b. Enter 2 for the editor.
   c. Enter 2 for the internal memory (IMEM) (displays remaining memory) and press the ENT button. The display will appear as follows:

      IMEM JOB 23:09
      JOB NO=2
      BEG END <--- --->

   d. Press the button directly under the begin (BEG) button to go to the "BEGINNING OF THE FILE, END TO START, <-- TO PRECEDING DATA, and --> TO FOLLOWING DATA?" prompt.
   e. Use the ARROW button to make corrections to the appropriate line (for example, point names and IHs). Press the ENT button to display the "DEL INS CHG FIND?" prompt on the last line. To change the data, press the STD button and make corrections on the display. For example, to change the PNO, the display will appear as follows:

      IMEM JOB 3:19
      CHANGE: PNO
      DATA = 1

NOTE: To change the PNO from 1 to 2, enter 2 and press the ENT button.

f. Press the MNU button twice to exit the program.

9. Exit Program 11/12 by pressing the power (PWR) button.

10. Move to the next station and complete the measurements.

NOTE: Program 11/12 does not compute angles between FS and BS points. This must be done manually. Stored values of BSs and FSs are directions. To determine the angles between the points, subtract the mean BS (HA) directions from the mean FS (HA) directions.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to perform an intersection with an AISI.

Performance Measures	**GO**	**NO GO**
1. Set up the instrument for an intersection.	____	____
2. Executed Program 11 and entered the administrative data.	____	____

Performance Measures	GO	NO GO
3. Made the reverse (Face II) measurements for the BS target.	____	____
4. Made the direct (Face I) measurements for the BS target.	____	____
5. Collected the data for the FS targets.	____	____
6. Performed a check on the BS station before leaving it.	____	____
7. Reobserved any bad measurements, if it was necessary.	____	____
8. Checked and/or edited the stored data.	____	____
9. Exited Program 11/12.	____	____
10. Moved to the next station and completed the measurements.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
AISI OPERATOR´S MANUAL	DMS ST 648
DMS ST 031	
TM 5-6675-332-10	

Subject Area 3: Traverse

Set Up a Target Set
052-260-1122

Conditions: As a topographic surveyor in a field environment, given a survey target with accessories, a survey control point, a tripod, a plumb bob, a 2-meter tape measure, and two intervisible survey stations.

Standards: Set up a survey target over a survey station and plumb the target within 2 millimeters of the center of the station. The target must be visible from the designated observation point. Measure the height of all well-defined points on the target to the nearest 0.001 meter.

Performance Steps

1. Set up the survey target (Figure 052-260-1122-1).

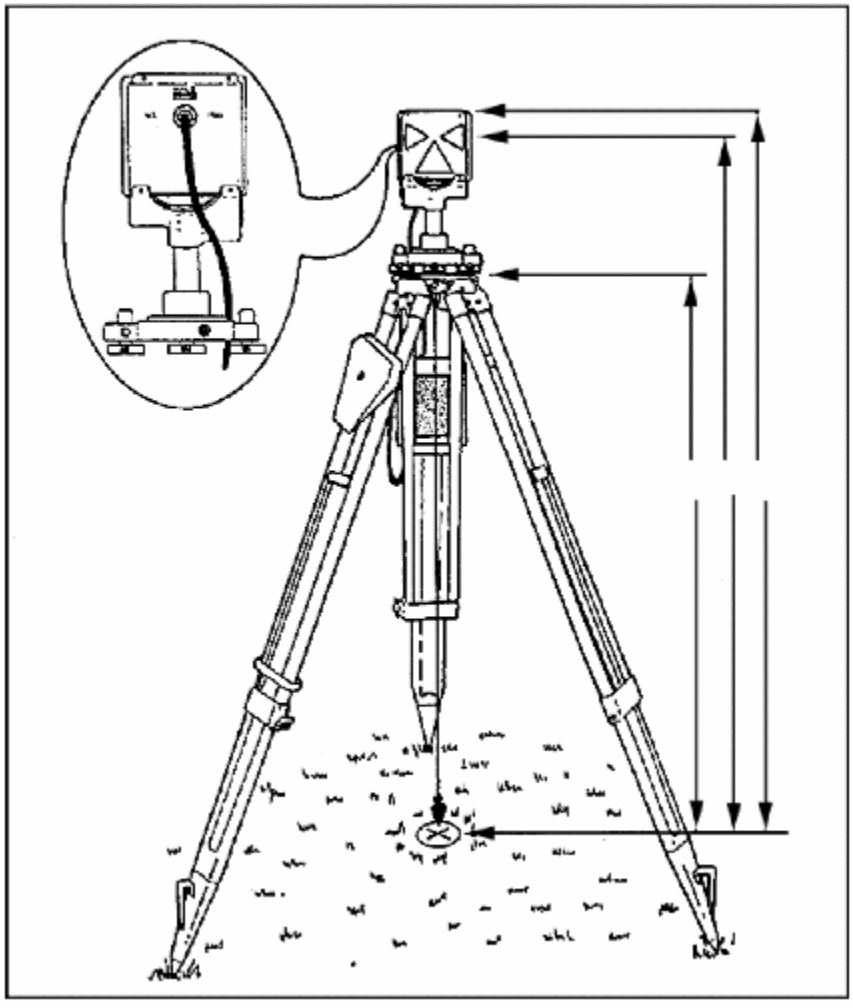


Figure 052-260-1122-1
T-2 Target set

Performance Steps

a. Extend the legs of the tripod equally and open them the same distance from the axis of the tripod.
b. Set the tripod over the survey station, attach the plumb bob, and position the tripod so that the plumb point is within 1 centimeter of the center of the survey station. The tripod head should be horizontal.
c. Ensure the stability of the tripod.
d. Remove the cover from tripod head and install the survey target.
e. Use the foot screws and the bull's-eye level bubble on the tribrach to level the target.
f. Plumb the target over the survey station using the plumb bob or optical plummet on the tribrach. Tighten the target on the tripod head. The target will be plumb within ± 2 millimeters from the center, and the tribrach will not overhang the edge of the tripod head.

2. Level the target.
   a. Recheck the level of the target and ensure that it is plumb over the survey station.
   b. Use the foot screws on the tribrach and the following steps to level the horizontal level vial on the target:
      (1) Turn the target so that the level vial is parallel to a line joining any two foot screws. Bring the bubble in the level vial to the center of the vial.
      (2) Turn the target 90° and bring the bubble toward the level using only one-third of the distance that the bubble moved off center.
      (3) Turn the target back to its original position. If the target is not level, repeat steps 1 and 2 until the bubble moves no more than one graduation on the level vial when the target is rotated through 360°.
   c. Recheck the plumb of the target.
3. Measure the height of target (HT) from the top of the survey station to all well-defined features on the target to the nearest 0.001 meter.
4. Aim the face of the target so that it is perpendicular to the line of sight between the observing station and the target.

Evaluation Preparation: Setup: Provide the soldiers with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two intervisible survey stations at least 400 meters apart. The evaluator must physically check the plumbing and leveling of the target, the measuring of the HT, and the aiming of the target to the observing station.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the station over which the target is to be set up and plumbed. Identify the location of the observing station. Tell the soldier to set up a target set.

Performance Measures	**GO**	**NO GO**
1. Set up the survey target.	____	____
2. Leveled the target.	____	____
3. Measured the HT from the top of the survey station to all well-defined features on the target to the nearest 0.001 meter.	____	____
4. Aimed the face of the target so that it was perpendicular to the line of sight between the observing station and the target.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required

Related

TM 5-6675-332-10

Record Electronic Distance-Measuring-Equipment (EDME) Values
052-260-1225

Conditions: As a topographic surveyor in a field environment, given an operational EDME (with accessories), two tripods, an instrument operator, an EDME target, Department of the Army (DA) Form 5819, a 2-meter tape measure, a thermometer, a barometer, and two intervisible survey control stations.

Standards: Record EDME values on DA Form 5819, to include all headings, meteorological data, and designated series of distance-measurement values to the nearest millimeter. All entries must be legible and without error.

Performance Steps

1. Record administrative data on DA Form 5819 in blocks 1 (Figures 052-260-1225-1 and 052-260-1225-2).

Performance Steps

FIELD SHEET, INFRARED

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT 1					
ORGANIZATION 1			DATE *(YYYYMMDD)* 1		APPROXIMATE DISTANCE 1
ZERO CORRECTION* 2	CALIBRATION DATE *(YYYYMMDD)*		OBSERVER 1		RECORDER 1
INSTRUMENT STATION 2	H.I. 2	ELEVATION 2	ELEVATION INSTRUMENT 2	ECCENTRICITY* TOWARD: AWAY: 2	INST. NO. 1
REFLECTOR STATION 2	H.T. 2	ELEVATION 2	ELEVATION REFLECTOR 2	ECCENTRICITY* TOWARD: AWAY: 2	PRISM. NO. 1

METEOROLOGICAL READINGS				ZD INSTRUMENT TO REFLECTOR		
	TIME	PRESSURE (Hg) IN. MM.	TEMP. (DRY) F° C°		DISTANCE *(Meters)*	
INSTRUMENT		3a	3b	1	4	4
REFLECTOR		3c	3d	2	4	4
SUM		3e	3f	3	4	4
MEAN		3e	3f	4	4	4
CORRECTION FACTOR (PPM)				5		
PRODUCT = UD x PPM RC = PRODUCT x 10^{-6} T = UD ± Z ± RC H' = $(T)^2 - (d)^2$ H' = SIN ZD x T HR = H' x 3.280840				6		
				7		
				8		
				9		
				10		
				SUM	5	5

UD		MEAN UNCORRECTED SLOPE DISTANCE (UD)		
PPM		ZERO CORRECTION° (Z)		
PRODUCT		REFRACTIVE INDEX CORRECTION (RC)		
RC		CORRECTED SLOPE DISTANCE (T)		
DIFF. OF ELEV. (d)		UNCORRECTED HORIZON DISTANCE (H')		
°Obtained from Instrument Calibration. *Toward Eccentricity must be ADDED. Away Eccentricity must be SUBTRACTED.		ECCENTRIC CORRECTION* (EC)		
		HORIZON DISTANCE (Hm) / (H_{FT})		

REMARKS

Sample

COMPUTED BY	DATE *(YYYYMMDD)*
CHECKED BY	DATE *(YYYYMMDD)*

DA FORM 5819, JUN 2001 Page _____ of _____ USAPA V1.00

Figure 052-260-1225-1
Sample of DA Form 5819 With Block Numbers

Performance Steps

FIELD SHEET, INFRARED

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT: West Range Artillery 3.79					
ORGANIZATION: 99th Engineer Company			DATE (YYYYMMDD): 20010818		APPROXIMATE DISTANCE: 1,500 m
ZERO CORRECTION*: -0.004	CALIBRATION DATE (YYYYMMDD): 20010818	OBSERVER: SPC Wilson			RECORDER: PFC White
INSTRUMENT STATION: Elkhorn (99th Engineer) 89	H.I.: 1.54 m	ELEVATION	ELEVATION INSTRUMENT	ECCENTRICITY*: TOWARD: AWAY: 0.000 m	INST. NO.: 1268
REFLECTOR STATION: Bullrush (99th Engineer) 89	H.T.: 1.60 m	ELEVATION	ELEVATION REFLECTOR	ECCENTRICITY*: TOWARD: AWAY: 0.000 m	PRISM. NO.: R-1268

METEOROLOGICAL READINGS

	TIME	PRESSURE (Hg) IN. MM.	TEMP. (DRY) F° C°
INSTRUMENT	0819	762	16
REFLECTOR	0817	761	10
SUM		1523	31
MEAN		762	16
CORRECTION FACTOR (PPM)		-5	

PRODUCT = UD x PPM
RC = PRODUCT x 10^{-6}
T = UD ± Z ± RC
H' = $(T)^2 - (d)^2$
H' = SIN ZD x T
Hn = H' x 3.280840

ZD INSTRUMENT TO REFLECTOR

	DISTANCE (Meters)	
1	1,527	308
2	1,527	306
3	1,527	311
4	1,527	306
5	1,527	306
6	1,527	307
7	1,527	304
8	1,527	310
9	1,527	310
10	1,527	307
SUM	15,273	075

UD	1527.308	MEAN UNCORRECTED SLOPE DISTANCE (UD)	1,527	308
PPM	+5	ZERO CORRECTION* (Z)	0	004
PRODUCT	7636.540	REFRACTIVE INDEX CORRECTION (RC)	0	008
RC	+0.008	CORRECTED SLOPE DISTANCE (T)	1,527	312
DIFF. OF ELEV. (d)		UNCORRECTED HORIZON DISTANCE (H')		
°Obtained from Instrument Calibration. *Toward Eccentricity must be ADDED. Away Eccentricity must be SUBTRACTED.		ECCENTRIC CORRECTION* (EC)		
		HORIZON DISTANCE (Hm) / (H_{FT})		

REMARKS

Sample

COMPUTED BY: SSG Zambrano	DATE (YYYYMMDD): 20010818
CHECKED BY: SFC Gan	DATE (YYYYMMDD): 20010818

DA FORM 5819, JUN 2001 — Page ____ of ____ — USAPA V1.00

Figure 052-260-1225-2
Completed Sample of DA Form 5819

Performance Steps

2. Record the height of instrument (HI) above the station, the height of reflector above the station, and the eccentricities at the instrument and reflector stations in blocks 2.
3. Read and record meteorological data.
   a. The barometric pressure at the instrument station (block 3a).
   b. The temperature at the instrument station (block 3b).
   c. The barometric pressure at the reflector station (block 3c).
   d. The temperature at the reflector station (block 3d).
   e. The sum and mean of the barometric pressures (blocks 3e). To determine the sum, add the barometric pressure at the instrument station with the barometric pressure at the reflector station and record it to one decimal place. Divide this amount by 2 to determine the mean and record it to one decimal place.
   f. The sum and mean of the temperature (blocks 3f). To determine the sum, add the temperature at the instrument station with the temperature at the reflector station and record it to one decimal place. Divide the amount by 2 to determine the mean and record it to one decimal place.
4. Enter the required distance measurements as they are made in blocks 4.
5. Determine and record the sum and mean slope distance for the readings in blocks 5.
6. Ensure that all entries are legible.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two intervisible survey stations at least 400 meters apart. The evaluator may serve as the instrument operator and, for recording purposes, will provide the necessary headings and meteorological data to the soldier being tested.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to record EDME values.

Performance Measures	**GO**	**NO GO**
1. Recorded administrative data on DA Form 5819.	____	____
2. Read and recorded meteorological data.	____	____
3. Recorded the HI above the station, the height of reflector above the station, and the eccentricities at the instrument and reflector stations.	____	____
4. Entered the required distance measurements as they were made.	____	____
5. Determined and recorded the sum and mean slope distance for the readings.	____	____
6. Ensured that all entries were legible.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5819	

Record Horizontal Directions for Theodolites

052-260-1226

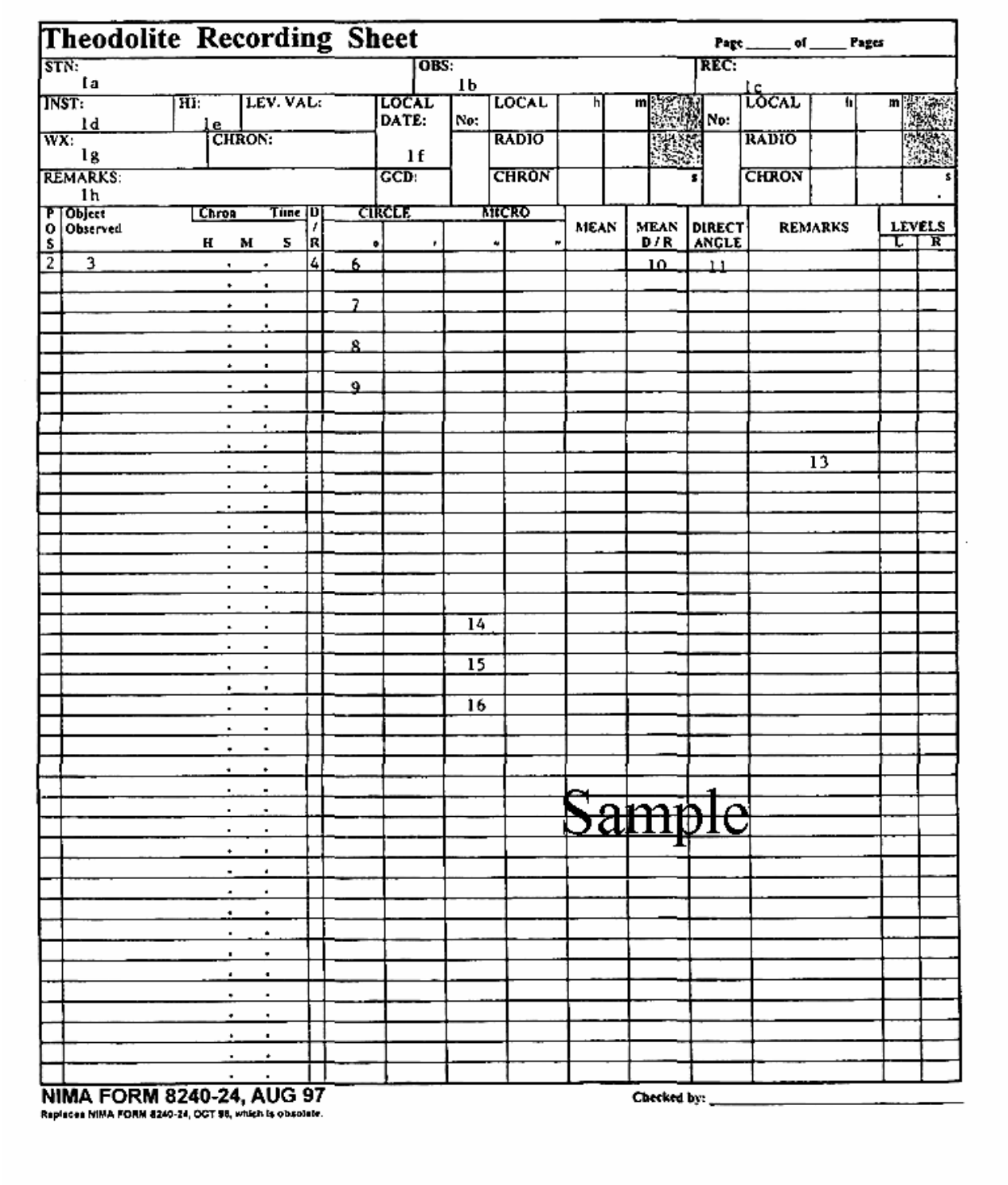
Conditions: As a topographic surveyor in a field environment, given the National Imagery and Mapping Agency (NIMA) Form 8240-24, a theodolite with an instrument operator making traverse observations, and the Defense Mapping School (DMS) Special Text (ST) 032.

Standards: Record horizontal directions for theodolites on NIMA Form 8240-24 to the nearest one-tenth of a millimeter. All records must be neat and legible and all computations must be complete and without error. The number of positions must be according to project specifications. Traverse station angles must be two positions within ± 5 seconds of the mean. Explement angles must be two positions within ± 5 seconds of the mean. Closure (mean station angle and mean explement angle) must be within ± 5 seconds of 360°.

Performance Steps

1. Enter administrative data on NIMA Form 8240-24 (Figures 052-260-1226-1 and 052-260-1226-2).

Performance Steps



Theodolite Recording Sheet

Page _____ of _____ Pages

STN: 1a			OBS: 1b					REC: 1c					
INST: 1d	HI: 1e	LEV. VAL:	LOCAL DATE: 1f	No:	LOCAL	h	m		No:	LOCAL	h	m	
WX: 1g	CHRON:				RADIO					RADIO			
REMARKS: 1h			GCD:		CHRON			s		CHRON			s

POS	Object Observed	Chron Time H M S	D/R	CIRCLE °	'	MICRO "	"	MEAN	MEAN D/R	DIRECT ANGLE	REMARKS	LEVELS L	R
2	3		4	6					10	11			
				7									
				8									
				9									
											13		
						14							
						15							
						16							

Sample

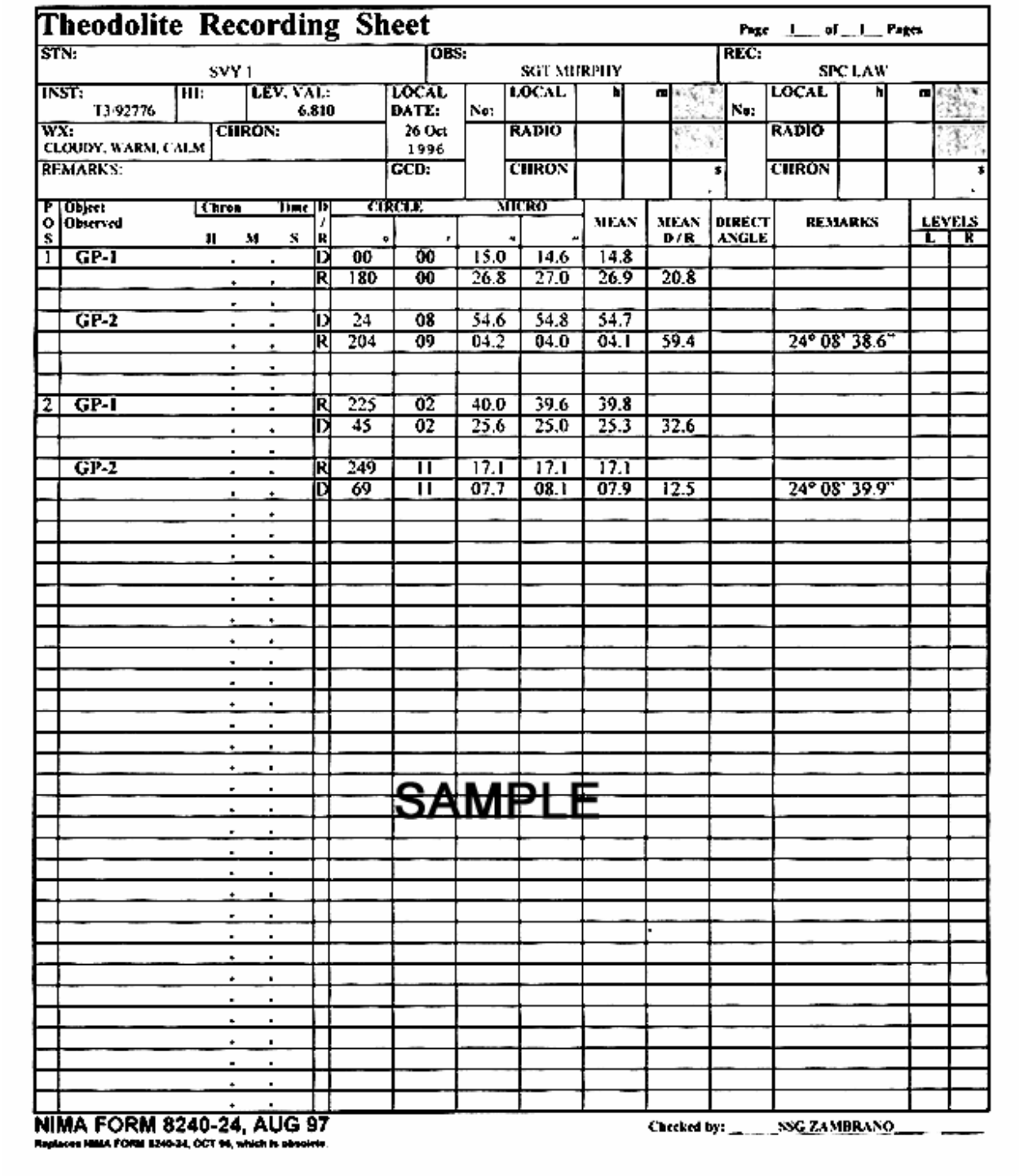
NIMA FORM 8240-24, AUG 97

Replaces NIMA FORM 8240-24, OCT 98, which is obsolete.

Checked by: _____

Figure 052-260-1226-1
Sample of NIMA Form 8240-24 With Block Numbers

Performance Steps



Theodolite Recording Sheet

Page 1 of 1 Pages

STN: SVY 1				OBS: SGT MURPHY						REC: SPC LAW									
INST: T3/92776	HI:	LEV. VAL: 6.810		LOCAL DATE: 26 Oct 1996	No:	LOCAL	h	m	s	No:	LOCAL	h	m	s					
WX: CLOUDY, WARM, CALM	CHRON:					RADIO					RADIO								
REMARKS:				GCD:		CHRON			s		CHRON			s					

POS	Object Observed	Chron Time H M S	D/R	CIRCLE °	CIRCLE '	MICRO "	MICRO "	MEAN	MEAN D/R	DIRECT ANGLE	REMARKS	LEVELS L	LEVELS R
1	GP-1		D	00	00	15.0	14.6	14.8					
			R	180	00	26.8	27.0	26.9	20.8				
	GP-2		D	24	08	54.6	54.8	54.7					
			R	204	09	04.2	04.0	04.1	59.4		24° 08' 38.6"		
2	GP-1		R	225	02	40.0	39.6	39.8					
			D	45	02	25.6	25.0	25.3	32.6				
	GP-2		R	249	11	17.1	17.1	17.1					
			D	69	11	07.7	08.1	07.9	12.5		24° 08' 39.9"		

SAMPLE

NIMA FORM 8240-24, AUG 97

Replaces NIMA FORM 8240-24, OCT 96, which is obsolete.

Checked by: SSG ZAMBRANO

Figure 052-260-1226-2
Completed Sample of NIMA Form 8240-24

a. The station name, establishing organization, and date of establishment (block 1a).
b. The observer's name and rank (block 1b).

Performance Steps

c. The recorder's name and rank (block 1c).
d. The type and serial number of the instrument used (block 1d).
e. The height of instrument (HI) to the nearest 0.001 meter (block 1e).
f. The date and time of the observations (block 1f).
g. The weather conditions (block 1g).
h. Any pertinent information or remarks (block 1h).

2. Number each individual position in sequence (block 2).
3. Name each individual station observed (block 3).
4. List the telescope direction (direct [D] or reverse [R]) for each station in block 4.
5. Provide the instrument operator with the circle settings, when necessary.
6. Record the D reading for the rear station in block 6.
7. Record the D reading for the forward station in block 7.
8. Record the R reading for the forward station in block 8.
9. Record the R reading for the rear station in block 9.
10. Compute the mean of seconds of the D and R readings for each station and record it in block 10.
11. Compute and record the angle between the stations in block 11.
    a. Compute the seconds of the angle by subtracting the mean of the rear station's seconds from the mean of the forward station's seconds.
    b. Compute the degrees and minutes of the angle by subtracting the rear station's D reading from the forward station's D reading.

NOTE: This completes the first position of the observation.

12. Repeat steps 2 through 11 for the second position.

NOTE: Observations for the second position start with the telescope in the R direction.

13. Compute and record the mean station angle in block 13 and check for rejection of the observed angle. The rejection limit is ± 5.0 seconds from the mean. Have the instrument operator reobserve the rejected positions, if necessary.
14. Repeat steps 2 through 12 to obtain the explement angle and record this value in block 14. To obtain the explement angle, the observer will sight on the forward station and turn to the rear station.
15. Compute and record the mean explement angle in block 15 and check for rejection of the observed angle. The rejection limit is ± 5.0 seconds from the mean. Have the instrument operator reobserve the rejected positions, if necessary.
16. Compute and record the circle closure for the combined station and explement angles in block 16 and check for rejection of the observed angle. The rejection limit is ± 5.0 seconds from 360°. Have the instrument operator reobserve the rejected positions, if necessary.
17. Give NIMA Form 8240-24 to the instrument operator to check.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark three stations. The distance between the occupied station and the target stations should be greater than 100 meters. The station angle should be greater than 45°. The instrument will be set up according to task 052-260-1134, and both targets will be set up according to task 052-260-1122. Obtain the help of an instrument operator who is qualified according to task 052-260-1134.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to record the horizontal directions for theodolites.

Performance Measures	**GO**	**NO GO**
1. Entered administrative data on NIMA Form 8240-24.	____	____
2. Numbered each individual position in sequence.	____	____
3. Named each individual station observed.	____	____
4. Listed the telescope direction for each station.	____	____
5. Provided the instrument operator with the circle settings, when it was necessary.	____	____
6. Recorded the D reading for the rear station.	____	____
7. Recorded the D reading for the forward station.	____	____
8. Recorded the R reading for the forward station.	____	____
9. Recorded the R reading for the rear station.	____	____
10. Computed the mean of the seconds of the D and R readings for each station.	____	____
11. Computed and recorded the angle between the stations.	____	____
12. Repeated performance steps 2 through 11 for the second position.	____	____
13. Computed and recorded the mean station angle and checked for rejection of the observed angle.	____	____
14. Repeated performance steps 2 through 12 for the explement angle.	____	____
15. Computed and recorded the mean explement angle and checked for rejection of the observed angle.	____	____
16. Computed the circle closure for the combined station and explement angles and checked for rejection of the observed angles.	____	____
17. Gave NIMA Form 8240-24 to the instrument operator to check.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS ST 032	
NIMA FORM 8240-24	

Record Vertical Angles (VAs)/Zenith Distances (ZDs) for Theodolites
052-260-1227

Conditions: As a topographic surveyor in a field environment, given Department of the Army (DA) Form 5817 for VA/ZD measurements, and a theodolite with an instrument operator making VA or ZD observations.

Standards: Demonstrate the ability to record VA or ZD field notes to the nearest one-tenth of a millimeter. All records must be neat and legible and all computations must be complete and without error. The number of repetitions must be according to project specifications.

Performance Steps

1. Enter administrative data on DA Form 5817 in blocks 1 (Figures 052-260-1227-1 and 052-260-1227-2):

Performance Steps

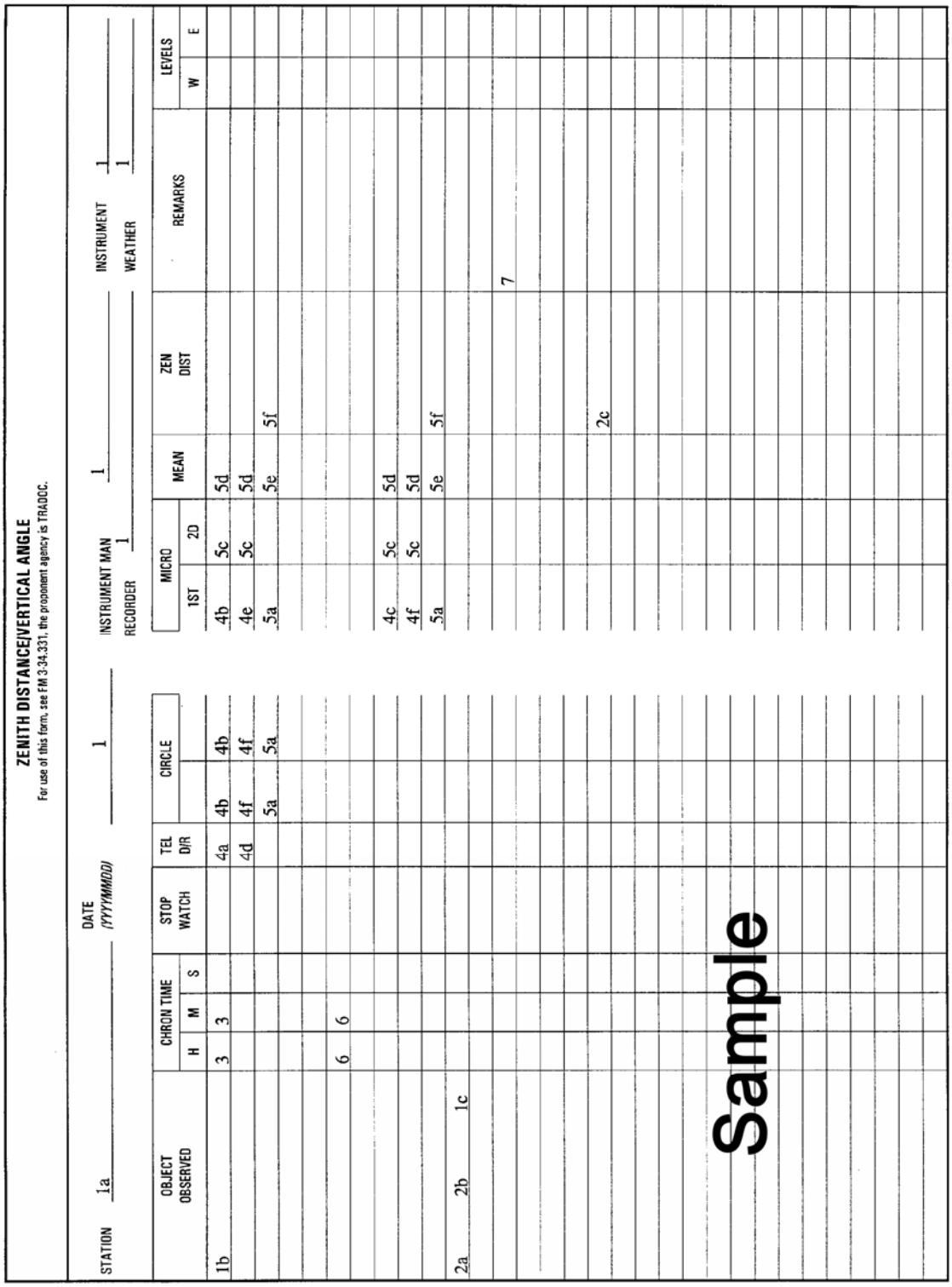
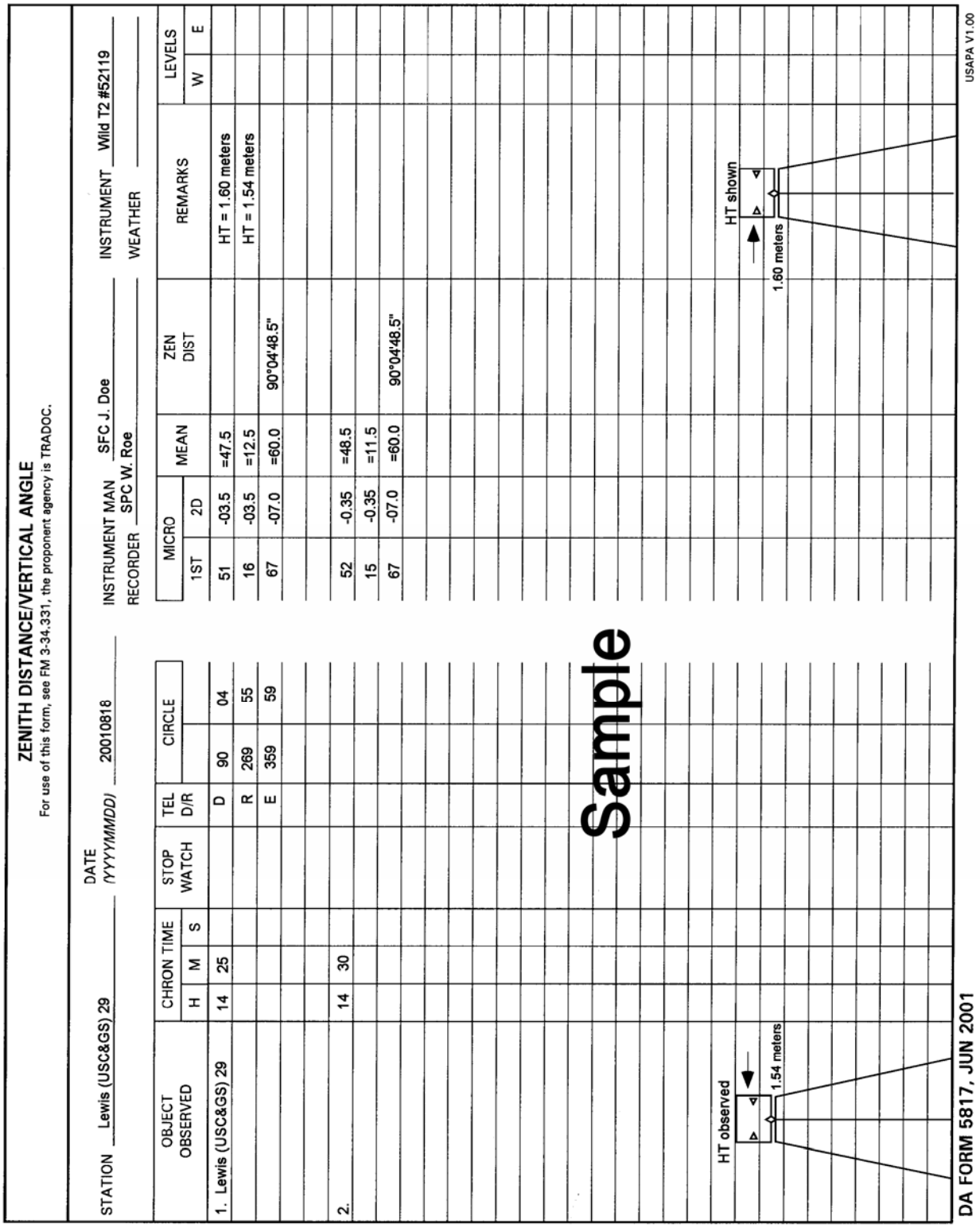


Figure 052-260-1227-1
Sample of DA Form 5817 With Block Numbers

Performance Steps



ZENITH DISTANCE/VERTICAL ANGLE

For use of this form, see FM 3-34.331, the proponent agency is TRADOC.

STATION Lewis (USC&GS) 29 DATE (YYYYMMDD) 20010818

INSTRUMENT MAN SFC J. Doe INSTRUMENT Wild T2 #52119

RECORDER SPC W. Roe WEATHER

OBJECT OBSERVED	CHRON TIME H	CHRON TIME M	CHRON TIME S	STOP WATCH	TEL D/R	CIRCLE		MICRO 1ST	MICRO 2D	MEAN	ZEN DIST	REMARKS	LEVELS W	LEVELS E
1. Lewis (USC&GS) 29	14	25			D	90	04	51	-03.5	=47.5		HT = 1.60 meters		
					R	269	55	16	-03.5	=12.5		HT = 1.54 meters		
					E	359	59	67	-07.0	=60.0	90°04'48.5"			
2.	14	30						52	-0.35	=48.5				
								15	-0.35	=11.5				
								67	-07.0	=60.0	90°0448.5"			

Sample

HT observed

1.54 meters

HT shown

1.60 meters

DA FORM 5817, JUN 2001

USAPA V1.00

Figure 052-260-1227-2
Completed Sample of DA Form 5817

Performance Steps

a. The station name (block 1a).
b. The correct number of positions and objects observed (block 1b).
c. The height of target (HT) and the height of instrument (HI) to 0.001 meter (block 1c).

2. Make a sketch of the target as shown and as observed.
   a. Make a sketch of the target as the instrument operator observes it (block 2a).
   b. Label the point at which the horizontal crosshair intersects the target (block 2b).
   c. Make a sketch of the target as shown to any other stations and record the heights of all possible points of observation (for reciprocal observations) in block 2c.

NOTE: For nonreciprocal observations, the HT above the station is not required.

3. Record the time (to the nearest minute) that the instrument operator started the observation in blocks 3, if necessary.

NOTE: If the observation is nonreciprocal (one way), the time is not needed.

4. Record the paired direct (D) and reverse (R) observations as read by the observer for the required number of repetitions.
   a. Enter the letter D for the direct position of the telescope in block 4a.
   b. Enter the degrees, minutes, and seconds (DDD.MMSS) as read by the instrument operator in blocks 4b.
   c. Record the double coincidence (second) reading for the seconds only in block 4c.
   d. Enter the letter R below the D for the reverse reading of the telescope in block 4d.
   e. Enter the degrees, minutes, and seconds as read by the instrument operator in blocks 4e.
   f. Record the double coincidence (second) reading for the seconds only in block 4f.

5. Compute the corrected ZD.
   a. Compute and record the sum of the paired D and R readings on the target for each repetition in blocks 5a.
   b. Compute the algebraic difference between 360° and the sum of each paired D and R readings.
   c. Record and apply one-half of the difference found in step 5b to the D reading and one-half to the R reading. Record this amount to one decimal place in blocks 5c and include the sign.
   d. Algebraically add each entry to the observed seconds of the D and R readings (blocks 5d).
   e. Sum the corrected seconds of the D and R readings. The result must equal 120.0, 60.0, or 0.00 seconds (blocks 5e).
   f. Record the observed ZD in blocks 5f. The ZD is the degrees, minutes, and corrected seconds for the D reading.
   g. Repeat steps 4 and 5 for each position.

6. Record the time the observer completed the observations in blocks 6, if necessary.

7. Determine the mean VA/ZD. Sum and mean the set of observations and enter this amount in block 7.

8. Give the form to the instrument operator to check.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two stations. The distance between the stations should be greater than 100 meters. (There should be a noticeable difference in elevation.) The instrument will be set up according to task 052-260-1134 and the target will be set up according to task 052-260-1122. Obtain the help of an instrument operator who is qualified according to task 052-260-1134. Measure the HT and HI.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the station to be occupied and the station to be observed. Tell him how many repetitions will be recorded. Give him the HT and HI. Tell him to record VAs/ZDs for theodolites.

Performance Measures	**GO**	**NO GO**
1. Entered administrative data on DA Form 5817.	____	____
2. Made a sketch of the target as shown and as observed.	____	____
3. Recorded the time (to the nearest minute) that the instrument operator started observations, if it was necessary.	____	____
4. Recorded the paired D and R observations as read by the observer for the required number of repetitions.	____	____
5. Computed the corrected ZD.	____	____
6. Recorded the time the observer completed the observations, if it was necessary.	____	____
7. Determined the mean VA/ZD.	____	____
8. Gave the form to the instrument operator to check.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5817	DMS ST 031

Check Field Notes and Abstracts for Errors

052-260-1234

Conditions: As a topographic surveyor in a field environment, given a set of field notes and abstracts, the project directive, Defense Mapping School (DMS) Special Text (ST) 031 and 032, and a scientific calculator.

Standards: Check the field notes and the abstracts recorded during a traverse, intersection observations, or a level line for errors. Check the field notes and the abstract entries to ensure that they are complete, neat, and legible. Spot-check the field notes and the abstract entries to ensure that they conform to the unit's standing operating procedure (SOP), references, and project specifications. Correct errors or omissions when found.

Performance Steps

1. Check the field notes and the abstract entries to ensure that are complete, neat, and legible; in addition, check the following items, if applicable.
   a. An index of the control points.
   b. A description of the line or network.
   c. A sketch of the work completed.
   d. A record of the survey-party personnel.
   e. The instrument data.
2. Spot-check the field notes and the abstract entries to ensure that they conform to the unit's SOP, references, and project specifications. Note any errors or omissions. If applicable, ensure that--
   a. All administrative items are entered on each page to include the following:
      (1) The azimuth of line, mean latitude, and calibration date.
      (2) The observer's and recorder's names
      (3) The project name and the organization.
   b. The height of instruments (HIs), height of targets (HTs), eccentricity, and instrument/target numbers are complete and accurate.
   c. Any circle settings are correct.
   d. The sums, means, and differences are accurately computed.
   e. The concluded angle is computed and entered for each position turned.
   f. The mean angle is computed and entered.
   g. The closure specifications are met.
   h. All entries are accurate.
   i. Any uncorrected distances are accurately resolved and entered.
   j. All measurements meet project requirements.
   k. Any errors or omissions are noted.
   l. All entries are neat and legible.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to check the field notes and abstracts for errors.

Performance Measures	**GO**	**NO GO**
1. Checked the field notes and the abstract entries to ensure that they were complete, neat, and legible.	____	____

Performance Measures	GO	NO GO
2. Spot-checked the field notes and the abstract entries to ensure that they conformed to the unit's SOP, references, and project specifications. Noted any errors or omissions.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DMS ST 031	
DMS ST 032	

Compute a Grid Traverse or Side Shot (SS)

052-260-1235

Conditions: As a topographic surveyor in a secure field environment, given a sketch of a traverse on Department of the Army [DA] Form 1962, starting and closing geodetic azimuths, all mean and corrected station angles for the traverse, all horizontal or geodetic distances, universal transverse Mercator (UTM) coordinates of the starting and closing stations, instructions on how to compute a traverse or SS, Defense Mapping School (DMS) Special Text (ST) 031, DA Form 1940, and a scientific calculator.

Standards: Compute a grid traverse or an SS. Compute the scale factor (K) to six places. Compute the grid distance to three decimal places. Enter the sines and cosines eight decimal places. Compute the delta northings (N) and eastings (E) to three decimal places. Distribute the error in position by carrying residuals. Compute the final position to three decimal places. Enter all computations. All entries must be accurate, neat, and legible.

Performance Steps

1. Enter administrative data on DA Form 1940 and abstract all information from DA Form 1962 onto DA Form 1940 (Figures 052-260-1235-1, 052-260-1235-2, and 052-260-1235-3).

Performance Steps

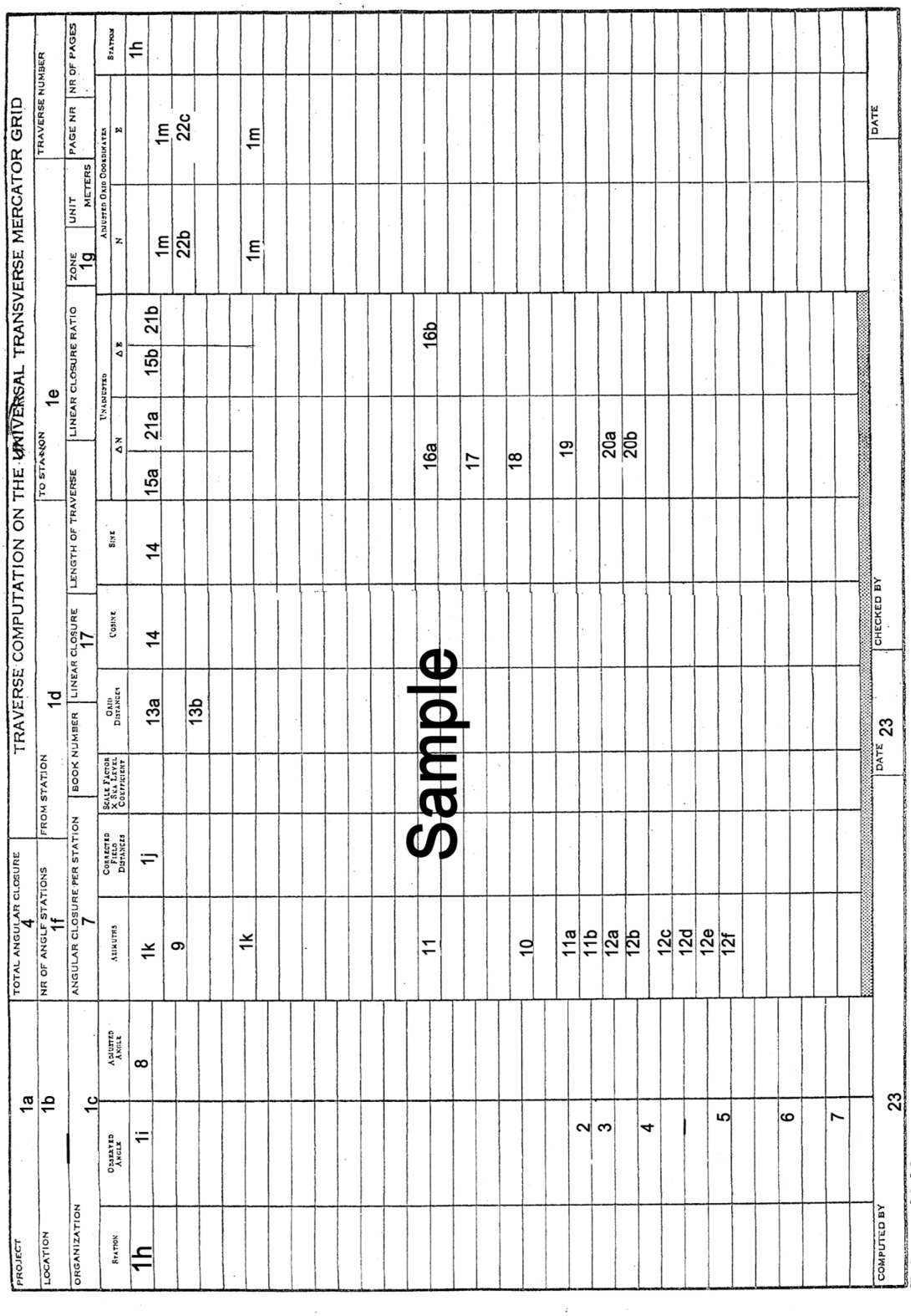


Figure 052-260-1235-1
Sample of DA Form 1940 With Block Numbers

Performance Steps

PROJECT
Example 1

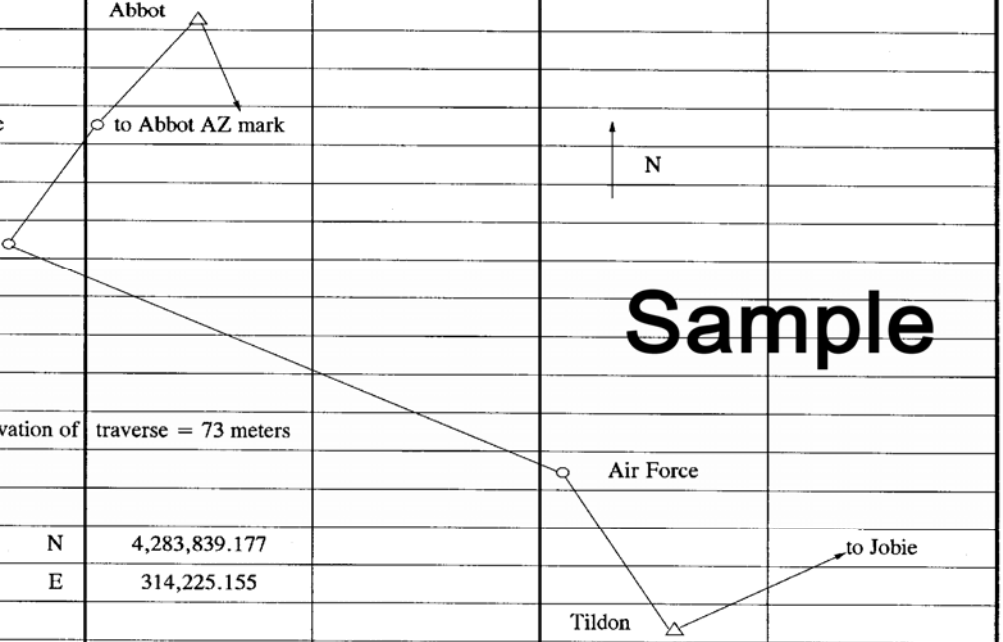
TABULATION OF GEODETIC DATA
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION
Fort Belvoir, VA

ORGANIZATION
DMS

STATION
Third-Order, Class 1 Traverse
Tildon to Abbot

Grid zone 18S



Mean elevation of	traverse = 73 meters				
Tildon	N	4,283,839.177			
	E	314,225.155			
Jobie	N	4,284,279.027			
	E	315,123.186	Abbot	N	2,287,595.893
				E	310,461.502
AZ (T) Tildon to Jobie					
63°54′20.3″			Abbot AZ	N	4,286,241.633
				E	311,106.466
Field	Angles		AZ (T) Abbot to		Abbot AZ mark
Tildon	263°24′13.6″		154°32′02.9″		
Air Force	149°47′12.2″				
Army	281°21′15.3″		Geodetic		Distance
Marine	152°22′39.3″		Tildon-Air Force		1,613.478
Abbot	323°42′12.5″		Air Force-Army		3,777.908
			Army-Marine		724.196
		(Horizontal tape)	Marine-Abbot		112.372

TABULATED BY
GySgt Cook

DATE (YYYYMMDD)
1980/08/14

CHECKED BY
SFC Edwards

DATE (YYYYMMDD)
1980/08/14

DA FORM 1962, FEB 57 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.01

Figure 052-260-1235-2
Completed Sample of DA Form 1962

Performance Steps

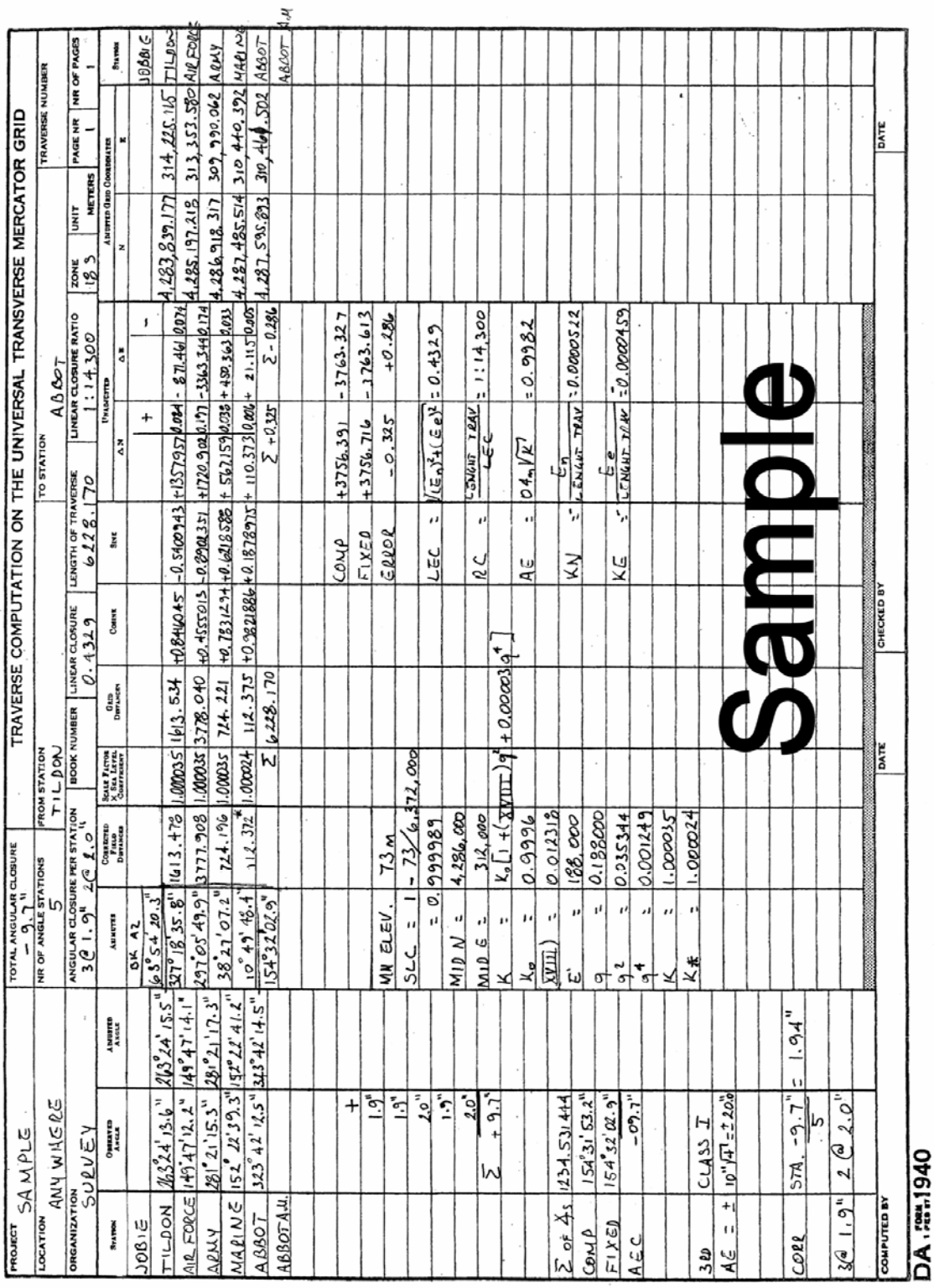


Figure 052-260-1235-3
Completed Sample of DA Form 1940

Performance Steps

NOTE: For SSs only, after completing step 1, skip steps 2 through 8 and go to step 9.

a. The project name (block 1a).
b. The project location (block 1b).
c. The organization (block 1c).
d. The "from station" (starting station) (block 1d).
e. The "to station" (ending station) (block 1e).
f. The number of angle stations (number of observed field angles) (block 1f).
g. The grid-zone number (block 1g).
h. The traverse or SS-station name (enter on both sides of DA Form 1940) (blocks 1h).
i. The observed angles (corrected-mean station angles) (block 1i).
j. The corrected field distances (block 1j).
k. The starting and ending projected geodetic azimuths (T) (block 1k).
l. The mean elevation (block 1l).
m. The starting and ending UTM grid coordinates for a traverse or the UTM grid coordinates of the occupied station for SSs (blocks 1m).

NOTE: The starting and ending projected T may be obtained from the UTM coordinates by computing the grid azimuth (t) and (t-T) on DA Form 1934.

2. Compute the sum of angles by adding all the observed angles to the starting back azimuth. Leave the value in decimal degrees and record it to six decimal places in block 2 (round the answer).

3. Compute the ending azimuth by subtracting 180° from the sum of the angles until you are as close as possible to the known ending azimuth. This is the computed ending azimuth. Record it in block 3 in degrees, minutes, and seconds (DDD.MMSS). Record the seconds to one decimal place (round the answer).

4. Compute the angular error of closure (AEC) by subtracting the fixed (known) ending azimuth from the computed ending azimuth. Compute the AEC to one decimal place with the sign and record it in block 4.

NOTE: The error is always equal to the computed values minus the fixed values.

5. Compute the allowable AEC (allowable error [AE]) using the formula from DMS ST 031 and record it to one decimal place in block 5.

NOTE: The AE is always truncated. Do not round up the AE, because rounding will allow more error.

6. Compute the correction per station by dividing the AEC by the number of observed angles, then change the sign of the answer. Record it to two decimal places with the sign in block 6 and truncate the answer.

NOTE: Since the angular error is accidental, it cannot be said that any one angle contains more of the error than another. The error must be distributed evenly among the station angles.

7. Compute the correction per observed angle and properly assign the corrections to the observed angles. Record it to one decimal place with the sign in block 7. After computing the correction per station, if the division does not result evenly to 0.1", produce a group of corrections that are within 0.1" of each other.

NOTE: The sum of corrections must equal the AEC with the opposite sign.

8. Compute the adjusted angles by algebraically adding the correction per angle to the observed angle. Record it to one decimal place in block 8.

9. Compute the azimuth of each traverse section or SS by adding the first adjusted angle to the starting back azimuth. If this azimuth is over 360°, subtract 360°. This is the azimuth to the forward station or SS station. Record it in block 9. The azimuth of all lines must always be stated in the direction in which the SS or traverse is being computed.

NOTE: For an SS, stop here and skip steps 10 through 13 and go to step 14.

Performance Steps

a. Convert the forward azimuth of the line to a back azimuth by either adding or subtracting 180º from the forward azimuth. The forward azimuth to the next station is then computed by adding the back azimuth from the previous line to the adjusted angle of the next station. If the new forward azimuth to the station is greater than 360°, subtract 360°.
b. Repeat this procedure until the final station obtains a perfect check. The computed closing azimuth must agree exactly with the known closing azimuth. If not, a math error has been made and must be corrected.

NOTE: It is very important that particular attention be given to the direction of azimuth. An error of 180° may go undetected and two errors of 180° will cancel out (providing a final azimuth check). This will result in some sections being reversed in direction. Always refer to the sketch provided with the surveyor's field notes.

10. Compute the sea-level coefficient (SLC). Record it to six decimal places in block 10.
    a. Use the following formula to compute the SLC:

       SLC = 1 - h/R

       where--
       h = the mean elevation.
       R = the mean radius of the earth. If h is in feet, use R as 20,906,000 feet. If h is in meters, use R as 6,372,000 meters.

    b. Reduce the corrected field distances to sea level. Along any traverse whose variations in elevation do not exceed 300 meters, sufficient accuracy may be obtained by computing a SLC for the entire traverse.

11. Compute the middle northing (MID N) and the middle easting (MID E).
    a. Add the northing of the beginning traverse station to the northing of the ending traverse station and divide by two to compute the MID N. Record this value to the nearest 1,000 meters in block 11a.
    b. Add the easting of the beginning traverse station to the easting of the ending traverse station and divide by two to compute the MID E. Record this value to the nearest 1,000 meters in block 11b.

12. Compute the scale factor (K).

NOTE: A scale factor is required to convert a measured distance to a grid distance. A mean scale factor may be computed for the entire traverse or for a section in the traverse.Traverses over 8,000 meters require a scale factor to be computed for each section. Compute the northing and easting of the midpoint for the desired traverse or section to the nearest 1,000 meters.

    a. Compute the XVIII value and record it in block 12a.

NOTE: Obtain Table 18 values. The XVIII value is extracted from the National Imagery and Mapping Agency (NIMA) Tables Program or from the tables in DMS ST 045, using the MID N as the argument. Interpolate to compute the XVIII value to six decimal places (round the answer).

    b. Compute E' by subtracting 500,000 from the MID E and record it to 1,000 meters in block 12b as an absolute value.
    c. Compute q by multiplying E' by .000001and record it to six decimal places in block 12c (round the answer).
    d. Compute q squared (q2) and q to the fourth power (q4) and record the values to six decimal places in block 12d (round the answer).

Performance Steps

e. Compute K using the following formula and record it to six decimals places in block 12e (round the answer).

K = Ko[1 + (XVIII) q2 + 0.00003 q4]
= 0.9996[1 + 0.012318 * 0.035344 + 0.00003 * 0.001249]
= 1.000035

where--
Ko = the scale factor at the CM (0.9996)
XVIII = the Table 18 value
q = a factor used to convert E' millionths
q2 = q squared
q4 = q to the fourth power

f. Compute the scale factor that is used to reduce the grid distance (KH) by multiplying K by the SLC. Record it to six decimal places in block 12f (round the answer).

KH = K * SLC

where--
K = scale factor
SLC = sea-level coefficient

NOTE: After computing K and KH, record the values in the "Scale Factor x SLC" column on DA Form 1940 beside the appropriate corrected field distance.

13. Compute the grid distances (G).
    a. Taped distances (corrected horizontal field distances) are reduced to grid distances by multiplying the taped distance by KH. Record this value in block 13a.

    G = H * KH

    where--
    H = taped distance
    KH = the scale factor used to reduce G
    b. Electronic distance-measuring equipment (EDME) distances (reduced geodetic distances) are corrected by multiplying the geodetic distance by K. Record this value in block 13b.

    G = S * K

    where--
    S = geodetic distance
    K = scale factor

NOTE: Compute the total length of the traverse. Record the values to three decimal places in the "Length of Traverse" block on DA Form 1940.

14. Compute the cosine and sine of azimuths. Record it to seven decimal places with the sign in blocks 14 (round the answer).

15. Compute the difference in northings (dNs) and difference in eastings (dEs).
    a. Compute the dN by multiplying the field distance (SS) or grid distance (traverse) by the cosine of the azimuth. Record it to three decimal places with the sign in block 15a (round the answer).
    b. Compute the dE by multiplying the field distance (SS) or grid distance (traverse) by the sine of the azimuth. Record it to three decimal places with the sign in block 15b (round the answer).

NOTE: For the SS, skip steps 16 through 21 and go to step 22 to compute the SS-station coordinates.

16. Compute the errors in the dN and dE (denoted by the errors in northing [En] and the errors in easting [Ee]).

Performance Steps

a. Compute the En by using the following formula. Record it to three decimal places with the sign in block 16a.

   En = computed dN - fixed dN
   (1) Algebraically add the column of dNs to get the computed dN.
   (2) Subtract the fixed starting northing from the fixed ending northing to get the fixed dE.

b. Compute the Ee by using the following formula. Record it to three decimal places with the sign in 6b.

   Ee = computed dE - fixed dE
   (1) Algebraically add the column of dEs to get the computed dE.
   (2) Subtract the fixed starting easting from the fixed ending easting to get the fixed dE.

17. Compute the linear error of closure (LEC) by using the following formula. Record it to four decimals places in block 17.

    LEC = the square root of the sum of the values ([En squared] + [Ee squared])

18. Compute the ratio of closure (RC) by dividing the length of the traverse (in meters) by the LEC. Use the following formula. Round down to the nearest 100. Record the value in block 18.

    RC = 1: length of traverse (in meters)/LEC

NOTE: The accuracy of a traverse is the ratio of error to the total length of traverse. The accuracy is normally expressed as a ratio of "one to something." The RC must meet the specifications for the order of work being performed. Third-order specifications require an RC of 1:10,000 and are found in DMS ST 031. If the traverse does not meet these specifications, no further computations are necessary.

19. Compute the AE for position closure using the formula found in DMS ST 031 and record this value in block 19.

NOTE: The LEC must be compared to the AE. If the LEC is equal to or less than the AE, the traverse has meet specifications. If the LEC is greater than the AE, no further computations are necessary.

20. Compute the correction factors (correction to northing [KN] and correction to easting [KE]) to be used in adjusting the traverse.
    a. KN is computed by dividing the En by the length of traverse in meters then changing the sign of the answer. Record it to seven decimal places with the sign in block 20a (round the answer).
    b. KE is computed by dividing Ee by the length of traverse in meters then changing the sign of the answer. Record it to seven decimal places with the sign in block 20b (round the answer).

NOTE: The correction factors will always have the opposite sign of the En and the Ee.

21. Compute the corrections to the dNs and the dEs.
    a. The corrections to the dNs are computed by multiplying KN by the grid distance. This is done for each section of the traverse. Record the value to three decimal places with the sign in block 21a (round the answer).
    b. The corrections to the dEs are computed by multiplying KE by the grid distance. This is done for each section of the traverse. Record the value to three decimal places with the sign in block 21b (round the answer).

NOTE: After all the corrections are recorded, sum the columns. The sum of the corrections must equal the errors of dN and dE with the opposite sign. If, because of rounding errors, the sum does not exactly equal the error of dN or dE, this difference must be distributed. For uniformity, the largest corrections are changed by one unit (third decimal place) until the correct sum is obtained.

22. Compute the SS or final adjusted traverse grid coordinates (northings and eastings).
    a. For an SS, algebraically add the dN and dE to the occupied station coordinates for each observation and proceed to step 23.

Performance Steps

b. For a traverse, compute the adjusted northing by algebraically adding the dN and the correction of the dN to the northing of the preceding station. Record the value to three decimal places in block 22b.
c. For a traverse, compute the adjusted easting by algebraically adding the dE and the correction of the dE to the easting of the preceding station. Record the value to three decimal places in block 22c.

NOTE: Continue this procedure in a like manner for each station. As a math check, apply the last dN and the last correction to the dN to the northing of the preceding station. The answer must equal the fixed northing of the closing station. The same is true for the easting.

23. Sign and date the form (blocks 23).

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to compute a grid traverse or an SS.

Performance Measures	**GO**	**NO GO**
NOTE: For a traverse, completed all the steps. For an SS, completed steps 1, 9, 14, 15, 22, and 23		
1. Entered administrative data on DA Form 1940 and abstracted all information from DA Form 1962 onto DA Form 1940.	____	____
2. Computed the sum of the angles.	____	____
3. Computed the ending azimuth.	____	____
4. Computed the AEC.	____	____
5. Computed the AE.	____	____
6. Computed the correction per station.	____	____
7. Computed the correction per observed angle and assigned those corrections.	____	____
8. Computed the adjusted angles.	____	____
9. Computed the azimuth of each traverse section or SS.	____	____
10. Computed the SLC.	____	____
11. Computed the MID N and MID E.	____	____
12. Computed the scale factor (K).	____	____
13. Computed the grid distances.	____	____
14. Computed the cosine and sine of the azimuths.	____	____
15. Computed the dNs and the dEs.	____	____
16. Computed the En and the Ee.	____	____
17. Computed the LEC.	____	____
18. Computed the RC.	____	____

Performance Measures	GO	NO GO
19. Computed the AE for position closure.	____	____
20. Computed the KN and the KE.	____	____
21. Computed the corrections to the dNs and the dEs.	____	____
22. Computed the SS or final adjusted grid coordinates.	____	____
23. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1940	DA FORM 1934
DA FORM 1962	
DMS ST 031	

Compute Distances

052-260-1236

Conditions: As a topographic surveyor in a secure field environment, given National Imagery Mapping Agency (NIMA) Form 8900-2 with the corrected slope distance (T), the azimuth of line, the mean latitude (h), any eccentric values, and the elevations of the instrument and reflector stations; a scientific calculator; a desktop personal computer (PC) with the NIMA Tables Program (for geodetic distances only); and the project directive.

Standards: Compute distances to ensure that all readings are summed and meaned and agree within ± 10 millimeters from the mean. Reject and reobserve any reading that exceeded the ± 10 millimeters. Compute the difference in elevation (d) to the same number of decimal places as the given elevations. Compute the horizontal distance (H) to three decimal places. Compute the eccentric correction (EC) to three decimal places, if necessary. Compute the geodetic distance (S) to three decimal places. All computations must be accurate. All entries must be neat and legible.

Performance Steps

1. Check all entries and computations on NIMA Form 8900-2 and correct them as necessary (Figures 052-260-1236-1 and 052-260-1236-2).

Performance Steps

PROJECT				FIELD SHEET - _____ EDME			
ORGANIZATION				DATE		APPROX. DISTANCE	
AZ. OF LINE	MEAN LATITUDE	CALIBRATION DATE		OBSERVER		RECORDER	
INSTRUMENT STATION		H.I.		ELEV.	ELEV. INST. 2a	ECCENTRICITY TOWARD / AWAY	INST NO.
REFLECTOR STATION		H.I.		ELEV.	ELEV. REF. 2b	ECCENTRICITY TOWARD / AWAY	PRISM NO.

METEOROLOGICAL READINGS

	TIME	PRESSURE ALTIMETER	TEMPERATURE (F°) DRY	(C°)
INSTRUMENT INITIAL				
REFLECTOR INITIAL				
INSTRUMENT FINAL				
REFLECTOR FINAL				
SUM				
MEAN				

BAROMETRIC PRESSURE (P)		mbar / IN HG / MM HG
PPM		
DIFF. OF ELEV. (d)	3	
MEAN ELEV. (h)	5	
MEAN RADIUS OF CURVATURE (ρ)	6	

DISTANCE

(meters)

1			
2			
3			
4			
5			
6			
7	Sample		
8			
9			
10			
SUM			

	MEAN UNCORRECTED SLOPE DISTANCE	(UD)		
	OFFSET CORRECTION *	(Z)		
$T = (UD) + (Z)$ ✧	SLOPE DISTANCE ✧	(T)		
$H = \sqrt{T^2 - d^2}$	HORIZONTAL DISTANCE	(H)	4	
	ECCENTRIC CORRECTION ^	(EC)	7	
$C = -H\frac{h}{\rho} + H\frac{h^2}{\rho^2}$	SEA-LEVEL CORRECTION	(C)	8	
$S = H + (EC) + C$	GEODETIC DISTANCE	(S)	9	

REMARKS

* Obtained from the instrument Calibration; Use only if computing manually.
✧ If the Offset Correction (Z) is computed internally in the instrument; Then (UD) = (T).
^ Toward Eccentricity must be ADDED (+); Away Eccentricity must be SUBTRACTED (-).

COMPUTED BY	DATE	CHECKED BY	DATE	PAGE OF
10	10			

NIMA Form 8900-2 JUN 97

Figure 052-260-1236-2
Sample of NIMA Form 8900-2 With Block Numbers

Performance Steps

PROJECT: Example				FIELD SHEET - _____ EDME			
ORGANIZATION: Engineer Company				DATE: 02 Apr 00		APPROX. DISTANCE: 1.5 Km	
AZ. OF LINE: 65°	MEAN LATITUDE: 38° 48'	CALIBRATION DATE:		OBSERVER: SGT Jones		RECORDER: PFC Dehoff	
INSTRUMENT STATION: Here		H.I.: 1.51 m		ELEV.: 102.733	ELEV. INST.	ECCENTRICITY TOWARD / AWAY 1.533	INST NO.
REFLECTOR STATION: There		H.I.: 1.59 m		ELEV.: 108.139	ELEV. REF.	ECCENTRICITY TOWARD / AWAY 2.100	PRISM NO.

METEOROLOGICAL READINGS

	TIME	PRESSURE ALTIMETER	TEMPERATURE (F°) DRY (C°)	
INSTRUMENT INITIAL		762	44.6	
REFLECTOR INITIAL		761	48.2	
INSTRUMENT FINAL				
REFLECTOR FINAL				
SUM		1523	92.8	
MEAN		761.5	46.4	

BAROMETRIC PRESSURE (P)	29.98	mbar / IN HG / MM HG
PPM	42	
DIFF. OF ELEV. (d)	5.406	
MEAN ELEV. (h)	105.436	
MEAN RADIUS OF CURVATURE (ρ)	6 377 804.157	

DISTANCE (meters)

1	1527	308
2		306
3		311
4		306
5		306
6		307
7		304
8		310
9		310
10		307
SUM	15273	075

Sample

	MEAN UNCORRECTED SLOPE DISTANCE	(UD)	1527	308
	OFFSET CORRECTION *	(Z)		
$T = (UD) + (Z)$ ✧	SLOPE DISTANCE ✧	(T)	1527	308
$H = \sqrt{T^2 - d^2}$	HORIZONTAL DISTANCE	(H)	1527	298
	ECCENTRIC CORRECTION ▲	(EC)	3	633
$C = -H\frac{h}{\rho} + H\frac{h^2}{\rho^2}$	SEA-LEVEL CORRECTION	(C)	-0	025
$S = H + (EC) + C$	GEODETIC DISTANCE	(S)	1530	906

REMARKS

* Obtained from the instrument Calibration. Use only if computing manually.
✧ If the Offset Correction (Z) is computed internally in the instrument. Then (UD) = (T).
▲ Toward Eccentricity must be ADDED (+). Away Eccentricity must be SUBTRACTED (-).

COMPUTED BY	DATE	CHECKED BY	DATE	PAGE OF
SSG Falcon	02 Apr 00			

NIMA Form 8900-2 JUN 97

Figure 052-260-1236-2
Completed Sample of NIMA Form 8900-2

Performance Steps

2. Compute and record the instrument and the reflector elevations.
   a. Compute the instrument elevation by adding the elevation of the instrument station with the height of instrument (HI) and record it in block 2a.
   b. Compute the reflector elevation by adding the elevation of the reflector station with the height of the reflector and record it in block 2b.

3. Compute and record the difference of elevation (d) in block 3. Subtract the instrument elevation from the reflector elevation and record the absolute value to the same number of decimal places as the given elevations.

4. Compute and record the horizontal distance (H) in block 4. The horizontal distance (H) is equal to the square root of the following value:

   T squared - d squared

   where--
   T = Corrected slope distance.
   d = Difference of elevation.

NOTE: If only the horizontal distance (H) is required, the computation is complete. Proceed to step 10.

5. Compute and record the mean elevation (h) in block 5. Add the elevation of the instrument with the elevation of the reflector and divide by two.

6. Determine the mean radius of curvature (rho). Use the NIMA Tables Program and input the following:
   a. Enter the tables program.
   b. Enter any letter.
   c. Select the "LONG PROMPTS" option.
   d. Enter a station name.
   e. Select an ellipsoid.
   f. Enter the mean latitude of the station.
   g. Select the "RADIUS OF CURVATURE" (Table XX).
   h. Record the mean rho on NIMA Form 8900-2 in block 6.
   i. Exit the tables program.

7. Determine and record the EC in block 7, if necessary. Algebraically add the eccentricity at the instrument station with the eccentricity at the reflector station. The toward eccentricity is a positive value and the away eccentricity is a negative value.

8. Compute the sea-level reduction factor (C). Use the following formula. Record it to three decimal places with the sign in block 8.

   C = (-H) x (h/rho) + H x ((h squared)/(rho squared))

   where--
   H = Horizontal distance.
   h = Mean elevation.
   rho = Radius of curvature.

Performance Steps

9. Compute the geodetic distance (S). Use the following formula. Record it to three decimal places in block 9.

   S = H + (EC) + C

   where--
   H = Horizontal distance.
   EC = Eccentric correction.
   C = Sea-level reduction factor.

10. Sign and date the form in blocks 10.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him if a horizontal or geodetic calculation is required. Tell him to compute distances.

Performance Measures	**GO**	**NO GO**
1. Checked all entries and computations on NIMA Form 8900-2 and corrected them, if it was necessary.	____	____
2. Computed and recorded the instrument and reflector elevations.	____	____
3. Computed and recorded the difference in elevation (d).	____	____
4. Computed and recorded the horizontal distance (H).	____	____
NOTE: If only the horizontal-distance (H) calculation is required, go to step 10.		
5. Computed and recorded the mean elevation (h).	____	____
6. Determined the radius of curvature (rho).	____	____
7. Determined and recorded the EC.	____	____
8. Computed the sea-level reduction factor (C).	____	____
9. Computed the geodetic distance (S).	____	____
10. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
NIMA FORM 8900-2	

Abstract Vertical Angles (VAs)/Zenith Distances (ZDs)
052-260-1313

Conditions: As a topographic surveyor in a field environment, given Department of the Army (DA) Form 5817 with observed VAs/ZDs, DA Form 1943, Defense Mapping School (DMS) Special Text (ST) 031, and a scientific calculator.

Standards: Abstract VAs/ZDs. Sum and mean the seconds of observed angles. Reject observations that fall outside the mean rejection limits as prescribed by DMS ST 03. Transcribe all necessary VAs/ZDs and instrument and target heights from DA Form 5817 to DA Form 1943. Compute the abstract through t-o and the mean angle without error.

Performance Steps

1. Fill out the headings on DA Form 1943 in blocks 1 (Figures 052-260-1313-1 and 052-260-1313-2).

Performance Steps

PROJECT 1		ABSTRACT OF ZENITH DISTANCES For use of this form, see FM 3-34.331; the proponent agency is TRADOC.
LOCATION 1	INSTR. (TYPE) (NO.) 1	STATION 1
ORGANIZATION 1	OBSERVER 1	HEIGHT OF STAND 1

DATE	HOUR	OBJECT OBSERVED	OBJECT ABOVE STATION = o (Meters)	TELESCOPE ABOVE STATION = t (Meters)	DIFF. OF HEIGHTS t-o (Meters)	REDUCTION TO LINE JOINING STATIONS	OBSERVED ZENITH DISTANCE	CORRECTED ZENITH DISTANCE
						"	° ' "	° ' "
2a	2b	3a	3b	4	5		6a	
	2c						7	

Sample

DATE	LIGHT SHOWN TO STATION	HEIGHT OF LIGHT* ABOVE STATION (Meters)	DATE	LIGHT SHOWN TO STATION	HEIGHT OF LIGHT* ABOVE STATION (Meters)
9a			9c		
	9b				
	9a			9c	

*Height of Light (or object above station) should also be entered on Abstract of Zenith Distances of station to which light was shown.

COMPUTED BY 10	DATE (YYYYMMDD) 10	CHECKED BY	DATE (YYYYMMDD)

DA FORM 1943, MAY 2001 EDITION OF FEB 57 IS OBSOLETE USAPA V1.00

Figure 052-260-1313-1
Sample of DA Form 1943 With Block Numbers

Performance Steps

ABSTRACT OF ZENITH DISTANCES

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT: St Elm		
LOCATION: Fort Belvoir, VA	INSTR. (TYPE) (NO.): T-2 Wild	STATION: Dart (USGS) 56
ORGANIZATION: DMS/BGS/BTOPO	OBSERVER: SSG Armando	HEIGHT OF STAND:

DATE	HOUR	OBJECT OBSERVED	OBJECT ABOVE STATION = o (Meters)	TELESCOPE ABOVE STATION = t (Meters)	DIFF. OF HEIGHTS t-o (Meters)	REDUCTION TO LINE JOINING STATIONS	OBSERVED ZENITH DISTANCE	CORRECTED ZENITH DISTANCE
20010818	0915	Dart-1-RM	1.63	1.66	+0.03	"	° " " 90 24 02.0	° " "
		(DMS) 1978					01.0	
						Σ	03.0	
						MN	90 24 01.5	

Sample

DATE	LIGHT SHOWN TO STATION	HEIGHT OF LIGHT* ABOVE STATION (Meters)	DATE	LIGHT SHOWN TO STATION	HEIGHT OF LIGHT* ABOVE STATION (Meters)
20010818	Dart-1-RM	1.70 m			

*Height of Light (or object above station) should also be entered on Abstract of Zenith Distances of station to which light was shown.

COMPUTED BY	DATE (YYYYMMDD)	CHECKED BY	DATE (YYYYMMDD)

DA FORM 1943, MAY 2001 EDITION OF FEB 57 IS OBSOLETE USAPA V1.00

Figure 052-260-1313-2
Completed Sample of DA Form 1943

Performance Steps

2. Abstract the times (for reciprocal angles only) and the date from DA Form 5817.
   a. Enter the year, month, and date (YYY.MMDD) that the observation was made on DA Form 1943 in block 2a.
   b. Enter the starting time of the observation on DA Form 1943 in block 2b.
   c. Enter the ending time of the observation on DA Form 1943 in block 2c.
3. Abstract the height of the object above the station (only for reciprocal angles on occupiable targets) from DA Form 5817.
   a. Enter the name of the object observed on DA Form 1943 in block 3a.
   b. Enter the height of the object above the station on DA Form 1943 in block 3b.
      (1) Use the height from the sketch of the target observed for nonreciprocal observations from DA Form 5817.
      (2) Use the field data recorded at the station observed for reciprocal observations from DA Form 5817.
4. Abstract the height of instrument (HI) (t) above the station from DA Form 5817. Enter the height to the nearest millimeter on DA Form 1943 in block 4.
5. Compute and enter the t-o on DA Form 1943 in block 5, where appropriate, using the formula t-o.
6. Abstract the observed VAs/ZDs from DA Form 5817.
   a. Enter the degrees, minutes, and seconds (DDD.MMSS) from the first position on DA Form 1943 in block 6a.
   b. Enter only the seconds for additional positions.
7. Compute and enter the mean VA/ZD on DA Form 1943 in block 7.
   a. Sum the seconds for all observations.
   b. Divide the sum by the number of positions.
8. Ensure that the VAs/ZDs meet the rejection limits.
9. Complete the data on the target shown on DA Form 1943.
   a. Enter the date and the name of the station to which you are showing a target on DA Form 1943 in blocks 9a.
   b. Draw a sketch of the target shown on DA Form 1943 in block 9b and indicate the points and heights that were measured.
   c. Date, name, and label the sketch of a target on DA Form 1943 in blocks 9c if more than one target is shown to a station or if a target is shown to another station.
10. Sign and date DA Form 1943 in blocks 10.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to abstract VAs/ZDs.

Performance Measures	**GO**	**NO GO**
1. Filled out the headings on DA Form 1943.	____	____
2. Abstracted the times (for reciprocal angles only) and the date from DA Form 5817.	____	____
3. Abstracted the height of the object above the station (only for reciprocal angles on occupiable targets) from DA Form 5817.	____	____

Performance Measures	GO	NO GO
4. Abstracted the HI (t) above the station from DA Form 5817. Entered the height to the nearest millimeter on DA Form 1943.	____	____
5. Computed and entered the t-o on DA Form 1943, where appropriate.	____	____
6. Abstracted the observed VAs/ZDs from DA Form 5817.	____	____
7. Computed and entered the mean VA/ZD on DA Form 1943.	____	____
8. Ensured that the VAs/ZDs met the rejection limits.	____	____
9. Completed the data on the target shown on DA Form 1943.	____	____
10. Signed and dated DA Form 1943.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1943	
DA FORM 5817	
DMS ST 031	

Abstract Horizontal Angles (HAs)

052-260-1314

Conditions: As a topographic surveyor in a field environment, given observed horizontal directions, Department of the Army (DA) Form 1916, a scientific calculator, and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Abstract horizontal directions. Sum and mean the seconds of observed angles. Reject observations that fall outside the mean rejection limits as prescribed by DMS ST 031. Compute the horizon closure and corrected angles. All entries must be neat and legible.

Performance Steps

1. Fill out the headings on DA Form 1916 in blocks 1 (Figures 052-260-1314-1 and 052-260-1314-2).

Performance Steps

ABSTRACT OF HORIZONTAL DIRECTIONS

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION	ORGANIZATION	STATION
1	1	1
OBSERVER	**DATE** *(YYYYMMDD)*	**INST. (TYPE) (NO.)**
1	1	1

POSITION NO.	STATIONS OBSERVED							
	2a	2b						
	(Initial) 0° 00′	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
1	0.00	2c						
2	0.00	2d						
3	0.00							
4	0.00							
5	0.00							
6	0.00					6		
7	0.00					7		
8	0.00							
9	0.00					8		
10	0.00					9		
11	0.00					9		
12	0.00							
13	0.00					10		
14	0.00							
15	0.00					11		
16	0.00							
Sum,		3						
Mean,		4						

COMPUTED BY	DATE *(YYYYMMDD)*	CHECKED BY	DATE *(YYYYMMDD)*
13	13		

DA FORM 1916, FEB 57

USAPA V1.01

Figure 052-260-1314-1
Sample of DA Form 1916 With Block Numbers

Performance Steps

ABSTRACT OF HORIZONTAL DIRECTIONS

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION	ORGANIZATION	STATION
Missouri	99th Engr Det (Survey)	Lake (USC&GS) 1932
OBSERVER	**DATE** *(YYYYMMDD)*	**INST. (TYPE) (NO.)**
SGT Smith	2001/05/22	Wild T-2 #28234

POSITION NO.	STATIONS OBSERVED							
	Brook (USACE) 1956	Bass (DMA) 1972		Explemen-tary Angle				
	(Initial) 0° 00′	° ′ 047 46	° ′	° ′ 312 13	° ′	° ′	° ′	° ′
	″	″	″	″	″	″	″	″
1	0.00	21.5		38.3				
2	0.00	22.0		38.1				
3	0.00	22.0		37.8				
4	0.00	21.0		38.3				
5	0.00	21.5		38.4				
6	0.00	22.5 (36.0)Ro		38.0				
7	0.00	21.0		38.1		EC		
8	0.00	21.5		38.2		Mean station	047 46	21.7
9	0.00	22.0		38.1		Explemen-tary	312 13	38.1
10	0.00	21.5		38.2				
11	0.00	22.0		37.9				
12	0.00	21.5		38.2		Closure	359 59	59.8
13	0.00					Error		-0.2
14	0.00							
15	0.00						Corrected	
16	0.00					Mean station	047 46	21.8
Sum,		260.0		457.6		Explemen-tary	312 12	38.2
Mean,		21.7		38.1				

COMPUTED BY	DATE *(YYYYMMDD)*	CHECKED BY	DATE *(YYYYMMDD)*
SPC Jones	2001/05/22	SSG J. Zambrano	2001/05/22

DA FORM 1916, FEB 57

USAPA V1.01

Figure 052-260-1314-2
Completed Sample of DA Form 1916

Performance Steps

2. Record the observed data.
   a. Record the name of the initial station in block 2a.
   b. Record the name of the forward station in block 2b.
   c. List the degrees and minutes of the reading at the top of each respective column (block 2c).
   d. Record the seconds for each position on the line adjacent to their respective reading (block 2d).

3. Sum the seconds of the readings in block 3.

4. Mean the seconds of the readings in block 4. Divide the sum by the number of positions observed.

5. Reject any readings that do not meet the specifications. Redetermine the mean of the seconds.

NOTE: Refer to DMS ST 031.

   a. Put parentheses around and a rejection number by the value that has been rejected, for example, (R1).
   b. Do not use rejected values in future computations.
   c. Reobserve those directions that were rejected using the correct circle setting for the rejected position.
   d. Record the reobserved directions (on the abstract) on the same line as the rejected value and repeat steps 3 and 4.

6. Enter the eccentric correction (EC) in seconds, if applicable.

NOTE: If there is no correction, proceed to step 8.

7. Algebraically add the mean station angle and EC. This value is the mean station angle. Record it in block 7.

8. Determine and record the mean explement angle in block 8. If more than two observations are made, perform steps 2 through 8.

9. Compute the horizon closure (HC) and the error by using the following formulas. Record these values in blocks 9.

   HC = mean station angle + mean explement angle
   Error = HC - 360°

10. Compute and record the corrections to the mean station and explement angles and record the values in blocks 10.
    a. Divide the error by two and then reverse the sign to determine the true correction value.
    b. Round one correction up to the nearest 0.1 decimal place and one correction down to the nearest 0.1 decimal place if the correction cannot be equally divided by two. The larger of the two corrections is applied to the larger of the angles (for example, an error of +02.7" is equal to a correction of -01.4" and -01.3").

11. Apply the corrections to determine the corrected station and explement angles and record the values in block 11.

NOTE: If the sum of the corrected angles does not equal 360°, a math error has been made.

12. Sign and date the form in blocks 12.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to abstract horizontal angles.

Performance Measures	GO	NO GO
1. Filled out the headings on DA Form 1916.	____	____
2. Recorded the observed data.	____	____
3. Summed the seconds of the readings.	____	____
4. Meaned the seconds of the readings.	____	____
5. Rejected any readings that did not meet the specifications. Redetermined the mean of the seconds.	____	____
6. Entered the EC in seconds, if it was applicable.	____	____
7. Algebraically added the mean station angle with the EC.	____	____
8. Determined the mean explement angle.	____	____
9. Computed the HC and the error.	____	____
10. Computed and recorded the corrections to the mean station and explement angles.	____	____
11. Applied the corrections to determine the corrected station angle and explement angles.	____	____
12. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1916	
DMS ST 031	

Measure Distances With Electronic Distance-Measuring Equipment (EDME)

052-260-1326

Conditions: As a topographic surveyor in a field environment, given an infrared EDME, a tripod, a 2-meter tape measure, a thermometer, a barometer, two intervisible survey stations, an EDME target set (set up and ready), Technical Manual (TM) 5-6675-332-10, Defense Mapping School (DMS) Special Text (ST) 031, and a recorder with Department of the Army (DA) Form 5819.

Standards: Measure distances with the EDME to third-order specifications according to DMS ST 031.

Performance Steps

1. Set up and plumb the EDME over the survey station.
   a. Open the tripod and, with the cover on, attach the plumb bob.
   b. Place the tripod over the survey control station and ensure that it is plumb over the mark. Embed the tripod legs firmly in the ground.
   c. Adjust the legs until the tripod head is horizontal. Ensure that the plumb bob is still plumb over the survey mark. If it is not, repeat steps 1a through c.
   d. Remove the tripod cover and attach the EDME to the tribrach.
   e. Move the EDME on the head of the tripod to bring the plumb bob directly over the survey mark. The base of the EDME will not overhang the tripod head. Firmly tighten the EDME to the tripod.
   f. Ensure that the battery is fully charged and attached to the EDME.
   g. Level the tribrach bull's-eye bubble using the tribrach foot screws.

2. Turn on the power and enter the atmospheric data.

NOTE: Refer to the appropriate TM for the EDME being used.

   a. Temperature.
   b. Barometric pressure.
   c. Parts-per-million (ppm) value, if necessary. Refer to Table 052-260-1326-1 to determine the ppm from the mean temperature and barometric pressure.

Distance in Meters	Correction to Rod in Meters
0 to 27	-0.0
27.0 to 46.8	-0.1
46.8 to 60.4	-0.2
60.4 to 71.4	-0.3
71.4 to 81.0	-0.4
81.0 to 89.5	-0.5
89.5 to 97.3	-0.6
97.3 to 104.5	-0.7

Table 052-260-1326-1
Corrections Applied to Distances

3. Align the EDME with the reflector. Alternately align the horizontal and vertical tangent screws to acquire a return signal from the reflector.

4. Measure and read the distance.

5. Repeat performance step 4 for the required number of readings.

NOTE: A complete measurement consists of ten readings. For higher-order specifications, refer to the standards and specifications in DMS ST 031.

Performance Steps

6. Repeat the observations if the accuracy does not meet the specifications.

NOTE: Readings should not exceed ± 0.010 meters from the mean.

7. Check DA Form 5819 to ensure that it is complete and correct.
8. Turn off and store the instrument.

Evaluation Preparation: Setup: Provide the soldiers with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two stations. The distance between the two should exceed 400 meters. Obtain the help of a recorder who is qualified according to task 052-260-1225. The reflector will be set up and ready. The height of instrument (HI) and the height of reflector will be measured.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the distance to be measured. Also explain that there will be a qualified recorder assigned and that the HI and the height of reflector will be given to the recorder. Tell the soldier that achieving the actual job standard depends on the performance of a team. Since he is only part of the team, a GO or NO-GO will be based on the demonstration of correct measuring procedures. Tell him to measure distances with an EDME.

Performance Measures	**GO**	**NO GO**
1. Set up and plumbed the EDME over the survey station.	____	____
2. Turned on the power and entered the atmospheric data.	____	____
3. Aligned the EDME with the reflector.	____	____
4. Measured and read the distances.	____	____
5. Repeated performance step 4 for the required number of readings.	____	____
6. Repeated the observations if the accuracy did not meet the specifications. The readings should not exceed ± 0.010 meters from the mean.	____	____
7. Checked DA Form 5819 to ensure that it was complete and correct.	____	____
8. Turned off and stored the instrument.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5819	
DMS ST 031	
TM 5-6675-332-10	

Measure Horizontal Directions With Theodolites

052-260-1328

Conditions: As a topographic surveyor in a field location, given an operational theodolite set up over a station, a target set up over a rear station, a target set up over a forward station, a recorder with Department of the Army (DA) Form 5818, and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Measure horizontal directions and two station angles and two explement angles with a theodolite. The station and explement angles must be within ± 5 seconds of their mean. Also, the mean station and explement angles must add up to ± 5 seconds of 360°. The measured horizontal and explement angles must conform to third-order specifications, according to DMS ST 031. Reobserve any rejected observations.

Performance Steps

1. Check the eyepiece for parallax. Remove the parallax by pointing the instrument toward the sky and rotating the eyepiece until the crosshairs appear sharp and intensely black.
2. Check the level of the instrument. Adjust the instrument, if necessary.
3. Locate and focus on the station's target to be observed.
   a. Point the instrument toward the target using the coarse sight for the telescope.
   b. Look through the eyepiece and rotate the focusing ring to focus on the target.
   c. Look through the eyepiece and fine-tune the pointing of the instrument by using the two-speed vertical and horizontal controls.
4. Tell the recorder the station name.
5. Set the circle settings as provided by the recorder.
6. Observe and read the direction to the initial station to the nearest second.
7. Observe and read the direction to the forward station to the nearest second.
   a. Unlock the horizontal clamp and turn the instrument in a clockwise direction toward the forward station.
   b. Focus and align the instrument on the target as recommended in step 3.
8. Invert (plunge) the telescope, resight on the forward station, and read the direction to the nearest second.
   a. Unlock the horizontal and vertical clamps.
   b. Invert the telescope and turn the instrument 180° to the same target.
   c. Focus and align the instrument on the target as recommended in step 3.
9. Observe and read the direction to the initial station to the nearest second.
   a. Unlock the horizontal clamp and turn the instrument in a clockwise direction toward the initial station.
   b. Focus and align the instrument on the target as recommended in step 3.

NOTE: This completes one position of horizontal directions.

10. Use the proper plate settings for station-angle observations and repeat the sequence of observations in steps 6 through 9 until the required number of acceptable positions has been observed.
    a. Leave the instrument in the reverse position.
    b. Set the circle settings as provided by the recorder.
    c. Repeat steps 6 through 9. The telescope will be in the opposite direction.
11. Use the proper initial increment settings for explement-angle observations and repeat the sequence of observations in steps 3 through 10 until the required number of acceptable positions have been observed.

Performance Steps
NOTE: Upon completion of two positions of station angles, the instrument is now pointed toward the forward station and the observation steps are repeated. The forward station becomes the initial station and the initial station becomes the forward station.

12. Reobserve any position(s) that are not within specifications as determined by the recorder.
13. Check DA Form 5818 for errors and ensure that the horizontal directions are within specifications.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark three stations. The distance between the stations should be greater than 100 meters. The instrument will be set up according to task 052-260-1134 and the target will be set up according to task 052-260-1122. The angle between the stations should be greater than 45°. Obtain the help of a recorder who is qualified according to task 052-260-1226.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the station to be occupied and the two stations to be observed. Tell him which station is to be the initial station. Tell him to measure horizontal directions with a theodolite.

Performance Measures	**GO**	**NO GO**
1. Checked the eyepiece for parallax. Removed the parallax, if it was necessary.	____	____
2. Checked the level of the instrument. Adjusted the instrument, if it was necessary.	____	____
3. Located and focused on the station's target to be observed.	____	____
4. Told the recorder the station name.	____	____
5. Set the circle settings as provided by the recorder.	____	____
6. Observed and read the direction to the initial station to the nearest second.	____	____
7. Observed and read the direction to the forward station to the nearest second.	____	____
8. Inverted the telescope, resighted on the forward station, and read the direction to the nearest second.	____	____
9. Observed and read the direction to the initial station to the nearest second.	____	____
10. Used the proper plate settings for station-angle observations and repeated the sequence of observations in performance steps 6 through 9 until the required number of acceptable positions had been observed.	____	____
11. Used the proper initial increment settings for explement-angle observations and repeated the sequence of observations in steps 3 through 10 until the number of acceptable positions required for the explement angle had been observed.	____	____
12. Reobserved any positions that were not within specifications.	____	____
13. Checked DA Form 5818 for errors and ensured that the horizontal directions were within specifications.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 5818	TM 5-6675-332-10
DMS ST 031	

Measure Vertical Angles (VAs)/Zenith Distances (ZDs) With Theodolites

052-260-1329

Conditions: As a topographic surveyor in a field environment, given an operational theodolite set up over a station, a target set up over a station, a tripod, a plumb bob, a 2-meter tape measure, Defense Mapping School (DMS) Special Text (ST) 031, and a recorder with Department of the Army Form 5817 or other VA/ZD note-keeping forms.

Standards: Measure two VAs/ZDs with a theodolite to third-order specifications (± 20 seconds between the two VAs/ZDs), according to DMS ST 031.

Performance Steps

1. Check the eyepiece for parallax. Remove the parallax by pointing the instrument toward the sky and rotating the eyepiece until the crosshairs appear sharp and intensely black.
2. Check the level of the instrument. Adjust the instrument, if necessary.
3. Locate and focus on the station's target to be observed.
   a. Point the instrument toward the target using the coarse sight for the telescope.
   b. Look through the eyepiece and rotate the focusing ring to focus on the target.
   c. Look through the eyepiece and fine-tune the pointing of the instrument by using the two-speed vertical and horizontal controls.
4. Tell the recorder the name of the occupied station and the observed station.
5. Tell the recorder what target is being observed.
6. Measure the height of instrument (HI) with the help of the recorder or evaluator.
7. Make a direct pointing on the target.
8. Observe and read the direct reading on the station.
9. Repeat steps 7 and 8 in the reverse position.
   a. Unlock the horizontal and vertical clamps.
   b. Invert (plunge) the telescope and turn the instrument 180° to the same target.
   c. Focus and align the instrument on the target as recommended in step 3.
10. Repeat steps 7 through 9 for the second position.
11. Reject positions that are not within specifications and reobserve them, if necessary.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two survey stations. The distance between the stations should be greater than 100 meters. The instrument will be set up according to task 052-260-1134 and the target will be set up according to task 052-260-1122. There should be at least a 5° difference vertically between the two stations. Obtain the help of a recorder who is qualified according to task 052-260-1227.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him the station to be occupied and the station to be observed. Tell him how many VAs/ZDs are to be observed and that the height of target (HT) will be furnished by the evaluator, if necessary. Tell him to measure VAs/ZDs with a theodolite.

Performance Measures	**GO**	**NO GO**
1. Checked the eyepiece for parallax. Removed the parallax, if it was necessary.	____	____
2. Checked the level of the instrument. Adjusted the instrument, if it was necessary.	____	____
3. Located and focused on the station's target to be observed.	____	____
4. Told the recorder the name of the occupied station and the observed station.	____	____
5. Told the recorder what target was being observed.	____	____
6. Measured the HI with the help of the recorder or evaluator.	____	____
7. Made a direct pointing on the target.	____	____
8. Observed and read the direct reading on the target.	____	____
9. Repeated steps 7 and 8 in the reverse position.	____	____
10. Repeated steps 7 through 9 for the second position.	____	____
11. Rejected positions that were not within specifications and reobserved them, if it was necessary.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5817	TM 5-6675-332-10
DMS ST 031	

Subject Area 4: Level

Determine the Level Error "C"
052-260-1109

Conditions: As a topographic surveyor in a field environment, given Defense Mapping School (DMS) Form 5820-R, the stadia constant for the instrument, a leveling instrument, an instrument operator and two rodmen with level rods, and turning pins.

Standards: Determine the level error "C." Field recordings must be neat and legible. Complete all computations and ensure that they contain no errors.

Performance Steps

1. Fill out the headings on DMS Form 5820-R (according to task 052-260-1228) in blocks 1 (Figures 052-260-1109-1 and 052-260-1190-2.

Performance Steps

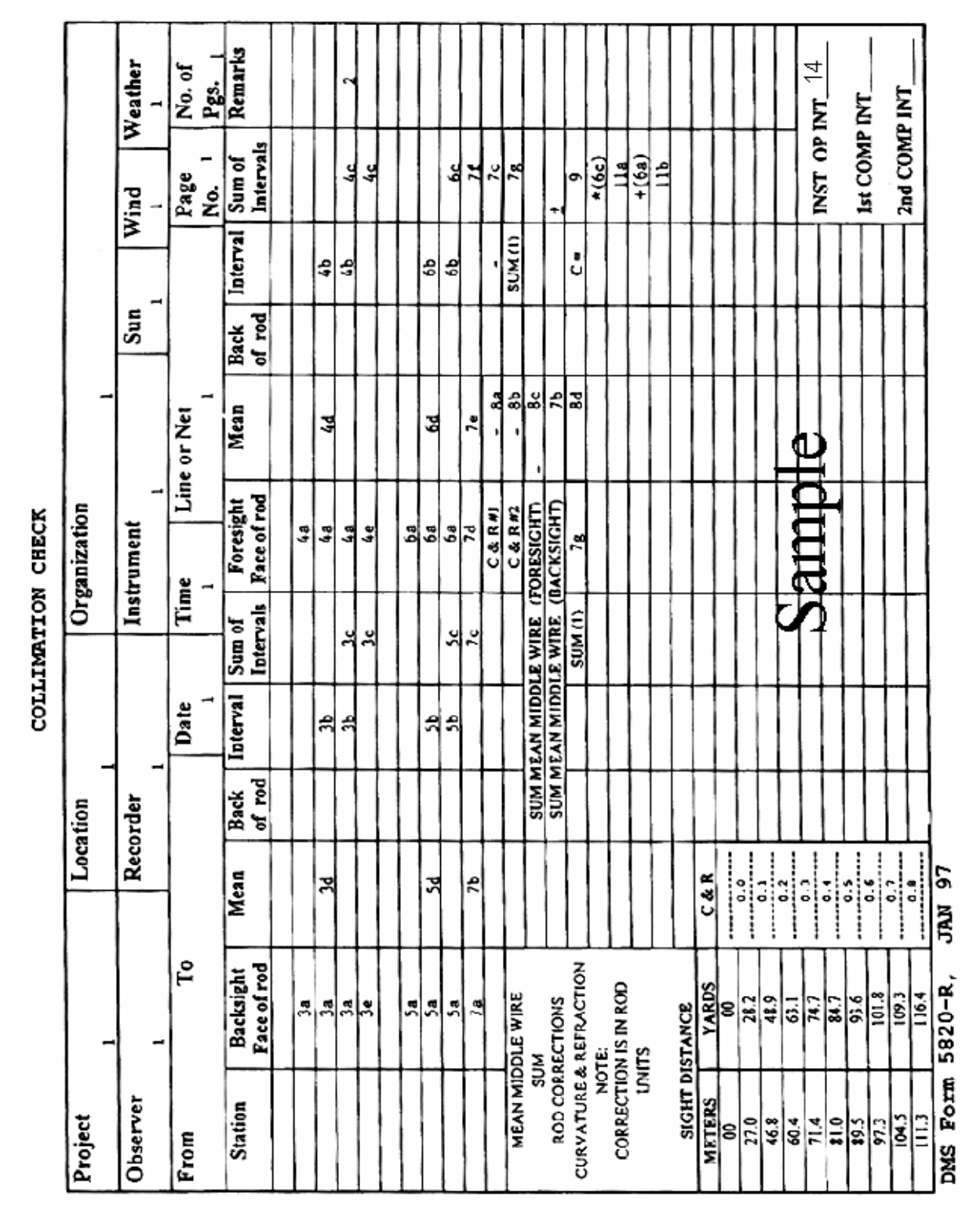
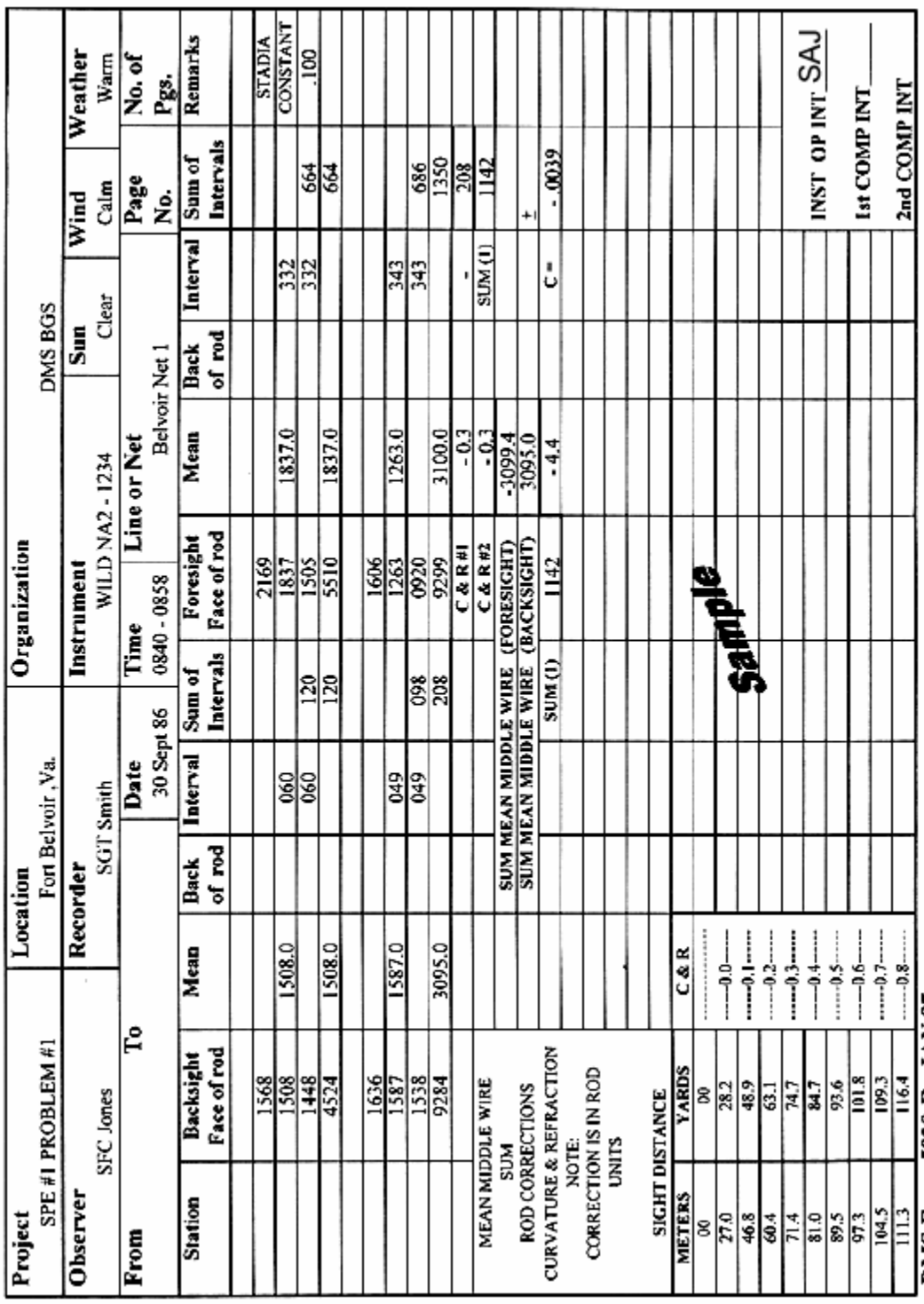


Figure 052-260-1109-1
Sample of DMS Form 5820-R With Block Numbers

Performance Steps



COLLIMATION CHECK

Project	Location	Organization								
SPE #1 PROBLEM #1	Fort Belvoir ,Va.	DMS BGS								
Observer	**Recorder**	**Instrument**		**Line or Net**		**Sun**	**Wind**	**Page**	**Weather**
SFC Jones	SGT Smith	WILD NA2 - 1234		Belvoir Net 1		Clear	Calm	No.	Warm
From To		**Date**	**Time**					**Page No.**	**No. of Pgs.**
		30 Sept 86	0840 - 0858						

Station	Backsight Face of rod	Mean	Back of rod	Interval	Sum of Intervals	Foresight Face of rod	Mean	Back of rod	Interval	Sum of Intervals	Remarks
	1568					2169					STADIA
	1508	1508.0		060		1837	1837.0		332		CONSTANT
	1448			060	120	1505			332	664	.100
	4524	1508.0			120	5510	1837.0			664	
	1636					1606					
	1587	1587.0		049		1263	1263.0		343		
	1538			049	098	0920			343	686	
	9284	3095.0			208	9299	3100.0			1350	
						C & R #1	- 0.3		-	208	
MEAN MIDDLE WIRE						C & R #2	- 0.3		SUM (1)	1142	
SUM			SUM MEAN MIDDLE WIRE (FORESIGHT)				-3099.4				
ROD CORRECTIONS			SUM MEAN MIDDLE WIRE (BACKSIGHT)				3095.0				+
CURVATURE & REFRACTION				SUM (1)	1142		- 4.4		C =	- .0039	
NOTE:											
CORRECTION IS IN ROD											
UNITS											
SIGHT DISTANCE											

METERS	YARDS	C & R
00	00	
27.0	28.2	----0.0----
46.8	48.9	-----0.1-----
60.4	63.1	------0.2------
71.4	74.7	-------0.3-------
81.0	84.7	----0.4----
89.5	93.6	-----0.5-----
97.3	101.8	------0.6------
104.5	109.3	-------0.7-------
111.3	116.4	------0.8------

Sample

INST OP INT SAJ

1st COMP INT

2nd COMP INT

DMS Form 5820-R, JAN 97

Figure 052-260-1109-2
Completed Sample of DMS Form 5820-R

Performance Steps

2. Record the stadia constant for the instrument in block 2.

3. Record the backsight (BS) (near-rod) reading for the first setup.
   a. Record the rod readings in millimeters in blocks 3a.
   b. Determine and enter the stadia intervals in millimeters in blocks 3b. If the difference is greater than 3, reobserve.
   c. Determine and enter the sum of intervals in blocks 3c.
   d. Determine and enter the mean middle-wire reading in millimeters to one decimal place in block 3d.
   e. Determine and enter the sum of the three wire readings (blocks 3a) in millimeters in block 3e.

4. Record the foresight (FS) (far-rod) reading.
   a. Record the rod readings in millimeters in blocks 4a.
   b. Determine and enter the stadia intervals in millimeters in blocks 4b. If the difference is greater than 3, reobserve.
   c. Determine and enter the sum of intervals in blocks 4c.
   d. Determine and enter the mean middle-wire reading in millimeters to one decimal place in block 4d.
   e. Determine and enter the sum of the three wire readings in millimeters in block 4e.

5. Record the BS (near-rod) reading after the level is moved to the second setup.
   a. Record the rod readings in millimeters in blocks 5a.
   b. Determine and enter the stadia intervals in millimeters in blocks 5b. If the difference is greater than 3, reobserve.
   c. Determine and enter the sum of intervals in block 5c.
   d. Determine and enter the mean middle-wire reading in millimeters to one decimal place in block 5d.

6. Record the FS (far-rod) reading.
   a. Record the rod readings in millimeters in blocks 6a.
   b. Determine and enter the stadia intervals in millimeters in blocks 6b. If the difference is greater than 3, reobserve.
   c. Determine and enter the sum of intervals in blocks 6c.
   d. Determine and enter the mean middle-wire reading in millimeters to one decimal place in block 6d.

7. Compute and enter the cumulative totals.
   a. Add the sums in blocks 3e and 5a (the sum of the second set of near-rod readings) and enter this value in block 7a.

   b. Add the sums in blocks 3d and 5d and enter this value in block 7b (perform a page check by dividing block 7a by 3).
   c. Add the sums in blocks 3c and 5c and enter this value in block 7c.
   d. Add the sums in blocks 4e and 6a (the sum of the second set of near-rod readings) and enter this value in block 7d.
   e. Add the sums in blocks 4d and 6d and enter this value in block 7e (perform a page check by dividing block 7d by 3).
   f. Add the sums in blocks 4c and 6c and enter this value in block 7f.
   g. Subtract block 7c from block 7f and enter this value in block 7g.

8. Apply the correction for curvature and refraction (Table 052-260-1109-1).

Performance Steps

Distance in Meters	Correction to Rod in Meters
0 to 27	-0.0
27.0 to 46.8	-0.1
46.8 to 60.4	-0.2
60.4 to 71.4	-0.3
71.4 to 81.0	-0.4
81.0 to 89.5	-0.5
89.5 to 97.3	-0.6
97.3 to 104.5	-0.7

Table 052-260-1109-1
Corrections Applied to Distances

NOTE: Due to the short distance from the instrument to the near rod, no corrections are required to these readings.

a. Divide the sum in blocks 4c by 10 (far-rod distance). Use this distance as an argument to determine the correction. Enter the determined correction from Table 052-260-1109-1 in block 8a.
b. Divide the sum in blocks 6c by 10 (far-rod distance). Use this distance as an argument to determine the correction. Enter the determined correction from Table 052-260-1109-1 in block 8b.

NOTE: The sum of the far-rod mean middle-wire readings must be corrected for curvature and refraction.

c. Algebraically add the sums of blocks 8a and 8b to block 7e and enter this value in block 8c.
d. Algebraically add blocks 8c and 7b and enter this amount with the sign in block 8d.

NOTE: Block 8d is always negative (-).

9. Compute the C value and truncate to four decimal places (0.0000) with the sign. Enter this amount in block 9.

   C = block 8d divided by block 7g.

NOTE: If the sum of the far-rod mean middle-wire readings (block 8c) is larger than the sum of the near-rod mean middle-wire readings (block 7b), then the C value is negative.

10. Determine if the C value is within specifications. (Compare the C value with that allowed for the instrument. The allowance for instruments used by most units is ± 0.004. If the C value is within specifications, no further computations are required.)

11. Determine the correction to the middle wire if the C value is not within specifications.
    a. Determine the correction to the middle wire, in millimeter, by multiplying the total rod interval of the last FS (blocks 6c) by the C value (block 9). Compute to one decimal place and round the answer. Enter this amount in block 11a.
    b. Algebraically add the correction to the middle wire (block 11a) to the last FS middle-wire rod reading (blocks 6a) to obtain the corrected rod reading. Compute to three decimal places and round the answer. Enter this amount in block 11b.

NOTE: Divide the correction by 1,000 to convert to meters before applying.

12. Perform adjustments to the middle wire, if necessary

13. Check the C value again. Repeat steps 1 through 12 until the C value is within specifications.

14. Initial the form in block 14.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to determine the level error "C."

Performance Measures	**GO**	**NO GO**
1. Filled out the headings on DMS Form 5820-R.	____	____
2. Recorded the stadia constant for the instrument.	____	____
3. Recorded the BS reading for the first setup.	____	____
4. Recorded the FS reading.	____	____
5. Recorded the BS reading after the level was moved to the second setup.	____	____
6. Recorded the FS reading.	____	____
7. Computed and entered the cumulative totals.	____	____
8. Applied the correction for curvature and refraction.	____	____
9. Computed the "C" value.	____	____
10. Determined if the "C" value was within specifications.	____	____
11. Determined the correction to the middle wire if the "C" value was not within specifications.	____	____
12. Performed adjustments to the middle wire, if it was necessary.	____	____
13. Checked the "C" value again. Repeated steps 1 through 12 until the "C" value was within specifications.	____	____
14. Initialed the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS FORM 5820-R	

Perform as a Rodman

052-260-1125

Conditions: As a topographic surveyor in a field environment, given a precise or semiprecise level rod, a rod level, a marlin pin, a hammer, and a designated area to be leveled.

Standards: Perform as a rodman during consecutive leveling turns between survey control points. Establish turning points, keep the level rod perpendicular to the ground, pace and maintain a balanced distance between sightings, and move according to the instrument operator's commands.

Performance Steps

1. Plumb the level rod over the survey control point or turning point using a rod level.
2. Pace forward for the next setup.
3. Set up the leveling turn by driving the marlin pin into the ground at a 45° angle until it is solid.
4. Remove the turning pin only upon the instrument operator's command.
5. Compensate the pace count to adjust for any unbalanced length of sight.
6. Read the rod thermometer, if necessary.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two survey control points at least 300 meters apart. Obtain the assistance of a leveling instrument operator who is qualified according to task 052-260-1330 and will double as an assistant evaluator. Have the assistant score the soldier's ability to plumb the level rod at each setup using the rod level. (Check the rod levels before testing to ensure that they are accurate.) Physically inspect the marlin pins before they are pulled out of the ground to ensure that they are solidly emplaced for each setup.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the starting survey control point. Explain to the soldier that this is a group task and that a GO or NO-GO depends on the performance of the group. Tell the soldier to perform as rodman.

Performance Measures	**GO**	**NO GO**
1. Plumbed the level rod over the survey control point or turning point using the rod level.	____	____
2. Paced forward for the next setup.	____	____
3. Set up the leveling turn by driving the marlin pin into the ground at a 45° angle until it was solid.	____	____
4. Removed the turning pin only upon instrument operator's command.	____	____
5. Compensated the pace count to adjust for any unbalanced length of sight.	____	____
6. Read the rod thermometer, if it was necessary.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

Record Level Data

052-260-1228

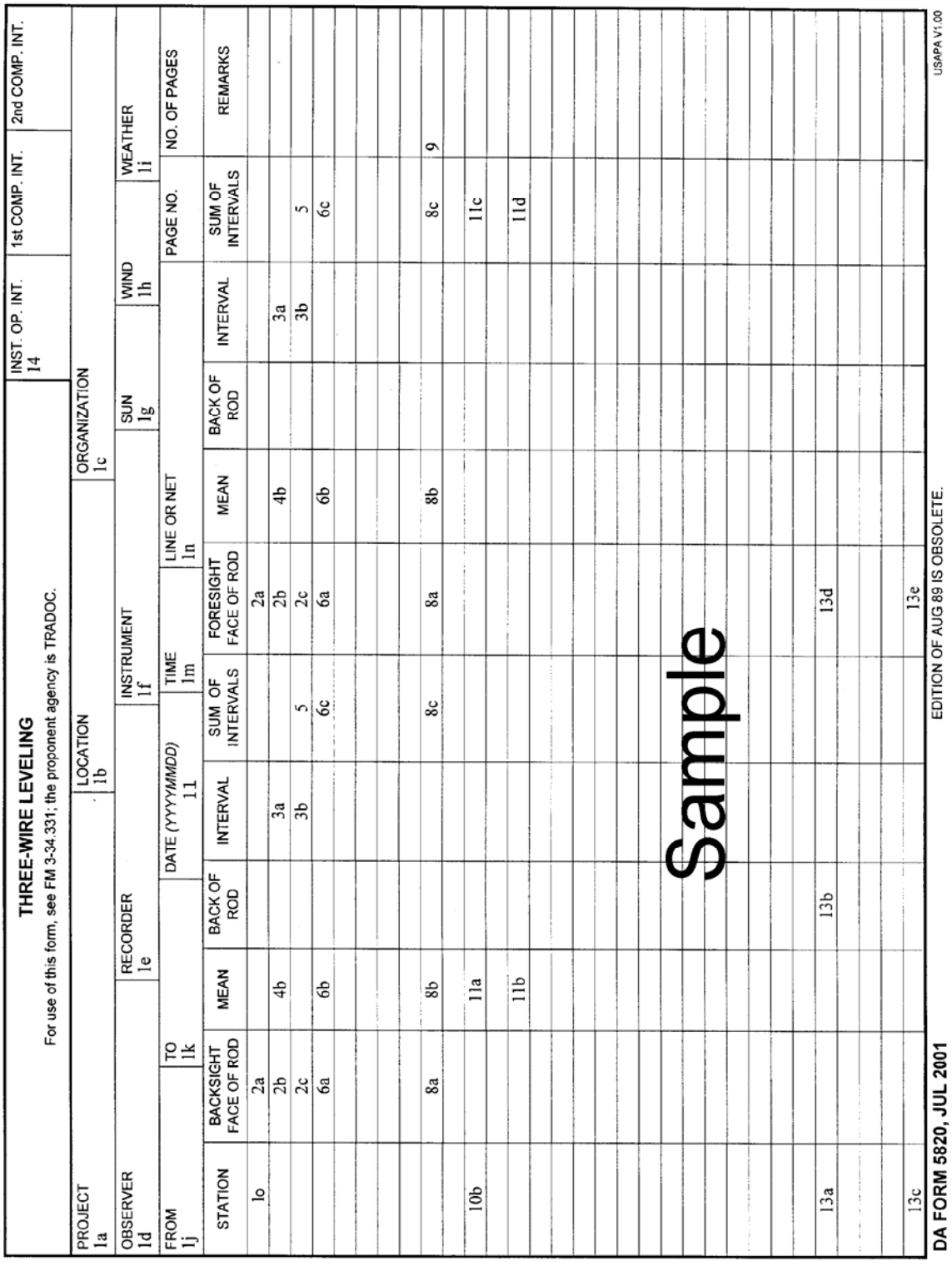
Conditions: As a topographic surveyor in a field environment, given Department of the Army (DA) Form 5820, Defense Mapping School (DMS) Special Text (ST) 031 an instrument with an operator observing a level line, and two rodmen with level rods and turning pins.

Standards: Record level data. Determine the mean middle-wire reading and rod intervals for each observation. Determine the accumulative sum of the three wire readings, mean middle-wire readings, and rod intervals for the page and the section. Determine the actual and allowable differences between the forward and backward runs of the section according to third-order specifications. Field recordings must be neat and legible. Complete all computations and ensure that they do not contain errors.

Performance Steps

1. Enter administrative data on DA Form 5820 (Figures 052-260-1228-1, 052-260-1228-2, and 052-260-1228-3).

Performance Steps



THREE-WIRE LEVELING

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

INST. OP. INT. 14 | 1st COMP. INT. | 2nd COMP. INT.

PROJECT 1a | LOCATION 1b | ORGANIZATION 1c

OBSERVER 1d | RECORDER 1e | INSTRUMENT 1f | SUN 1g | WIND 1h | WEATHER 1i

FROM 1j | TO 1k | DATE (YYYYMMDD) 11 | TIME 1m | LINE OR NET 1n | PAGE NO. | NO. OF PAGES

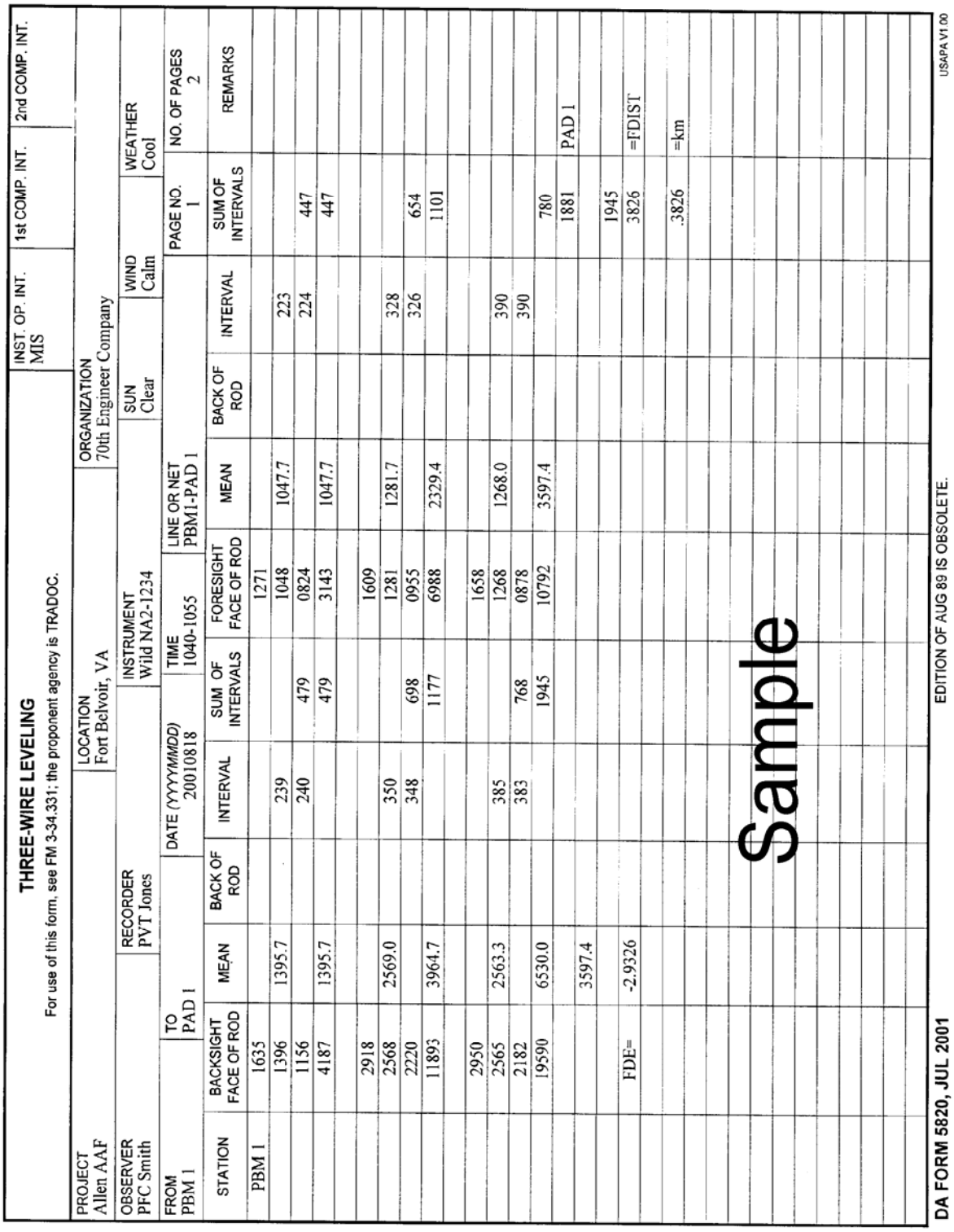
STATION	BACKSIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	FORESIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	REMARKS
1o	2a					2a					
	2b	4b		3a		2b	4b		3a		
	2c			3b	5	2c			3b	5	
	6a	6b			6c	6a	6b			6c	
	8a	8b			8c	8a	8b			8c	9
10b		11a								11c	
		11b								11d	
13a			13b			13d					
13c						13e					

Sample

DA FORM 5820, JUL 2001 EDITION OF AUG 89 IS OBSOLETE. USAPA V1.00

Figure 052-260-1228-1
Sample of DA Form 5820 With Block Numbers

Performance Steps



THREE-WIRE LEVELING

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

INST. OP. INT. MIS | 1st COMP. INT. | 2nd COMP. INT.

PROJECT: Allen AAF | LOCATION: Fort Belvoir, VA | ORGANIZATION: 70th Engineer Company

OBSERVER: PFC Smith | RECORDER: PVT Jones | INSTRUMENT: Wild NA2-1234 | SUN: Clear | WIND: Calm | WEATHER: Cool

FROM: PBM 1 | TO: PAD 1 | DATE (YYYYMMDD): 20010818 | TIME: 1040-1055 | LINE OR NET: PBM1-PAD 1 | PAGE NO.: 1 | NO. OF PAGES: 2

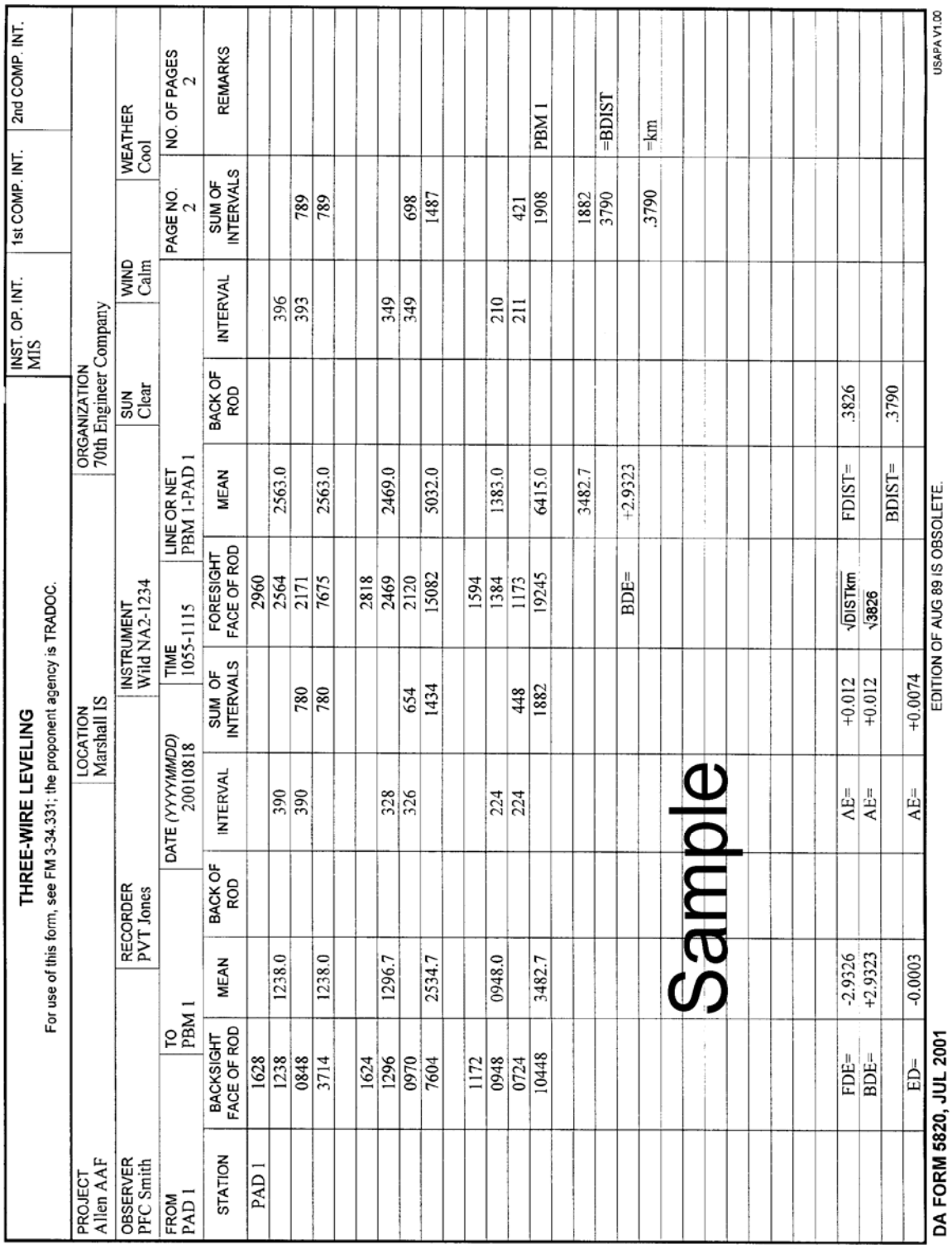
STATION	BACKSIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	FORESIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	REMARKS
PBM 1	1635					1271					
	1396	1395.7		239		1048	1047.7		223		
	1156			240	479	0824			224	447	
	4187	1395.7			479	3143	1047.7			447	
	2918					1609					
	2568	2569.0		350		1281	1281.7		328		
	2220			348	698	0955			326	654	
	11893	3964.7			1177	6988	2329.4			1101	
	2950					1658					
	2565	2563.3		385		1268	1268.0		390		
	2182			383	768	0878			390		
	19590	6530.0			1945	10792	3597.4			780	
										1881	PAD 1
		3597.4									
										1945	
	FDE=	-2.9326								3826	=FDIST
										.3826	=km

Sample

DA FORM 5820, JUL 2001 — EDITION OF AUG 89 IS OBSOLETE. — USAPA V1.00

Figure 052-260-1228-2
Completed Sample of DA Form 5820

Performance Steps



THREE-WIRE LEVELING

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

INST. OP. INT. MIS | 1st COMP. INT. | 2nd COMP. INT.

PROJECT: Allen AAF | LOCATION: Marshall IS | ORGANIZATION: 70th Engineer Company | WEATHER: Cool

OBSERVER: PFC Smith | RECORDER: PVT Jones | INSTRUMENT: Wild NA2-1234 | SUN: Clear | WIND: Calm | PAGE NO.: 2 | NO. OF PAGES: 2

FROM: PAD 1 | TO: PBM 1 | DATE (YYYYMMDD): 20010818 | TIME: 1055-1115 | LINE OR NET: PBM 1-PAD 1

STATION	BACKSIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	FORESIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	REMARKS
PAD 1	1628					2960					
	1238	1238.0		390		2564	2563.0		396		
	0848			390	780	2171			393	789	
	3714	1238.0			780	7675	2563.0			789	
	1624					2818					
	1296	1296.7		328		2469	2469.0		349		
	0970			326	654	2120			349	698	
	7604	2534.7			1434	15082	5032.0			1487	
	1172					1594					
	0948	0948.0		224		1384	1383.0		210		
	0724			224	448	1173			211	421	
	10448	3482.7			1882	19245	6415.0			1908	PBM 1
							3482.7			1882	
										3790	=BDIST
						BDE=	+2.9323				
										.3790	=km
	FDE=	-2.9326		AE=	+0.012	√DISTKm	FDIST=	.3826			
	BDE=	+2.9323		AE=	+0.012	√3826					
							BDIST=	.3790			
	ED=	-0.0003		AE=	+0.0074						

Sample

DA FORM 5820, JUL 2001 — EDITION OF AUG 89 IS OBSOLETE. — USAPA V1.00

Figure 052-260-1228-3
Completed Sample of DA Form 5820

Performance Steps

NOTE: Figure 052-260-1228-2 is a forward run, and Figure 052-260-1228-3 is a backward run.

a. The name of the project (block 1a).
b. The location of the project (block 1b).
c. The name of the organization doing the project (block 1c).
d. The rank and name of the instrument operator (block 1d).
e. The rank and name of the recorder (block 1e).
f. The type and serial number of the instrument being used (block 1f).
g. The type of day it is (for example, clear, overcast, or cloudy) (block 1g).
h. The type of wind (for example, calm, slight breeze, breezy, or windy) (block 1h).
i. The weather (for example, cold, cool, warm, or hot) (block 1i).
j. The name of the starting benchmark or the temporary benchmark for the section (block 1j).
k. The name of the closing benchmark or the temporary benchmark for the section (block 1k).
l. The full date (block 1l).
m. The starting time (24-hour system) and ending time (block 1m).
n. The name of the line or net (for example, WAAF net 1) (block 1n).

NOTE: Leave the sequential page-number block blank until the line, net, or section is completed.

o. The name of the starting benchmark or the temporary benchmark (for example, TRENO 4) (block 1o).

2. Enter the wire reading (in millimeters) for the backsight (BS) and the foresight (FS) observed (the BS is on the left side of the page and the FS is on the right side of the page).
   a. Top wire (largest numerical reading) (blocks 2a).
   b. Middle wire (blocks 2b).
   c. Bottom wire (blocks 2c).

3. Determine and enter the stadia intervals (no decimal).
   a. Subtract the middle-wire reading from the top-wire reading block and enter the sum in blocks 3a.
   b. Subtract the bottom-wire reading from the middle-wire reading and enter the sum in blocks 3b.

NOTE: The maximum allowable difference between steps 3a and 3b is +3. If the difference is greater, the readings must be reobserved.

4. Determine the mean reading by applying the correction to the middle-wire reading using the 3-7-10 rule.
   a. Use the scale to determine the correction to the middle-wire reading (see Table 052-260-1228-1).

Difference in Interval	Correction to Middle-Wire Reading
0	0.0
1	0.3
2	0.7
3	1.0

Table 052-260-1228-1
Correction to the Middle-Wire Reading

   b. Apply the correction to the middle-wire reading using the following guidance. If the top interval (step 3a) is larger than the bottom interval (step 3b), then the correction is added to the middle-wire reading. If the bottom interval (step 3b) is larger than the top interval (step 3a), then the correction is subtracted from the middle-wire reading. Enter this value in blocks 4b.

5. Determine and enter the sum of intervals (step 3a + 3b) in blocks 5.

Performance Steps

6. Compute the cumulative sums.
    a. Determine and enter the sum of the three wire readings (step 2a + 2b + 2c) in blocks 6a.
    b. Determine and enter the sum of the mean middle-wire readings in blocks 6b.
    c. Determine and enter the sum of intervals in blocks 6c.

NOTE: The difference between the BS sum of intervals and the FS sum of intervals (step 5) must not exceed 100 (a 10-meter stadia distance) at any time. If the difference is larger than 100, tell the operator to balance the sights by relocating the FS-rod position.

7. Repeat steps 2, 3, 4, 5, and 6.

8. Determine and enter the cumulative sums for all successive BS and FS readings.
    a. The total of all wire readings (blocks 8a).
    b. The total of all mean middle-wire readings (blocks 8b).
    c. The total of all sums of intervals (blocks 8c).

NOTE: The difference between the BS sum of intervals and the FS sum of intervals (step 8c) must not exceed 100 (a 10-meter stadia distance) at any time. When the difference between the sums of intervals is 30 (a 3-meter stadia distance), it is recommended that corrections be made to the FS by either lengthening or shortening the FS about one-half of the difference between the BS and the FS sum of intervals.

9. Enter the name of the closing benchmark or the temporary benchmark for the section (for example, TBM 1) in block 9.

NOTE: If more than one page of notes is required to reach the closing station, the cumulative totals (steps 8a, 8b, and 8c) must be carried over to the first line of the new page.

10. Perform a page check. A page check is required for each completed page of DA Form 5820 before transcribing running totals to the next page. It is also required upon completion of a section and is accomplished in the following manner:
    a. Divide the final sum of all wire readings (BS and FS [step 8a]) by three and compare this amount to the running total of the mean middle-wire sums (step 8b). A difference exceeding 0.1 indicates an error. Check all interim sums for math errors.
    b. Enter your initials to indicate a page check has been accomplished in block 10b.

11. Compute the differences in elevation and distance between the stations.
    a. Compare the total BS-mean middle-wire reading and the total FS-mean middle-wire reading (step 8b). Enter the smaller of the two directly below the larger in block 11a.
    b. Algebraically add the running total of the BS-mean middle-wire readings and the running total of the FS-mean middle-wire readings. Convert the total sums to meters by dividing by 1,000. Enter the result in meters with the proper sign and appropriately label it as the forward difference in elevation (FDE) for the forward run or as the backward difference in elevation (BDE) for the backward run. Record this value to four decimal places in block 11b.

NOTE: The BS is always positive (+) and the FS is always negative (-).

    c. Add the total sums of intervals of both the BSs and FSs (step 8c). Appropriately label the amount as the forward distance (F DIST) or as the backward distance (B DIST) and enter it in block 11c.
    d. Convert the total sum to kilometers by dividing it by 10,000 and record it to four decimal places in block 11d.

NOTE: This represents the one-way distance between the starting and closing stations of the section. The section must be observed in the reverse direction (backward run) to complete the line.

12. Perform the backward run by repeating steps 1 through 11 and recording all observations.

13. Compute and record the error of closure (EC) and the allowable error (AE) for the completed level line.
    a. Tabulate the one-way distances for the F DIST and B DIST runs of the section and circle the shorter of the two and enter the amount in block 13a.

Performance Steps

b. Tabulate the differences in elevation for the FDE and BDE runs of the section and enter this amount in block 13b.
c. Algebraically add the two DEs and list the sum as EC to represent the EC for the section. Record this sum to four decimal places in block 13c.
d. Determine the AE to third-order specification for the section and enter it in block 13d. Use the following formula:

   AE = ± 0.012 meters times the square root of the distance in Km.

   where--

   Km = Shortest one-way distance of the section in kilometers.
e. Truncate and enter the AE to four decimal places in block 13e. The section is "good" or has met the specifications if the EC is equal to or less than the value for the AE.
f. Conduct a final check. Both the instrument operator and the computers for the project will conduct a final check. Each person will initial the form in blocks 13f.

14. Initial the form in block 14.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to record level data.

Performance Measures	**GO**	**NO GO**
1. Entered administrative data on DA Form 5820.	____	____
2. Entered the wire readings (in millimeters) for the BS and FS observed.	____	____
3. Determined and entered the stadia intervals.	____	____
4. Determined the mean reading by applying the correction to the middle-wire reading.	____	____
5. Determined and entered the sum of intervals.	____	____
6. Computed the cumulative sums.	____	____
7. Repeated steps 2, 3, 4, 5, and 6.	____	____
8. Determined and entered the cumulative sums for all successive BS and FS readings.	____	____
9. Entered the name of the closing benchmark or temporary benchmark for the section.	____	____
10. Performed a page check.	____	____
11. Computed the differences in elevation and distance between the stations.	____	____
12. Performed the backward run by repeating steps 1 through 11 and recording all observations.	____	____
13. Computed and recorded the EC and AE for the completed level line.	____	____
14. Initialed the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5820	
DMS ST 031	

Measure the Difference in Elevation With a Level

052-260-1330

Conditions: As a topographic surveyor in a field location, during daylight hours with no precipitation, given an adjusted, a precise, a semiprecise, or a digital level with all accessories; a set of rods with all accessories; two survey benchmarks; two rodmen; a recorder; Department of the Army (DA) Form 5820, and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Measure the difference in elevation with a level. Operate the level and read the rods with accuracy. The readings must be sufficient to close a level line or loop within third-order specifications, according to DMS ST 031.

Performance Steps

1. Pace the correct distance.
    a. Set up the instrument about halfway between the two turning points.

NOTE: The distance between the instrument and the rods depends on the terrain but cannot exceed 90 meters. The backsight (BS) and foresight (FS) distances must be within 10 meters of each other.

    b. Place the tripod legs so that they are parallel to the line or are in a down-slope position if on a hill.

2. Level the bull's-eye bubble and say "Bubble leveled."

3. Sight on the rear rod and take three wire readings. Press the compensator button. Yell "Rod" to ready the rodman before the reading and "Relax" to relax the rodman after the reading.

4. Sight on the forward rod and take three wire readings. Yell "Rod" to ready the rodman before the reading and "Relax" to relax the rodman after the reading.

5. Verify the correctness of the rod reading with the recorder.
    a. Ensure that the rod intercepts agree to within ± 0.003 meters.
    b. Ensure that the BS and FS sums of intervals are within 10 meters. If the difference is larger than 10 meters, reposition the FS-rod position and reobserve.
    c. Ensure that the BS and FS sums of all previous "sums of intervals" balance within 10 meters.

6. Move the level crew to the next setup. If all reading and recording requirements have been met, the FS rodman remains in place. Signal the rear rodman and move the instrument forward for the next setup.

7. Repeat steps 1 through 6 until the level line is complete.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark two survey points at least 300 meters apart. The difference in elevation between the survey points must be known.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him the survey line to be leveled, the equipment to be used, and which personnel will assist in the leveling operation. Explain that scoring will be GO or NO-GO based on the correct lengths of sight, the correct leveling of the instrument, the correct three wire and back-of-rod readings, and the accuracy of the readings. Tell the soldier to measure the difference in elevation with a level.

Performance Measures	**GO**	**NO GO**
1. Paced the correct distance.	____	____

Performance Measures	GO	NO GO
2. Leveled the bull's-eye bubble and said "Bubble leveled."	____	____
3. Sighted on the rear rod and took three wire readings.	____	____
4. Sighted on the forward rod and took three wire readings.	____	____
5. Verified the correctness of the rod reading with the recorder.	____	____
6. Moved the level crew to the next setup.	____	____
7. Repeated steps 1 through 6 to complete the level line.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 5820	
DMS ST 031	

Compute a Differential Level Line

052-260-1340

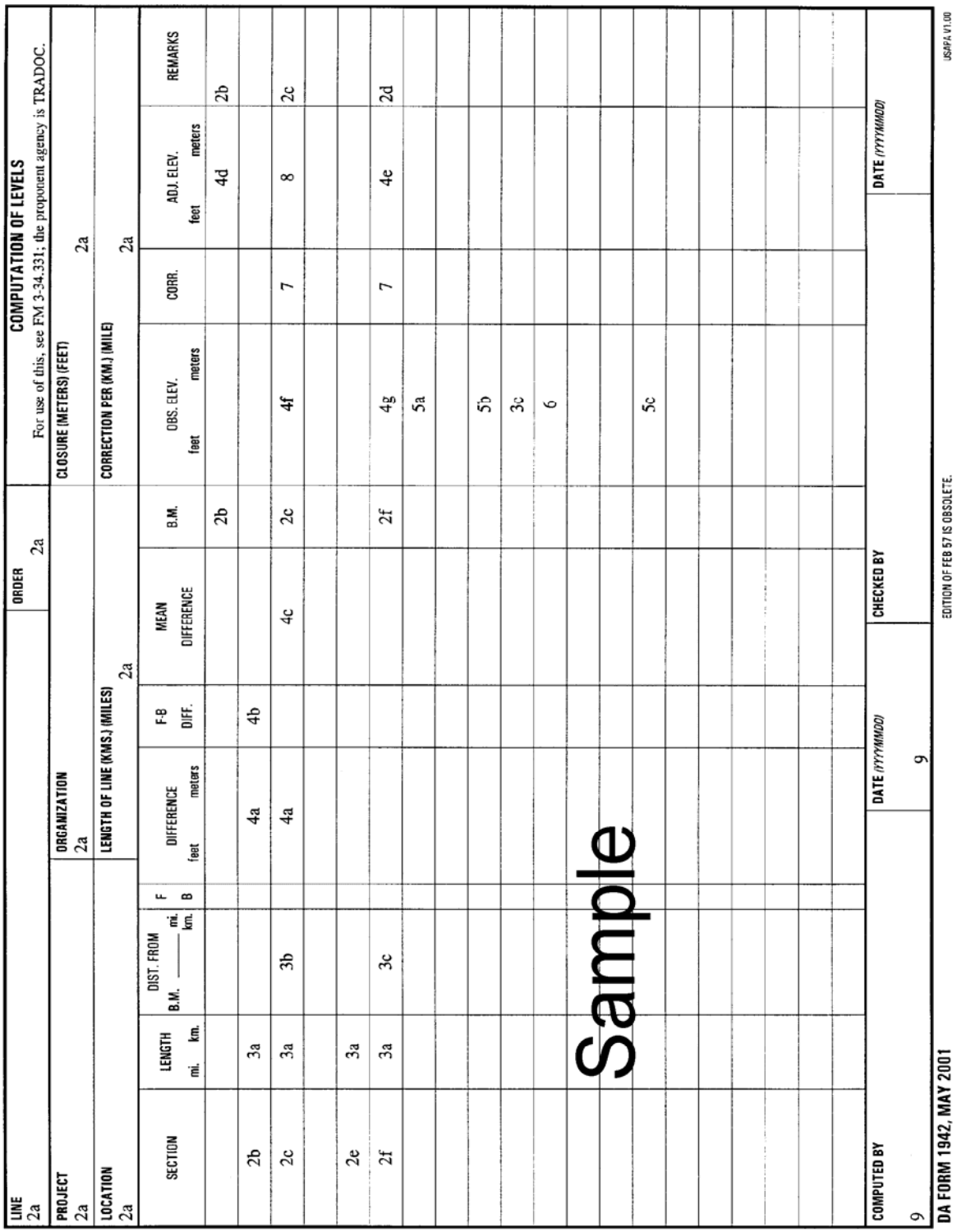
Conditions: As a topographic surveyor in a secure field environment, given a programmable calculator, field notes containing field observations for third-order double-run differential levels, and Department of the Army (DA) Form 1942.

Standards: Check the field notes for omissions and errors, abstract the field data, compute the error of closure (EC), and adjust the elevations of the intermediate stations. Compute the final elevation to three decimal places. All entries must be accurate, neat, and legible

Performance Steps

1. Check all field notes for omissions and errors. Correct any errors that are found.
2. Enter all administrative and known data on DA Form 1942 (Figures 052-260-1340-1 and 052-260-1340-2). Notify the supervisor if errors cause the rejection of the field data.

Performance Steps



LINE 2a | ORDER 2a | COMPUTATION OF LEVELS (For use of this, see FM 3-34.331; the proponent agency is TRADOC.)

PROJECT 2a | ORGANIZATION 2a | CLOSURE (METERS) (FEET) 2a

LOCATION 2a | LENGTH OF LINE (KMS.) (MILES) 2a | CORRECTION PER (KM.) (MILE) 2a

SECTION	LENGTH mi. km.	DIST. FROM B.M. ——— mi. km.	F B	DIFFERENCE feet meters	F-B DIFF.	MEAN DIFFERENCE	B.M.	OBS. ELEV. feet meters	CORR.	ADJ. ELEV. feet meters	REMARKS
							2b			4d	2b
2b	3a			4a	4b						
2c	3a	3b		4a		4c	2c	4f	7	8	2c
2e	3a										
2f	3a	3c					2f	4g	7	4e	2d
								5a			
								5b			
								3c			
								6			
								5c			

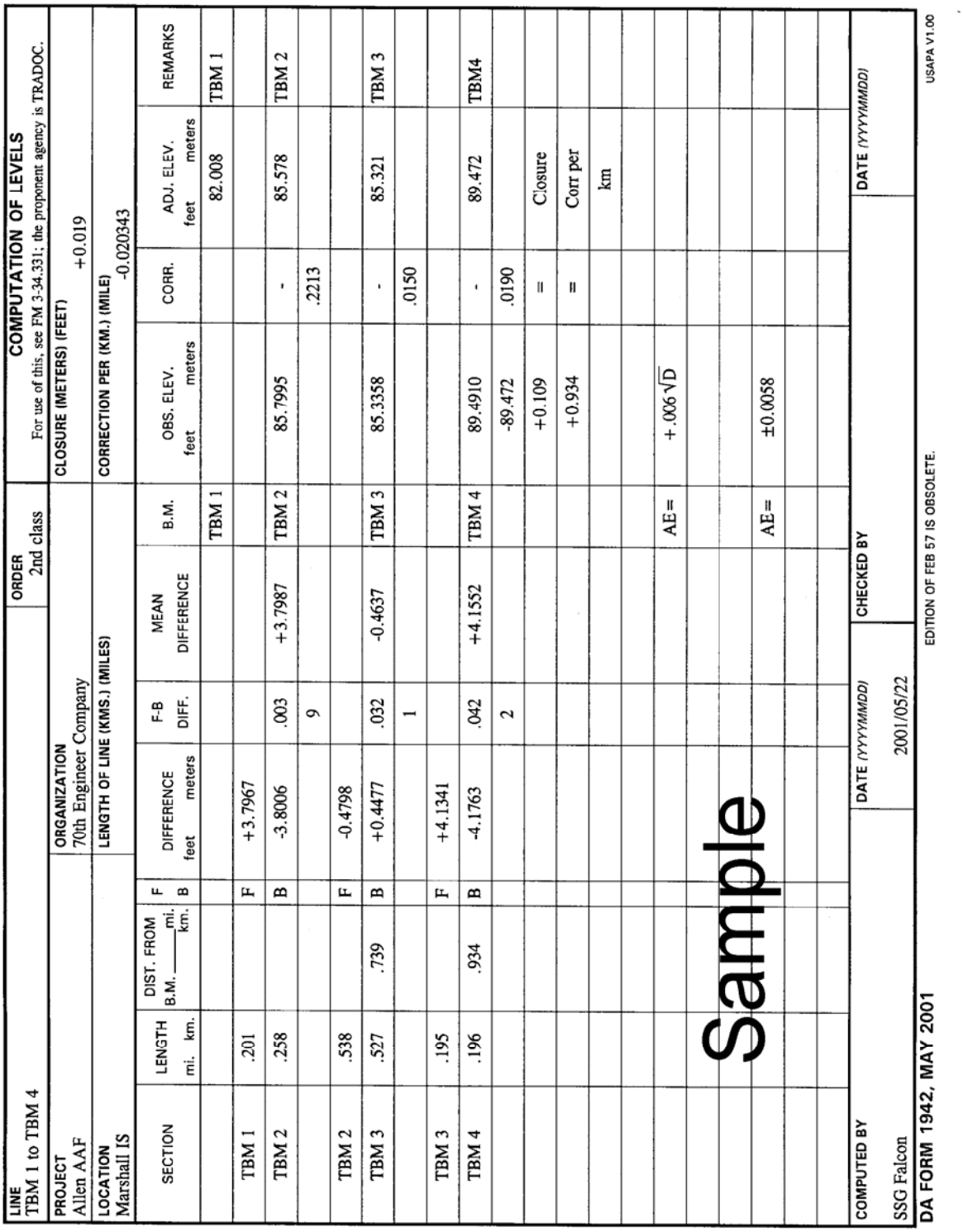
Sample

COMPUTED BY 9 | DATE (YYYYMMDD) 9 | CHECKED BY | DATE (YYYYMMDD)

DA FORM 1942, MAY 2001 | EDITION OF FEB 57 IS OBSOLETE. | USAPA V1.00

Figure 052-260-1340-1
Sample of DA Form 1942 With Block Numbers

Performance Steps



COMPUTATION OF LEVELS
For use of this, see FM 3-34.331; the proponent agency is TRADOC.

LINE: TBM 1 to TBM 4 | ORDER: 2nd class
PROJECT: Allen AAF | ORGANIZATION: 70th Engineer Company | CLOSURE (METERS) (FEET): +0.019
LOCATION: Marshall IS | LENGTH OF LINE (KMS.) (MILES): | CORRECTION PER (KM.) (MILE): -0.020343

SECTION	LENGTH mi. km.	DIST. FROM B.M. ____ mi. ____ km.	F B	DIFFERENCE feet meters	F-B DIFF.	MEAN DIFFERENCE	B.M.	OBS. ELEV. feet meters	CORR.	ADJ. ELEV. feet meters	REMARKS
							TBM 1			82.008	TBM 1
TBM 1	.201		F	+3.7967							
TBM 2	.258		B	-3.8006	.003	+3.7987	TBM 2	85.7995	-	85.578	TBM 2
					9				.2213		
TBM 2	.538		F	-0.4798							
TBM 3	.527	.739	B	+0.4477	.032	-0.4637	TBM 3	85.3358	-	85.321	TBM 3
					1				.0150		
TBM 3	.195		F	+4.1341							
TBM 4	.196	.934	B	-4.1763	.042	+4.1552	TBM 4	89.4910	-	89.472	TBM4
					2			-89.472	.0190		
								+0.109	=	Closure	
								+0.934	=	Corr per	
										km	
							AE=	+.006 $\sqrt{D}$			
							AE=	±0.0058			

Sample

COMPUTED BY: SSG Falcon | DATE (YYYYMMDD): 2001/05/22 | CHECKED BY | DATE (YYYYMMDD)

DA FORM 1942, MAY 2001 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.00

Figure 052-260-1340-2
Completed Sample of DA Form 1942

Performance Steps

a. Complete the headings (blocks 2a).
b. Enter the name of the beginning benchmark in blocks 2b.
c. Enter the name of the benchmark that the elevation is being computed for in blocks 2c.
d. Enter the name of the ending benchmark in block 2d.
e. Enter the name of the beginning benchmark for each section in block 2e.

NOTE: See blocks 2b for the first benchmark.

f. Enter the name of the ending benchmark for each section in blocks 2f.

NOTE: See block 2d for the ending benchmark.

g. Enter the direction of the run (forward or backward) in blocks 2g.

3. Compute and enter the length of each section to the nearest 0.001 kilometer.
   a. Abstract the length of the forward and backward runs per section and enter these amounts to the nearest 0.001 kilometer in blocks 3a (in their respective directions).
   b. Compute the length of the line by adding the shortest distance of each section of the level line and enter this amount in block 3b.
   c. Enter the total length of the line in blocks 3c.

4. Compute and enter the observed elevation for each benchmark to the nearest 0.0001 meter.
   a. Compute the observed difference in elevation (DE) of the forward and backward runs per section from the field notes. Enter these amounts to four decimal places with the sign in blocks 4a (in their respective running directions).
   b. Compute the DE between the forward and backward runs per section and enter this amount to four decimal places as an absolute value (no sign) in block 4b.
   c. Determine the mean DE by computing the absolute mean of the forward and backward DE. Enter the mean DE with the sign of the forward run to four decimal places (round the answers) in block 4c.
   d. Enter the known elevation of the beginning benchmark in block 4d.
   e. Enter the known elevation of the ending benchmark in block 4e.
   f. Compute the observed elevation by algebraically adding the mean DE (step 4c) and the known elevation of the beginning benchmark (step 4d). Enter this amount to four decimal places in block 4f.
   g. Compute each successive observed elevation by algebraically adding the respective section's mean DE to the preceding elevation (step 4f). Enter this amount to four decimal places in block 4g.

NOTE: The last entry will be the observed elevation of the ending benchmark, which must be compared to the fixed ending elevation.

5. Compute and enter the EC and the allowable error (AE) to the nearest 0.0001 meter.
   a. Enter the known elevation of the ending benchmark (from step 4e) in block 5a.
   b. Compute the closure by subtracting the known elevation of the ending benchmark (step 5a) from the computed observed elevation of the ending benchmark (step 4g). Enter this amount to four decimal places with the sign in block 5b.
   c. Compute and truncate the AE to four decimal places. Enter this amount in block 5c. For third-order specification, use the following formula:

      AE = ± 0.012 meters times the square root of the distance in Km.

      where--
      Km = the length of line in kilometers
   d. Compare the AE (step 5c) to the closure (step 5b).

NOTE: If the numerical value of the closure is equal to or smaller than the AE, then the level line meets third-order specifications. If it does not, there is no need to continue with the computations on DA Form 1942

Performance Steps

6. Compute the adjustment correction per kilometer to the nearest 0.000001 meter by dividing the closure (step 5b) by the total length of line (step 3c) and changing the sign. Enter this amount to six decimal places with the sign (round the answer) in block 6.
7. Compute the correction to each observed elevation to the nearest 0.0001 meter by multiplying the length of line (step 3b) of each section by the correction per kilometer (step 6). Enter this amount to four decimal places with the sign (round the answer) in blocks 7.
8. Compute the adjusted elevation of each benchmark to the nearest 0.001 meter by algebraically adding the correction (step 7) to the observed elevation (steps 4f and 4g) of each station. Enter this amount to three decimal places (round the answer) in block 8.
9. Sign and date the form in blocks 9.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to compute a differential level line.

Performance Measures	**GO**	**NO GO**
1. Checked all field notes for omissions and errors. Corrected any errors that were found.	____	____
2. Entered all administrative and known data on DA form 1942. Notified the supervisor if errors caused the rejection of the field data.	____	____
3. Computed and entered the length of each section to the nearest 0.001 kilometer.	____	____
4. Computed and entered the observed elevation for each benchmark to the nearest 0.0001 meter.	____	____
5. Computed and entered the EC and AE to the nearest 0.0001 meter.	____	____
6. Computed and entered the adjustment correction per kilometer to the nearest 0.000001 meter.	____	____
7. Computed and entered the correction to each observed elevation to the nearest 0.0001 meter.	____	____
8. Computed and entered the adjusted elevation of each benchmark to the nearest 0.001 meter.	____	____
9. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1942	

Subject Area 5: Differential Global Positioning System

Collect Data With Differential Global-Positioning-System (DGPS) Equipment
052-260-1401

Conditions: As a topographic surveyor in a field environment, given a global-positioning-system (GPS) receiver with accessories, a tripod, a tribrach, a plumb bob, a tape measure, a four-section, collapsible height-of-instrument (HI) rod, a GPS recording sheet as prescribed by the unit's standing operating procedure (SOP), and Defense Mapping School (DMS) Special Text (SP) 005 and 097.

Standards: Collect data with the DGPS equipment. Set up the antenna over a prestablished point and connect all cables to the receiver. Operate the DGPS receiver by performing the standing operating procedure (SOP) required to collect data for a static GPS survey.

Performance Steps

1. Transport the equipment to the work site.
   a. Place the receiver in the antenna container to transport it for static operations.
   b. Ensure that the following equipment, which is needed for static operations, is in large shipping container.
      (1) A 4,000 MSGR with a battery tray.
      (2) A compact L1/L2 with a ground-plane (GP) antenna.
      (3) Camcorder batteries.
      (4) 10-ampere-hour batteries.
      (5) A tribrach with an optical plummet device.
      (6) A two-piece tribrach adapter.
      (7) A compass.
      (8) Antenna cable.
      (9) An HI rod.
      (10) An adjustable-leg tripod.

2. Set up the antenna.
   a. Set up the tripod and ensure that it is plumb over the station.
   b. Remove the tripod cover and secure it.
   c. Place and secure the tribrach on the tripod.
   d. Accurately plumb the tribrach over the station and level it using the tribrach's circular bubble.
   e. Mount and lock the antenna platform using the two-piece tribrach adapter on the tribrach.
   f. Orient the antenna to the north.
   g. Tighten the horizontal clamp on the tribrach adapter to prevent the antenna from moving.
   h. Attach the antenna cable to the receiver and the antenna.
   i. Check the tribrach's level bubble and relevel, if necessary.

3. Enter administrative data on the recording sheet.

4. Measure and record the antenna's height on the recording sheet.

NOTE: The height of the antenna can be measured by using a four-section collapsible HI rod or a tape measure. Use steps 4a through e when using the HI rod and steps 4f through h when using the tape measure. Indicate the method used to measure the HI.

   a. Assemble the four-section collapsible HI rod.
   b. Place the point of the HI rod at the center of the station.
   c. Read the HI-rod graduations from the bottom inside edge of the notches.

Performance Steps

d. Measure the HI three times using three diametrically opposite holes to confirm the HI and enter this information on the recording sheet. Check the antenna to see if it is level. All three measurements should be within 1 millimeter of each other. If they are not, relevel the antenna and remeasure the HI.
e. Measure the HI once in feet for verification.
f. Have an assistant hold the end of a tape measure on the station and measure to the bottom inside edge of the notches.
g. Measure the HI three times using three sides of the antenna to confirm the HI and to check the level and enter this information on the recording sheet.
h. Measure the HI once in feet for verification.

5. Interconnect all required components.
   a. Remove the antenna cable and unroll it to its full length.
   b. Connect one end of the cable to the antenna and the other end to the receiver.
   c. Ensure that there are at least two camcorder batteries in the receiver. Connect one 10-ampere-hour battery to power port 1.

6. Set up the receiver.
   a. Turn on the receiver about 10 minutes before the session.
   b. Set the MSGR into the Standard-Positioning-Service (SPS) mode if not selected.
      (1) Press the CLEAR button.
      (2) Press the CONTROL button.
      (3) Go to menu 7 of 8.
      (4) Select L1/L2 OPERATION.
      (5) Change L2 TRACKING to the PE-SPS mode.
      (6) Press the ENTER button.
      (7) Press the STATUS button.

NOTE: The receiver is now locked onto the satellite vehicles (SVs).

   c. Press the LOG DATA button.
   d. Select MORE.
   e. Select SETUP SURVEY CONTROLS.
   f. Select MODIFY QUICK/START CONTROLS.

NOTE: Normally, the settings should be as follows:

ELEV MASK 15°
MIN SVS 03
MEAN SYNC TIME 15.0 SEC

   g. Select ACCEPT.
   h. Select MORE.

NOTE: The MSGR must be manually set to the SPS mode every time the receiver is turned on unless keyed.

7. Operate the receiver to collect static data by selecting QUICK START NOW.

NOTE: The screen should say "STARTED SURVEY." Monitor the receiver until it is time to end the survey.

8. Enter the site data into the receiver.
   a. Press the LOG DATA button.
   b. Select CHANGES.
   c. Select ANTENNA HEIGHTS.
   d. Enter the following information:

      ANT HEIGHT:
      MEAS TYPE: UNCORRECTED
      ANT TYPE: COMPACT L1/L2 W/GP
      ANT SERIAL:

Performance Steps

e. Select ACCEPT.
f. Select FILE NAME.
g. Enter the four-character station name, the Julian day, and the session number (EX-GPS5-045-1).
h. Select ACCEPT.

9. Enter the site data on the recording sheet.
   a. Press the STATUS button.
   b. List any problems with the receiver on the recording sheet.

10. End the survey.
    a. Remeasure and record the HI on the recording sheet.
    b. Press the LOG DATA button.
    c. Make changes to the file name and the antenna's height, if necessary.
    d. Select END SURVEY.
    e. Select YES.
    f. Turn off the receiver and store it in the correct storage container.

11. Disconnect all components.
    a. Disconnect the antenna from the receiver and replace the caps.
    b. Disconnect the 10-ampere-hour battery from the receiver and replace the caps.
    c. Disconnect the antenna cable from the antenna, replace the caps, and roll the cable from the antenna to the receiver (do not kink the cable).
    d. Remove the antenna, adapter, and tribrach from the tripod.
    e. Place all equipment in the correct storage container.
    f. Place the cap on the tripod and return it to the travel configuration.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to collect data with the DGPS equipment.

Performance Measures	**GO**	**NO GO**
1. Transported the equipment to the work site.	____	____
2. Set up the antenna.	____	____
3. Entered administrative data on the recording sheet.	____	____
4. Measured and recorded the antenna's height on the recording sheet.	____	____
5. Interconnected all required components.	____	____
6. Set up the receiver.	____	____
7. Operated the receiver to collect static data.	____	____
8. Entered the site data into the receiver.	____	____
9. Entered the site data on the recording sheet.	____	____
10. Ended the survey.	____	____
11. Disconnected all components.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS ST 005	
DMS ST 097	

Collect Site Information for Differential Global-Positioning-System (DGPS) Planning

052-260-1406

Conditions: As a topographic surveyor in a field environment, given a project directive or an operation order (OPORD), instructions on global positioning system (GPS) survey planning, an inclinometer, a recording sheet as prescribed by the unit's standing operating procedure (SOP), a station-description form for each station to be surveyed, a military map containing the points to be surveyed, a compass, a 30-meter tape measure, and Defense Mapping School (DMS) Special Text (ST) 005.

Standards: Collect site information for DGPS planning. Plan the survey according to the guidelines set forth in the unit's recommended procedures and the specifications contained in the DMS ST 005.

Performance Steps

1. Read and comply with the project directive or OPORD.
2. Obtain station descriptions for all points to be included in the survey.
3. Recover all stations. Ensure that they have not been disturbed.
4. Enter administrative data for the station on the recording sheet. Provide data for each station that has obstructions that fall above the 15° elevation.
   a. The station name.
   b. The agency.
   c. The observer.
   d. The date.
   e. The observer's height in feet.
   f. The map scale.
   g. The map sheet.
   h. The elevation of the station.
   i. The latitude and longitude, to include the datum.
5. Perform and record observations on the recording sheet.
   a. Identify the possible obstructions to the observation.
   b. Measure and record the azimuth in degrees and minutes to the center, left edge, and right edge of the object using a compass.
   c. Measure and record the vertical angle (VA) in degrees and minutes to the center, left edge, and right edge of the object using an inclinometer.
   d. Describe the object.
   e. Record multiple measurements for the entire area that a large object covers.

NOTE: Continue observations for all possible obstructing objects.

6. Plot the observations on the recording sheet.
   a. Plot each individual point observed in terms of azimuth and elevation.
   b. Connect the perimeter of the points.
   c. Shade in the enclosed area of the obstructing object.
7. Identify and record possible radio or multipath problems on the recording sheet. Note any large object that may cause a problem with the multipath.
8. Reconnoiter the route between all points to be surveyed. Identify any overhead obstructions that would prohibit the use of the kinematic survey method on the recording sheet.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to collect site information for DGPS planning.

Performance Measures	**GO**	**NO GO**
1. Read and complied with the project directive or OPORD.	____	____
2. Obtained station descriptions for all points to be included in the survey.	____	____
3. Recovered all stations and ensured that they were not disturbed.	____	____
4. Entered administrative data for the station on the recording sheet.	____	____
5. Performed and recorded observations on the recording sheet.	____	____
6. Plotted the observations on the recording sheet.	____	____
7. Identified and recorded listed possible radio or multipath problems on the recording sheet.	____	____
8. Reconnoitered the route between all points to be surveyed. Identified any overhead obstructions that would prohibit the use of the kinematic survey method on the recording sheet.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS ST 005	

Skill Level 2

Subject Area 1: General

Perform Operator Maintenance on Theodolites

052-260-2338

Conditions: As a topographic surveyor in a secure field environment, given a theodolite (with all accessories and the applicable technical manuals [TMs]), an area with at least 100 meters visibility, and appropriate cleaning materials.

Standards: Perform operator maintenance on a theodolite according to the applicable TMs and make any adjustments that are necessary.

Performance Steps

1. Wipe off the instrument with a clean, dry, lint-free cloth.
   a. Take the instrument indoors after being used in moist weather.
   b. Open the transport case and remove the instrument.
   c. Allow the instrument to dry naturally.
   d. Allow condensation on the lenses to evaporate naturally.
2. Clean the lenses with lens cleaning tissue and solution.
   a. Use caution when removing dust or sand from the lenses and reflectors.
   b. Never use a coarse or dirty cloth or hard paper.
   c. Use an antistatic lens paper, cotton wad, or lens brush (if possible).
3. Inspect the instrument for damage or wear.
   a. Visually inspect the instrument for broken or missing parts.
   b. Check for cracked or scratched lenses or mirrors.
4. Clean the carrying case and replace the desiccant.
   a. Open and remove the instrument.
   b. Turn the case over and shake out any loose dust and dirt.
   c. Check the exterior for damage.
   d. Inspect the clamps, locks, and carrying straps for defects.
   e. Inspect the desiccant for discoloration.
   f. Clean the case, as required.
5. Test all the controls for correct operation.
   a. Rotate the three leveling foot screws and ensure that they turn freely and are stable.
   b. Inspect the telescope and horizontal clamps for improper operation.
   c. Inspect the horizontal and vertical slow-motion screws for improper operation.
   d. Inspect the reticle for smooth operation.
   e. Inspect the telescope's focusing mechanism for smooth operation.
6. Test the horizontal and vertical collimation. Test the horizontal and vertical collimation according to task 051-260-1134 or the appropriate TM.
7. Inspect the battery and connection accessories, if appropriate.
   a. Inspect the battery for damage.
   b. Inspect all electrical contacts for loose connections or corrosion.
   c. Inspect the connecting cables for insecure or damaged plugs and cracked or frayed insulation.
8. Adjust the plate level, if needed.
   a. Bring the plate level to as near center as possible.
   b. Correct one-half of the bubble error by turning the foot screw.
   c. Turn the plate level to correct the other half of the error using an adjustment pin.

Performance Steps

d. Repeat steps 8a through 8c until the plate bubble remains centered regardless of the position the theodolite is traversed.

9. Adjust the circular level, if needed.
   a. Level the theodolite.

NOTE: Level the theodolite using the fine-tune electronic compensator or the plate level, as applicable.

   b. Adjust the three leveling foot screws to bring the bubble to center if the circular-level bubble is not centered in the vial.

10. Adjust the optical plumb, if needed.
    a. Set up the instrument according to task 051-260-1134 or the appropriate TM.
    b. Observe the station point through the optical plummet.
    c. Use an adjusting pin to horizontally and vertically center the point if the station point is not centered in the circular marks with the crosshair mark.
    d. Make sure that the adjustment mechanism is tightened when the station point is centered.

11. Adjust the tension on the three leveling foot screws, if needed.

12. Test the instrument's lighting system.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select and mark a well-defined point about 100 meters from the instrument at about instrument height. Have on hand a theodolite with all accessories and appropriate cleaning materials.

Brief Soldier: Give the soldier a safety briefing before starting the test. Identify the equipment, cleaning materials, and the point to be used for checking the horizontal collimation and the vertical crosshair. Explain that scoring will be GO or NO-GO based on the proper cleaning of the instrument and the checking of the horizontal collimation and the vertical crosshair. Tell the soldier to perform operator maintenance on a theodolite.

Performance Measures	**GO**	**NO GO**
1. Wiped off the instrument with a clean, dry, lint-free cloth.	____	____
2. Cleaned the lenses with lens cleaning tissue and solution.	____	____
3. Inspected the instrument for damage or wear.	____	____
4. Cleaned the carrying case and replaced the desiccant.	____	____
5. Tested all the controls for correct operation.	____	____
6. Tested the horizontal and vertical collimation.	____	____
7. Inspected the battery and connection accessories, if it was appropriate.	____	____
8. Adjusted the plate level, if it was needed.	____	____
9. Adjusted the circular level, if it was needed.	____	____
10. Adjusted the optical plumb, if it was needed.	____	____
11. Adjusted the tension on the three leveling foot screws, if it was needed.	____	____
12. Tested the instrument's lighting system.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
	TM 5-6675-332-10

Supervise Operator Maintenance of Survey Equipment

052-260-2340

Conditions: As a topographic surveyor in a secure field location, during daylight hours with no precipitation, given either a traverse, a global-positioning system (GPS), or leveling survey equipment; a tripod; appropriate accessories; the maintenance manual or applicable technical manual (TM) for the equipment; the appropriate cleaning materials; an adjusting pin; an instrument operator; and Department of the Army (DA) Form 2404.

Standards: Supervise the soldier performing preventative maintenance and checks. Instruct the operator to correct only operator-level faults and record all uncorrectable faults on DA Form 2404. Perform a final inspection on the equipment.

Performance Steps

1. Assign personnel to perform maintenance on the survey equipment according to the maintenance manual or applicable TM.
2. Instruct the operator to perform troubleshooting according to the maintenance checklist for the equipment during or after operations.
3. Instruct the operator to clean the equipment and accessories.
4. Instruct personnel to perform calibration checks for the equipment.
5. Ensure that the operator performs only operator-level maintenance.
    a. Inventory of all the equipment components and accessories.
    b. Wipe the dirt and dust from all components with a dry cloth.
    c. Clean glass surfaces with lens cleaning tissue.
    d. Inspect the exterior of the equipment for damage, cracks, and wear.
    e. Check the motion locks and ensure that the controls rotate freely and function properly.
    f. Inspect the tribrach and tribrach leveling screws for damage. Clean as required.
    g. Inspect the tripod, bayonet screw, and other screws and nuts for damage. Clean and tighten, as required.
    h. Inspect the transport case.
        (1) Open and remove the instrument.
        (2) Turn the case over and shake out any loose dust and dirt.
        (3) Check the exterior for damage (cracks, broken hinges, broken latches, and so forth).
        (4) Clean the case as required.
    i. Store the equipment in its transport case.
6. Inspect the operator's maintenance and instrument tests.
7. Instruct the operator to list uncorrectable faults on DA Form 2404.
8. Perform a final inspection on the equipment.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Have on hand either a traverse, a GPS, or leveling equipment; a tripod; the maintenance manual or applicable TM for the equipment; the appropriate cleaning materials; an adjusting pin; a blank sheet of paper; and an assistant trained according to task 051-260-1131 to act as an instrument operator. In order to perform the instrument tests, this task must be done outside during daylight hours.

Brief Soldier: Give the soldier a safety briefing before starting the test. Identify the equipment and the

instrument operator. Explain that scoring will be GO or NO-GO based on the successful completion of all performance measures. Tell the soldier to supervise operator maintenance of the survey equipment.

Performance Measures	**GO**	**NO GO**
1. Assigned personnel to perform maintenance on the survey equipment according to the maintenance manual or applicable TM.	____	____
2. Instructed the operator to perform troubleshooting according to the maintenance checklist for the equipment during or after operations.	____	____
3. Instructed the operator to clean the equipment and accessories.	____	____
4. Instructed personnel to perform calibration checks on the equipment.	____	____
5. Ensured that the operator performed only operator-level maintenance.	____	____
6. Inspected the operator's maintenance and instrument tests.	____	____
7. Instructed the operator to list uncorrectable faults on DA Form 2404.	____	____
8. Performed a final inspection on the equipment.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 2404	TM 5-6675-332-10

Compute the Instrument Constant for Electronic Distance-Measuring Equipment
052-260-2460

Conditions: As a topographic surveyor in a level and secure field environment, during daylight hours with no precipitation, given a pair of EDMEs with horizontal distances measured, tripods and accessories, power sources, Department of the Army (DA) Forms 5819 and 1962, scratch paper, a scientific calculator, and a survey party.

Standards: Compute a calibration constant which agrees with the precomputed calibration. Verify all measured distances to ensure that they meet the allowable error.

Performance Steps

1. Compute the individual determination for the calibration constant from the following expressions on DA Form 1962 (Figure 052-260-2460-1):

Performance Steps

PROJECT: Example		TABULATION OF GEODETIC DATA For use of this form, see FM 3-34.331; the proponent agency is TRADOC.		
LOCATION: Luckytown		ORGANIZATION: Engineer Company		
STATION				
D(0-50) - D(50-100)	=	49.997 - 49.998	=	-0.001 = Z1
D(0-200) - D(0-100)	- D(100-200) =	199.995 - 99.996	- 99.997 =	0.002 = Z2
D(0-300) - D(0-150)	- D(150-300) =	299.993 - 149.996	- 149.995 =	0.002 = Z3
D(0-400) - D(0-200)	- D(200-400) =	399.992 - 199.995	- 199.996 =	0.001 = Z4
D(0-500) - D(0-250)	- D(250-500) =	499.992 - 249.996	- 249.995 =	0.001 = Z5
D(0-600) - D(0-300)	- D(300-600) =	599.990 - 299.993	- 299.994 =	0.003 = Z6
	Mean calib constant	= (Z1 + Z2 + Z3 +	Z4 + Z5 + Z6) / 6	
		= ((-0.001) + 0.002	+ 0.002 + 0.001 +	0.001 + 0.003) / 6
		= (0.008) / 6		
		= 0.001		
	NOTE: No	distances deviate from	the mean by more than	0.002 meters.
TABULATED BY: SSG J. Zambrano	DATE (YYYYMMDD): 2001/05/22	CHECKED BY		DATE (YYYYMMDD)

Sample

DA FORM 1962, FEB 57 — EDITION OF FEB 57 IS OBSOLETE. — USAPA V1.01

Figure 052-260-2460-1
Completed Sample of DA Form 1962

Performance Steps

NOTE: D is the distance measured (in meters) and Z is the calibration constant.

a. D(0-50) - D(50-100) = Z1
b. D(0-200) - D(0-100) - D(100-200) = Z2
c. D(0-300) - D(0-150) - D(150-300) = Z3
d. D(0-400) - D(0-200) - D(200-400) = Z4
e. D(0-500) - D(0-250) - D(250-500) = Z5
f. D(0-600) - D(0-300) - D(300-600) = Z6

2. Compute the mean calibration constant for Z1 through Z6.
3. Remeasure any rejected distances. Tell the survey party which distances deviate from the mean by more than 0.02 meters and have them remeasure those.
4. Record the calibration constant on DA Form 5819 (Figures 052-250-2460-2).

Performance Steps

FIELD SHEET, INFRARED

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT: Example					
ORGANIZATION: Engineer Company			DATE (YYYYMMDD): 20010522	APPROXIMATE DISTANCE: 1.5 km	
ZERO CORRECTION*	CALIBRATION DATE (YYYYMMDD): 20010522	OBSERVER: SPC Doe		RECORDER: SGT Smith	
INSTRUMENT STATION: Here	H.I.: 1.592 m	ELEVATION: 102.733	ELEVATION INSTRUMENT: 104.325	ECCENTRICITY* TOWARD: AWAY:	INST. NO.: 1
REFLECTOR STATION: There	H.T.: 1.416 m	ELEVATION: 103.139	ELEVATION REFLECTOR: 104.555	ECCENTRICITY* TOWARD: AWAY:	PRISM. NO.: 1

METEOROLOGICAL READINGS

TIME	PRESSURE (Hg) IN. MM.	TEMP. (DRY) F° C°
INSTRUMENT	762	44.6
REFLECTOR	761	48.2
SUM	1523	92.8
MEAN	761.5	46.4
CORRECTION FACTOR (PPM)		

PRODUCT = UD x PPM
RC = PRODUCT x 10^{-6}
T = UD ± Z ± RC
H' = $(T)^2 - (d)^2$
H' = SIN ZD x T
H_R = H' x 3.280840

ZD INSTRUMENT TO REFLECTOR

	DISTANCE (Meters)	
1	49	999
2		998
3		998
4		999
5		997
6		998
7		999
8		996
9		997
10	49	998
SUM	499	979

UD		MEAN UNCORRECTED SLOPE DISTANCE (UD)	49	998
PPM	42	ZERO CORRECTION° (Z)	*0.001	
PRODUCT		REFRACTIVE INDEX CORRECTION (RC)		
RC		CORRECTED SLOPE DISTANCE (T)	49	998
DIFF. OF ELEV. (d)	0.230	UNCORRECTED HORIZON DISTANCE (H')	49	997
°Obtained from Instrument Calibration. *Toward Eccentricity must be ADDED. Away Eccentricity must be SUBTRACTED.		ECCENTRIC CORRECTION* (EC)		
		HORIZON DISTANCE (H_m) / (H_{F_T})		

REMARKS

Sample

COMPUTED BY: SSG D. Jones	DATE (YYYYMMDD): 20010522
CHECKED BY	DATE (YYYYMMDD):

DA FORM 5819, JUN 2001 — Page _____ of _____ — USAPA V1.00

Figure 052-260-2460-2
Completed Sample of DA Form 5819

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Select an area that is level or of constant slope for a distance of about 700 meters. Mark 10 stations at the approximate distances prescribed (no taping is necessary): station 1: 0 meters, station 2: 50 meters, station 3: 100 meters, station 4: 150 meters, station 5: 200 meters, station 6: 250 meters, station 7: 300 meters, station 8: 400 meters, station 9: 500 meters, station 10: 600 meters. Obtain the assistance of two instrument operators who are qualified according to task 051-260-1326 and two recorders who are qualified according to task 051-260-1225. Measure the following distances: 0 to 50 meters, 0 to 100 meters, 0 to 150 meters, 0 to 200 meters, 0 to 250 meters, 0 to 300 meters, 50 to 100 meters, 100 to 200 meters, 150 to 300 meters, 200 to 400 meters, 250 to 500 meters, and 300 to 600 meters. Reduce the distance to horizontal.

Brief Soldier: Tell the soldier that all distances received are horizontal and that it is not necessary to check NIMA Form 8900-2. Give him a safety briefing before starting the test. Show him the work area and all equipment and personnel. Explain that scoring will be GO or NO-GO based on the successful completion of all performance measures. Tell the soldier to compute the instrument constant for the EDME.

Performance Measures	**GO**	**NO GO**
1. Computed the individual determination for the calibration constant for the prescribed distances.	____	____
2. Computed the mean calibration constant.	____	____
3. Remeasured any rejected distances.	____	____
4. Recorded the calibration constant on DA Forms 5819 and 1962.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1962	DMS ST 031
DA FORM 5819	TM 5-6675-332-10

Convert Universal Transverse Mercator (UTM) Grid Coordinates to Geodetic Coordinates 052-260-2466

Conditions: As a topographic surveyor in a secure field environment, given the UTM grid coordinates of a point, a scientific calculator, a desktop personal computer (PC) with the National Imagery Mapping Agency (NIMA) Tables Program, instructions on how to convert coordinates, Technical Manual (TM) 8358.1, and Department of the Army (DA) Form 1933.

Standards: Convert the UTM grid coordinates to geodetic coordinates. Enter all factors to eight decimal places. Take tabular values VII, VIII, IX, X, D6, and E5 from the appropriate spheroid tables and record them to the same decimal places as given in the tables. Compute the final grid position to three decimal places. All entries and computations must be accurate, neat, and legible.

Performance Steps

1. Fill in the headings on DA Form 1933 (Figures 052-260-2466-1 and 052-260-2466-2).

Performance Steps

PROJECT 1a	GEOGRAPHIC COORDINATES FROM U.T.M. GRID COORDINATES For use of this form, see FM 3-34.331; the proponent agency is TRADOC.				
LOCATION 1a	ORGANIZATION 1a				
ELLIPSOID	CENTRAL MERIDIAN	ZONE	UNIT	FE	

STATION 1b	CM 1c(1)	ELLIPSOID 1c(2)	ZONE 1c(3)	STATION	CM	ELLIPSOID	ZONE

N	1b	E	1b	N		E	
N'	2a	E'	2b	N'		E'	
φ'	6n	IX	7f	φ'		IX	
VII	7e	q	3	VII		q	
q^2	4	X	7f	q^2		X	
VIII	7e	q^3	4	VIII		q^3	
q^4	4	E_5	7f	q^4		E_5	
D_6	7e	q^5	4	D_6		q^5	
q^6	4	Δλ"	11	q^6		Λλ"	
Δφ"	8 9	Δλ	12	Δφ"		Δλ	
φ	10	λ	13	φ		λ	

STATION	CM	ELLIPSOID	ZONE	STATION	CM	ELLIPSOID	ZONE

N		E		N		E	
N'		E'		N'		E'	
φ'		IX		φ'		IX	
VII		q		VII		q	
q^2		X		q^2		X	
VIII		q^3		VIII		q^3	
q^4		E_5		q^4		E_5	
D_6		q^5		D_6		q^5	
q^6		Δλ"		q^6		Λλ"	
Δφ"		Δλ		Δφ"		Δλ	
φ		λ		φ		λ	

N' = N in NORTHERN HEMISPHERE
N' = 10,000,000.000 - N in SOUTHERN HEMISPHERE
E' = E - FE or FE - E q = 0.000001 * |E'|
Δφ" = (VII) q^2 - (VIII) q^4 + (D_6) q^6 φ' = φ' - Δφ
Δλ" = (IX) q - (x) q^3 + (E_5) q^5 λ = CM + λ or CM - λ

Sample

COMPUTED BY 14	DATE (YYYYMMDD) 14	CHECKED BY	DATE (YYYYMMDD)

DA FORM 1933, JUL 2001 EDITION OF FEB 1957 IS OBSOLETE. USAPA V1.00

Figure 052-260-2466-1
Sample of DA Form 1933 With Block Numbers

Performance Steps

PROJECT	GEOGRAPHIC COORDINATES FROM U.T.M. GRID COORDINATES							
Example	For use of this form, see FM 3-34.331; the proponent agency is TRADOC.							
LOCATION	ORGANIZATION							
Fort Belvoir, VA	DMS							
ELLIPSOID	CENTRAL MERIDIAN			ZONE	UNIT		FE	
STATION	CM	ELLIPSOID	ZONE	STATION	CM	ELLIPSOID	ZONE	
BHTW 36° 43'		WGS84	17S-81					
N	4070658.696	E	279412.593	N		E		
N'	4070658.696	E'	220587.407	N'		E'		
φ'	36° 46' 54.205"	IX	40345.286	φ'		IX		
VII	1900.435	q	0.220587407	VII		q		
q^2	0.04865880	X	350.211	q^2		X		
VIII	25.883	q^3	0.01073352	VIII		q^3		
q^4	0.00236768	E_5	5.709	q^4		E_5		
D_6	0.400	q^5	0.00052228	D_6		q^5		
q^6	0.00011521	Δλ"	8895.906	q^6		Δλ"		
Δφ"	00° 01' 32.412" 92.412"	Δλ	02° 28' 15.906"	Δφ"		Δλ		
φ	36° 45' 21.793"	λ	-83° 28' 15.906"	φ		λ		
STATION	CM	ELLIPSOID	ZONE	STATION	CM	ELLIPSOID	ZONE	
N		E		N		E		
N'		E'		N'		E'		
φ'		IX		φ'		IX		
VII		q		VII		q		
q^2		X		q^2		X		
VIII		q^3		VIII		q^3		
q^4		E_5		q^4		E_5		
D_6		q^5		D_6		q^5		
q^6		Δλ"		q^6		Δλ"		
Δφ"		Δλ		Δφ"		Δλ		
φ		λ		φ		λ		

N ' = N in NORTHERN HEMISPHERE
N ' = 10, 000,000.000 - N in SOUTHERN HEMISPHERE
E ' = E - FE or FE - E q = 0.000001 * | E ' |
Δφ" = (VII) q^2 - (VIII) q^4 + (D_6) q^6 φ' = φ' - Δφ
Δλ" = (IX) q - (x) q^3 + (E_5) q^5 λ = CM + λ or CM - λ

Sample

COMPUTED BY	DATE (YYYYMMDD)	CHECKED BY	DATE (YYYYMMDD)
SSG Zambrano	20010818		

DA FORM 1933, JUL 2001 EDITION OF FEB 1957 IS OBSOLETE. USAPA V1.00

Figure 052-260-2466-2
Completed Sample of DA form 1933

Performance Steps

a. Enter the project name, location name, and organization in blocks 1a.
b. List the station name and UTM grid coordinates in blocks 1b.
c. Use TM 8358.1 to obtain the following information and record it on DA Form 1933:
   (1) Central meridian (CM) (block 1c(1). The longitudes that are listed across the top and bottom of the chart are for zone boundaries. The CM of the zone is the mean of the zone boundaries.

NOTE: The CM must be entered with the appropriate sign.

   (2) Ellipsoid (block 1c(2). The plotted point will be in one of the bordered areas on the chart indicating the ellipsoid used in that area.
   (3) Grid zone where the point is located (block 1c(3). Find the longitude across the top or bottom of the map and the latitude along the right or left side of the map. The point where the longitude and latitude intersect is the grid zone (consisting of a number and a letter).

2. Compute and record the absolute values for the easting prime (E') and the northing prime (N') by using the following formulas:
   a. N' = N (Use this formula if the station is in the northern hemisphere) (block 2a).
      N' = 10,000,000 - N (Use this formula if the station is in the southern hemisphere) (block 2a).

      where--
      N = northing
   b. E' = E - 500,000 (Use this formula if the station is east of the CM of the grid zone) (block 2b).
      E' = 500,000 - E (Use this formula if the station is west of the CM of the grid zone) (block 2b).

      where--
      E = easting

3. Compute the value of q by using the following formula and record it to nine decimal places in block 3.

   q = E' divided by 1,000,000

   where--
   E' = easting prime

4. Compute the values of q squared (q2), q cubed (q3), q to the fourth power (q4), q to the fifth power (q5), and q to the sixth power (q6) and record them to eight decimal places in blocks 4.

5. Determine the preliminary latitude.
   a. Divide N' by 30.8
   b. Divide the value of step 5a by 3,600.
   c. Convert the value of step 5b to degrees, minutes, and seconds (DDD.MMSS) and round to the nearest minute.

6. Determine the actual latitude prime.
   a. Turn on the computer and the monitor and allow the system to boot up in Windows.
   b. Click on "Start," "Programs," and then the "MS-DOS Command Prompt."
   c. Type CD and press the enter key to ensure that you are at the C:> prompt after the system has restarted.
   d. Type CD SVY\TABLES at the C:> prompt and press the enter key.
   e. Type TABLES at the C:\SVY\TABLES prompt and press the enter key to start the program.

NOTE: The first screen explains what the program does and prompts you to enter a letter.

   f. Enter any letter when prompted to "INPUT ANY LETTER (A-Z)" and press the enter key.

Performance Steps

NOTE: The next screen is "PROGRAM USER NOTES."

g. Select one of the following at the "SELECT THE TYPE OF PROMPTS DESIRED" prompt.

0 = SHORT PROMPTS
1 = LONG PROMPTS TO INCLUDE SAMPLES

NOTE: Select the LONG PROMPTS until you become accustomed to the program. Enter 1 and press the enter key.

h. Input the title (maximum number of characters is 60).
i. Select the "ELLIPSOID" to be used for the computations.
j. Select one of the following modes of computation:

1 = INDIVIDUAL POINT
2 = TABLE (FROM BLOCK OF POINTS)

NOTE: To determine the actual preliminary latitude (j'), create a block of points around the seed latitude. Enter 2 and press the enter key.

k. Input the latitude interval degrees, minutes, and seconds (DMS) for building the table.

NOTE: To build the table on a 1-minute interval, enter 0 1 0 and press the enter key.

l. Input the southern latitude limit (DMS).

NOTE: For the southern limit, deduct 5 minutes from the seed latitude and press the enter key.

m. Input the northern latitude limit (DMS) for the table.

NOTE: For the northern limit, add 5 minutes from the seed latitude and press the enter key.

n. Select the table or value to construct. Round the final answer to three decimal places and record it in block 6n.

NOTE: Select "OPTION 5 (LATITUDE FROM GRID COORDINATES)" and press the enter key. Look at the values in column I and find the value that is as close to but less than the N'. The latitude associated with this value becomes the degrees and minutes of the latitude. To find the seconds, subtract the tabular value I from the N' and divide by the difference (1" for the latitude associated). This is the value you will use to generate the tabular values.

7. Generate tabular values VII, VIII, D6, IX, X, and E5 using the NIMA Tables Program for the appropriate ellipsoid.
   a. Enter 99 and press the enter key.
   b. Select "OPTION 5 (CHANGE COMPUTATION MODE)" from the "PROGRAM CONTROL CODE MENU" and press the enter key.
   c. Select "OPTION 1 (INDIVIDUAL POINT)" and press the enter key.
   d. Enter the latitude that you figured when prompted to "INPUT LATITUDE OF POINT" and press the enter key.
   e. Select the table or value to construct the screen. Select "OPTION 5 (LATITUDE FROM GRID COORDINATES" and press the enter key. The program immediately computes and displays tabular values VII, VIII, and D6. Record these values in blocks 7e.
   f. Determine the longitude and record in blocks 7f. Select "OPTION 6 (LONGITUDE FROM GRID COORDINATES)" and press the enter key. The program immediately computes and displays tabular values IX, X, and E5.

Performance Steps

8. Compute the delta latitude by using the following formula. Round the answer and record it to three decimals places in block 8.

   Delta latitude = (VII)q2 - (VIII)q4 + (D6)q6

   where--
   q = E' divided by 1,000,000
   q2 = q squared
   q4 = q to the fourth power
   q6 = q to the sixth power
   VII = Tabular value 7
   VIII = Tabular value 8
   D6 = Tabular value D6

9. Convert the delta latitude (seconds) into delta latitude (degrees). Divide the delta latitude (seconds) by 3,600 and convert to DDD.MMSS. Round the answer and record it to three decimal places in block 9.

10. Compute the latitude by using the following formula and record it to three decimal places in block 10.

    Latitude = latitude prime - delta latitude

NOTE: If the station is in the northern hemisphere, the final answer will be preceded by a plus (+) sign. If the station is in the southern hemisphere, the final answer will be preceded by a minus (-) sign.

11. Compute the delta longitude (seconds) by using the following formula and record it to three decimal places in block 11.

    Delta longitude (seconds) = (IX)q - (X)q3 + (E5)q5

    where--
    q = E' divided by 1,000,000
    q3 = q cubed
    q5 = q to the fifth power
    IX = Tabular value 9
    X = Tabular value 10
    E5 = Tabular value E5

12. Determine the delta longitude (degrees) by using the following formula, convert it to DDD.MMSS, and record it in block 12.

    Delta longitude = delta longitude in (sec)/3,600

Performance Steps

13. Compute the longitude by using one of the following formulas and record it to three decimal places in block 13.

    Longitude = CM value + delta longitude (Use this formula if the station is in the eastern hemisphere and east of the CM of the grid zone).
    Longitude = CM value - delta longitude (Use this formula if the station is in the eastern hemisphere and west of the CM of the grid zone.)
    Longitude = CM value + delta longitude (Use this formula if the station is in the western hemisphere and west of the CM of the grid zone.)
    Longitude = CM value - delta longitude (Use this formula if the station is in the western hemisphere and east of the CM of the grid zone.)

    where--
    CM = central meridian

NOTE: Longitudes that are reckoned westward from the Greenwich meridian are preceded by a minus (-) sign.

14. Sign and date the form blocks 14.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to convert the UTM grid coordinates to geodetic coordinates.

Performance Measures	**GO**	**NO GO**
1. Filled in the headings on DA Form 1933.	____	____
2. Computed and recorded the absolute values for E' and N'.	____	____
3. Computed and recorded the value of q.	____	____
4. Computed and recorded the values for q2, q3, q4, q5, and q6.	____	____
5. Determined the preliminary latitude.	____	____
6. Determined the actual latitude prime.	____	____
7. Generated tabular values VII, VIII, D6, IX, X, and E5 using the NIMA Tables Program.	____	____
8. Computed and recorded the delta latitude.	____	____
9. Converted the delta latitude (seconds) into delta latitude (degrees) and recorded it.	____	____
10. Computed and recorded the latitude.	____	____
11. Computed and recorded the delta longitude (seconds).	____	____
12. Determined the delta longitude (degrees), converted it to DDD.MMSS, and recorded it.	____	____
13. Computed and recorded the longitude.	____	____
14. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1933	
TM 8358.1	

Convert Geodetic Coordinates to Universal Transverse Mercator (UTM) Grid Coordinates 052-260-2470

Conditions: As a topographic surveyor in a secure field environment, given the geodetic coordinates of a point, a scientific calculator, a desktop personal computer (PC) with the National Imagery Mapping Agency (NIMA) Tables Program, instructions on how to convert coordinates, Technical Manual (TM) 8358.1, and Department of the Army (DA) Form 1932.

Standards: Convert geodetic coordinates to UTM grid coordinates. Enter all factors to eight decimal places. Take tabular values II, III, IV, V, A6, and B5 from the appropriate spheroid tables and record them to the same decimal places as given in the tables. Compute the final grid position to three decimal places. All entries and computations must be accurate, neat, and legible.

Performance Steps

1. Fill in the headings on DA Form 1932 (Figures 052-260-2470-1 and 052-260-2470-2).

Performance Steps

PROJECT 1a	U.T.M. GRID COORDINATES FROM GEOGRAPHIC COORDINATES For use of this form, see FM 3-34.331; the prponent agency is TRADOC.				
LOCATION 1a			ORGANIZATION 1a		
SPHEROID 1c(1)	CENTRAL MERIDIAN 1c(2)	ZONE 1c(3)	UNIT Meter	FE 500,000 m.	

Station 1b				Station			
∅	1b	λ	1b	∅		λ	
(I)	5h	Δλ	2b 2c 2b/2c	(I)		Δλ	
(II)	5h	P^2	4	(II)		P^2	
(III)	5h	P^4	4	(III)		P^4	
A_6	5h	P^5	4	A_6			
(IV)	5i	P	3	(IV)		P	
(V)	5i	P^3	4	(V)		P^3	
B_5	5i	P^6	4	B_5			
N'	6a	E'	6c				
N	6b	E	6d	N		E	

Station				Station			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	

Sample

Station				Station			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	

COMPUTED BY 7	DATE (YYYYMMDD) 7	CHECKED BY	DATE (YYYYMMDD)

DA FORM 1932, FEB 1957 USAPA V1.00

Figure 052-260-2470-1
Sample of DA Form 1932 With Block Numbers

Performance Steps

PROJECT: 412-104-E-100 LTPE	U.T.M. GRID COORDINATES FROM GEOGRAPHIC COORDINATES For use of this form, see FM 3-34.331; the prponent agency is TRADOC.						
LOCATION: Fort Belvoir, VA				ORGANIZATION: AGS, DMS			
SPHEROID: WGS/84	CENTRAL MERIDIAN	ZONE: 43R +75	UNIT: Meter	FE: 500,000 m.			
Station: Sample problem				Station:			
∅	31-41-16.641	λ	74-18-23.672	∅		λ	
(I)	3507696.088	Δλ	2496.328 00-41-36.328	(I)		Δλ	
(II)	3353.198	P^2	0.06231653	(II)		P^2	
(III)	2.216	P^4	0.00388335	(III)		P^4	
A_6	0.0011	P^6	0.00024200	A_6			
(IV)	263213.604	P	0.24963280	(IV)		P	
(V)	46.518	P^3	0.01555625	(V)		P^3	
B_5	-0.0112	P^5	0.00096941	B_5			
N'	3507905.056	E'	65707.473				
N	3507905.056	E	434292.527	N		E	
Station:				Station:			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	
Station:				Station:			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	
COMPUTED BY: SSG Zambrano	DATE (YYYYMMDD): 20010818	CHECKED BY:	DATE (YYYYMMDD):				

Sample

DA FORM 1932, FEB 1957 USAPA V1.00

Figure 052-260-2470-2
Completed Sample of DA Form 1932

Performance Steps

a. Enter the project name, location name, and organization in blocks 1a.
b. List the station name and geographic coordinates in blocks 1b.
c. Use TM 8358.1 to obtain the following information and record it on DA Form 1932.
   (1) Ellipsoid (block 1c[1]). The plotted point will be in one of the bordered areas on the chart indicating the ellipsoid used in that area.
   (2) Central meridian (CM) (block 1c[2]). Longitudes that are listed across the top and bottom of the chart are for zone boundaries. The CM of the zone is the mean of the zone boundaries.
   (3) Grid zone where the point is located (block 1c[3]). Find the longitude across the top or bottom of the map and the latitude along the right or left side of the map. The point where the longitude and latitude intersect is the grid zone (consisting of a number and a letter).

2. Compute and record the difference in longitude.
   a. Compute the difference in longitude by using the following formula:

      Difference in longitude = longitude - CM.
   b. Record the absolute value in degrees, minutes, and seconds (DDD.MMSS) in block 2b. The absolute value is always positive.
   c. Convert the difference in longitude to seconds by changing the value to decimal degrees then multiplying by 3,600. Record it to three decimal places in block 2c.

3. Compute p by using the following formula and record it to eight decimal places in block 3.

   p = .0001 times the difference in longitude or p = the difference in longitude divided by 10,000

4. Compute the values of p squared (p2), p cubed (p3), p to the 4th power (p4), p to the 5th power (p5), and p to the 6th power (p6) and record them to eight decimal places in blocks 4.

5. Generate tabular values I, II, III, IV, V, A6, and B5 using the NIMA Tables Program for the appropriate ellipsoid. The given latitude is the argument used. Record the values to the number of decimal places generated by the program.
   a. Enter the tables program.
   b. Enter any letter.
   c. Select "LONG PROMPTS."
   d. Input the station name.
   e. Select the ellipsoid.
   f. Select "INDIVIDUAL POINT."
   g. Enter the latitude.
   h. Select the "GRID NORTHING FROM GEOGRAPHIC COORDINATES" option and record tabular values I, II, III, and A6 in blocks 5h.
   i. Select the "GRID EASTING FROM GEOGRAPHIC COORDINATES" option and record tabular values IV, V, and B5 in blocks 5i.
   j. Exit the tables program.

6. Compute the grid position.

Performance Steps

a. Compute the northing prime (N') value by using the following formula and record it in block 6a.

N' = (I) + (II)p2 + (III)p4 + (A6)p6

where--
I = Tabular value 1
II = Tabular value 2
III = Tabular value 3
A6 = Tabular value A6
p = .0001 times the difference in longitude or p = the difference in longitude divided by 10,000
p2 = p squared
p4 = p to the fourth power
p6 = p to the sixth power

b. Compute the northing (N) by using one of the following formulas and record it to three decimal places in block 6b.

N = N' (Use this formula if the station is in the northern latitude.)
N = 10,000,000 - N' (Use this formula if the station is in the southern latitude.)

c. Compute the easting prime (E') by using the following formula and record it in block 6c.

E' = (IV)p + (V)p3 + (B5)p5

where--
IV = Tabular value 4
V = Tabular value 5
B5 = Tabular value B5
p = .0001 times the difference in longitude or p = the difference in longitude divided by 10,000
p3 = p cubed
p5 = p to the fifth power

d. Compute the easting (E) by using one of the following formulas and record it to three decimal places in block 6d.

E = 500,000 + E' (Use this formula if the station is east of the central meridian of the grid zone.)
E = 500,000 - E' (Use this formula if the station is west of the central meridian of the grid zone.)

7. Sign and date the form in blocks 7.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to convert geodetic coordinates to UTM grid coordinates.

Performance Measures	**GO**	**NO GO**
1. Filled in the headings on DA Form 1932.	____	____
2. Computed and recorded the difference in longitude.	____	____
3. Computed and recorded the p value.	____	____
4. Computed and recorded the values of p2, p3, p4, p5, and p6.	____	____
5. Generated tabular values I, II, III, IV, V, A6, and B5 using the NIMA Tables Program.	____	____

Performance Measures	GO	NO GO
6. Computed the grid position.	____	____
7. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1932	
TM 8358.1	

Compute the Convergence
052-260-2479

Conditions: As a topographic surveyor, given the geodetic coordinates of the point under consideration, instructions on how to compute the convergence from geodetic coordinates, Technical Manual (TM) 8358.1 (specified for new mappings), a desktop personal computer (PC) with the National Imagery Mapping Agency (NIMA) Tables Program, Department of the Army (DA) Form 1932, and a scientific calculator.

Standards: Compute the convergence. Enter all factors to eight decimal places. Take the tabular values from the appropriate spheroid table and record them to the same decimal places as given in the tables. Record the final convergence to three decimal places. All entries and computations must be accurate, neat, and legible.

Performance Steps

1. Fill in the headings on DA Form 1932 (Figures 052-260-2479-1 and 052-260-2479-2).

Performance Steps

PROJECT 1a	U.T.M. GRID COORDINATES FROM GEOGRAPHIC COORDINATES For use of this form, see FM 3-34.331; the prponent agency is TRADOC.				
LOCATION 1a		ORGANIZATION 1a			
SPHEROID 1c(1)	CENTRAL MERIDIAN 1c(2)	ZONE 1c(3)	UNIT Meter	FE 500,000 m.	

Station	1b			Station			
∅	1b	λ	1b	∅		λ	
(I)		Δλ	2b 2c 2b/2c	(I)		Δλ	
(II)		P^2	4	(II)		P^2	
(III)		P^4		(III)		P^4	
A_6		C5	5h	A_6			
(IV)		P	3	(IV)		P	
(V)		P^3	4	(V)		P^3	
B_5		XIII	5h	B_5			
XII	5h	C	6	C	6b		
N		E		N		E	

Station				Station			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	

Station				Station			
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	

COMPUTED BY 7	DATE (YYYYMMDD) 7	CHECKED BY	DATE (YYYYMMDD)

DA FORM 1932, FEB 1957 USAPA V1.00

Figure 052-260-2479-1
Sample of DA Form 1932 With Block Numbers

Performance Steps

PROJECT: 412-104-E-100 LTPE	U.T.M. GRID COORDINATES FROM GEOGRAPHIC COORDINATES For use of this form, see FM 3-34.331; the prponent agency is TRADOC.						
LOCATION: Fort Belvoir, VA			ORGANIZATION: AGS, DMS				
SPHEROID: Clark 1866	CENTRAL MERIDIAN: 99°	ZONE: 1B	UNIT: Meter	FE: 500,000 m.			
Station			Station				
∅	34° 15' 34.742"	λ	96° 02' 43.158"	∅		λ	
(I)		Δλ	02° 57' 16.842"	(I)		Δλ	
(II)		P^2	1.1314241	(II)		P^2	
(III)		P^4		(III)		P^4	
A_6		C5	+0.002	A_6			
(IV)		P		(IV)		P	
(V)		P^3	1.2034780	(V)		P^3	
B_5		XIII	3.055	B_5			
XII	5629.441	C	1° 39' 51.626"	C	+5991.626		
N		E		N		E	
Station			Station				
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	
Station			Station				
∅		λ		∅		λ	
(I)		Δλ		(I)		Δλ	
(II)		P^2		(II)		P^2	
(III)		P^4		(III)		P^4	
A_6				A_6			
(IV)		P		(IV)		P	
(V)		P^3		(V)		P^3	
B_5				B_5			
N		E		N		E	
COMPUTED BY: SSG Zambrano	DATE (YYYYMMDD): 20010818		CHECKED BY	DATE (YYYYMMDD)			

Sample

DA FORM 1932, FEB 1957 USAPA V1.00

Figure 052-260-2479-2
Completed Sample of DA Form 1932

Performance Steps

a. Enter the project name, location name, and organization in blocks 1a.
b. List the station name and geographic coordinates in blocks 1b.
c. Use TM 8358.1 to obtain the following information and record it on DA Form 1932.
   (1) Ellipsoid (block 1c[1]). The plotted point will be in one of the bordered areas on the chart indicating the ellipsoid used in that area.
   (2) Central meridian (CM) (block 1c[2]). Longitudes that are listed across the top and bottom of the chart are for zone boundaries. The CM of the zone is the mean of the zone boundaries.
   (3) Grid zone where the point is located (block 1c[3]). Find the longitude across the top or bottom of the map and the latitude along the right or left side of the map. The point where the longitude and latitude intersect is the grid zone (consisting of a number and a letter).

2. Compute and record the difference in longitude.
   a. Compute the difference in longitude by using the following formula:

      Difference in longitude = longitude - CM.
   b. Record the absolute value in degrees, minutes, and seconds (DDD.MMSS) in block 2b. The absolute value is always positive.
   c. Convert the difference in longitude to seconds by changing the value to decimal degrees then multiplying that value by 3,600. Record the value to three decimal places in block 2c.

3. Compute the p value by using the following formula and record it to eight decimal places in block 3.

   p = .0001 times the difference in longitude (in seconds) or p = the difference in longitude (in seconds) divided by 10,000.

4. Compute the values of p squared (p2) and p cubed (p3) and record them in blocks 4 to eight decimal places.

5. Generate tabular values XII, XIII, and C5 using the NIMA Tables Program for the appropriate ellipsoid. The given latitude is the argument used. Record the values to the number of decimal places generated by the program.
   a. Enter the tables program.
   b. Enter any letter.
   c. Select "LONG PROMPTS."
   d. Input the station name.
   e. Select the ellipsoid.
   f. Select "INDIVIDUAL POINT."
   g. Enter the latitude.
   h. Select the option "CONVERGENCE FROM GEOGRAPHIC COORDINATES" and record the XII, XIII, and C5 values in blocks 5h.
   i. Exit the tables program.

6. Compute the convergence (C) by using the following formula and record it in block 6:

   C = (XII)p + (XIII)p3 + C5

   where--
   XII = Tabular value 12.
   XIII = Tabular value 13.
   C5 = Tabular value C5.
   p = .0001 times the difference in longitude or p = the difference in longitude divided by 10,000.
   p3 = p cubed.
   a. Divide the result of C (which is in seconds) by 3,600 and convert the value to degrees, minutes, and seconds.
   b. Record the convergence to three decimal places in block 6b.

Performance Steps

7. Sign and date the form in blocks 7.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Ensure that grid coordinates are converted to geodetic coordinates according to task 051-260-2466, if necessary.

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him where to record the tabular values and the convergence on the modified DA Form 1932. Tell him to compute the convergence.

Performance Measures	**GO**	**NO GO**
1. Filled in the headings on DA Form 1932.	____	____
2. Computed and recorded the difference in longitude.	____	____
3. Computed and recorded the p value.	____	____
4. Computed and recorded the values for p2 and p3.	____	____
5. Generated the tabular values for XII, XIII, and C5 using NIMA Tables Program.	____	____
6. Computed the convergence (C).	____	____
7. Signed and dated the form.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1932	
TM 8358.1	

Compute Datum Transformations

052-260-2482

Conditions: As a topographic surveyor in a secure field environment, given the universal transverse Mercator (UTM) grid coordinates of a point, a scientific calculator, a desktop personal computer (PC) with the National Imagery Mapping Agency (NIMA) Tables Program, instructions on how to convert coordinates, Technical Manual (TM) 8358.1, and Department of the Army (DA) Forms 1932 and 1933.

Standards: Transform the given coordinates in an adjacent zone to geodetic coordinates and then to UTM grid coordinates. Enter all factors to eight decimal places. Take tabular values VII, VIII, IX, X, D6, and E5 from the appropriate spheroid tables and record them to the same decimal places as given in the tables. Take tabular values I, II, III, IV, V, A6, and B6 from the appropriate spheroid tables and record them to the same decimal places as given in the tables. Compute the final grid position to three decimal places. All entries and computations must be accurate, neat, and legible.

Performance Steps

1. Enter administrative data on DA Forms 1932 and 1933.
   a. Enter the project name, location name, and organization on both forms.
   b. List the station name and geographic coordinates on both forms.
   c. Use TM 8358.1 to obtain the following information and record it on both forms.
      (1) Ellipsoid. The plotted point will be in one of the bordered areas on the chart indicating the ellipsoid used in that area.
      (2) Central Meridian (CM). Longitudes listed across the top and bottom of the chart are for zone boundaries. The CM of the zone is the mean of the zone boundaries.
      (3) Grid zone the point is located in. Find the longitude across the top or bottom of the map and the latitude along the right or left side of the map. The point where the longitude and latitude intersect is the grid zone (consisting of a letter or number).
2. Convert the given coordinates for the spheroid that the point is in to UTM grid coordinates (see task 052-260-2466).
3. Convert the UTM grid coordinates to geodetic grid coordinates for the spheroid that the station is being transformed to (see task 052-260-2470).
4. Sign and date both forms.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier. Give the soldier a safety briefing before starting the test. Tell him to compute datum transformations.

Performance Measures	**GO**	**NO GO**
1. Entered administrative data on DA Forms 1932 and 1933.	____	____
2. Converted the given coordinates for the spheroid that the point was in to UTM grid coordinates.	____	____
3. Converted the UTM grid coordinates to geodetic grid coordinates for the spheroid that the point was being transformed to.	____	____
4. Signed and dated both forms.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1932	
DA FORM 1933	
TM 8358.1	

Check Intersection Computations

052-260-2491

Conditions: As a topographic surveyor in a secure field environment, given a scientific calculator; completed intersection field notes; completed computations on Department of the Army (DA) Forms 1920, 1938 and 1947; and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Check the field data, abstracts, and intersection computations for accuracy and compare them to the independent computations. Compare the final position and elevation to ensure that they are correct.

Performance Steps

NOTE: Figure 052-260-2491-1 is a sample of the three forms together for easier handling in the field.

1. Ensure that administrative and field data are entered correctly on the following forms:
   a. DA Form 1920 (Figure 052-260-2491-1).

Performance Steps

PROJECT Example					TWO-POINT INTERSECTION (OBSTRUCTION COMPUTATION)					
LOCATION Fort Wainwright, Alaska.			ORGANIZATION DMS/BGS					DATE Today's Date		
STATION		OBSERVED ANGLE	SINE		DISTANCE			SIDE		
1 ANT 1		37°17′26.6″	+0.605859583		2934.878		2-3	BHTW-CTWR		
2 BHTW		82°07′00.9″	+0.990550001		4798.378		1-3	ANT 1-CTWR		
3 CTWR		60°35′32.5″	+0.871148354		4219.978		1-2	ANT 1-BHTW		
				D=Ratio, side/sine	4844.155448					
PART I, DA Form 1920										
		t2to3	156°34′32.0″				t3to2	336°34′32.0″		
		+∠2	82°07′00.9″				-∠3	60°35′32.5″		
Sin(2to1)	-0.854390566	t2to1	238°41′32.9″	Sin(3to1)	-0.994552512		t3to1	275°58′59.5″		
Cos(2to1)	-0.519631370	∠1		Cos(3to1)	+0.104236753					
N_2	7193431.450	2	BHTW	E_2	469533.340	N_3	7190738.450	3	CTWR	E_3	470700.070
ΔN	-2192.833	S	4219978	ΔE	-3605.509	ΔN	+500.167	S	4798378	ΔE	-4772.239
N_1	7191238.617	1	ANT1	E_1	465927.831	N_1	7191238.617	1	ANT1	E_1	465927.831
Part II, DA Form 1938											
Station 1, occ		BHTW			[illegible]WR		t2to1=(t2to3+∠2)				
Station 2, obs		ANT 1			[illegible]		t3to1=(t3to2-∠3)				
Object sighted		Top of ANT			[illegible] of ANT						
ζ1		92°06′00.5″			89°35′16.2″						
α and mean ϕ		238°42′/64°51′			275°59′/64°51′						
(0.5-m)		0.4290			0.4290						
s		4219.978			4798.378						
ρ sin 1″		30.997			31.007						
κ in secs		58.4″			66.4″						
(90°-ζ1+κ)		-02°05′02.1″			+00°25′50.2″						
tan(90°-ζ1+κ)		-0.036387254			+0.007515723						
h_2-h_1		-153.553			+36.063						
h_1		345.786			156.208						
HI		1.699			1.421						
Corrected elevation		193.932			193.692						
$h_2-h_1 = s \bullet \tan(90°-\zeta_1+\kappa)$			κ in secs. = $\frac{(0.5-m)s}{\rho \sin 1''}$								
Part III, DA Form 1947											
COMPUTED BY SSG BAKER			DATE 20010818		CHECKED BY			DATE			

Figure 052-260-2491-1
Completed Sample of DA Forms 1920, 1938, and 1947

(1) Station names.
(2) Observed angles.

b. DA Form 1938 (Figure 052-260-2491-1).
(1) Grid azimuths.

Performance Steps

(2) Station names.
(3) Station angles.
(4) Station grid coordinates.
(5) Grid distances.

c. DA Form 1947(Figure 052-260-2491-1).
(1) Known and unknown station names.
(2) Object sighted.
(3) Zenith distance.
(4) Azimuth of line.
(5) Mean latitude.
(6) Weighted mean coefficient.
(7) Grid distance.
(8) Elevations of the occupied stations.
(9) Heights of instrument (HIs).

2. Check all computations on the following forms to ensure that they are correct:
a. DA Form 1920.
(1) Unknown angles.
(2) Sines of the angles.
(3) Ratios.
(4) Each side of the triangle.
b. DA Form 1938.
(1) Grid azimuth.
(2) Sines and cosines
(3) Difference in northings (N) and eastings (E).
(4) Position computations.
(5) Two independently computed positions within ± 0.002.
c. DA Form 1947.
(1) Mean radius of curvature.
(2) Value for p sine 1".
(3) Value for k in seconds.
(4) Angular computations.
(5) Elevation determinations.
(6) Both independently determined elevations for the unknown station agree and meet project specifications.

3. Ensure that the computed positions and elevations are true and correct.

4. Ensure that each form is signed and dated.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. The evaluator will obtain a set of intersection field notes for a single intersection computation. The evaluator will have a sample sheet with all the errors identified.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell the soldier to check the intersection computations. Use third-order specifications.

Performance Measures	**GO**	**NO GO**
1. Ensured that administrative and field data were entered correctly on DA Forms 1920, 1938, and 1947.	____	____
2. Checked all computations on the forms.	____	____

Performance Measures	GO	NO GO
3. Ensured that the computed positions and elevations were true and correct.	____	____
4. Ensured that each form was signed and dated.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DA FORM 1920	
DA FORM 1938	
DA FORM 1947	
DMS ST 031	

Establish a Declination Station

052-260-2492

Conditions: As a topographic surveyor in a field environment, given (tables of organization and equipment [TOE]) survey equipment for a survey team; a survey control point with known starting coordinates; known coordinates for a second survey control point or azimuth mark; a coordinate scale; a protractor; a standard 1:50,000-scale military map; a scientific calculator; Department of the Army (DA) Form 1934; Field Manual 6-2; and instructions on how to convert degrees, minutes, and seconds (DDD.MMSS) into mils.

Standards: Establish a declination station according to the procedures outlined in FM 6-2.

Performance Steps

1. Locate a declination station that is convenient to the using unit(s) and away from magnetic attractions. Observe the following:
   a. Power lines and electronic equipment--150 meters.
   b. Railroad tracks, artillery, tanks, and vehicles--75 meters.
   c. Barbwire, steel helmets, and personal weapons--10 meters.

2. Establish a declination station.
   a. Provide four azimuth marks (one in each quadrant) to prominent features located at least 1,000 meters from the declination station.

NOTE: When the time, tactical situation, or lack of prominent features limit operations, the standard in step 2a can be relaxed. The minimum distance should not be closer than 300 meters. Two azimuth marks are desired but one will suffice.

   b. Determine the grid azimuth(s) to the azimuth mark(s) by using either of the following methods:
      (1) Compute the grid azimuth if the coordinates of the declination station and azimuth mark(s) are known.
      (2) Apply a measured angle to a known direction. Use a theodolite to observe the azimuths for each declination station.
   c. Determine the vertical angle (VA) to each azimuth mark.
   d. Convert all angular measurements to mils (6,400 mils = 360°).

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to establish a declination station.

Performance Measures	**GO**	**NO GO**
1. Located a declination station that was convenient to the using unit(s) and away from magnetic attractions.	____	____
2. Established a declination station.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1934	

References

Required

FM 6-2

Related

Subject Area 2: Automated Integrated Survey Instrument

Postprocess Automated Integrated Surveying-Instrument (AISI) Data
052-260-2486

Conditions: As a topographic surveyor, given an AISI with data from a survey project, field notes for the data, coordinates for the project control points used, appropriate AISI accessories, a desktop personal computer (PC) with the TerraModel Drafting Program, an alternating-current (AC) power source, the TerraModel user's manual, Defense Mapping School (DMS) Special Text (ST) 648, and instructions on how to use the TerraModel Drafting Program and to transfer AISI data.

Standards: Postprocess data for the AISI using a microprocessor. Postprocess the data according to the standards set forth in the project directive, the unit's standing operating procedure (SOP), and the AISI operator's manual and the recommended procedures in DMS ST 648.

Performance Steps

1. Open a project directory.
   a. Start the TerraModel Program.
   b. Select the option to configure the system.
   c. Specify a prototype file name and complete the data in the dialog box. Press the enter button or select "OK."
   d. Select "FILE" and the "NEW PROJECT" option.
   e. Type in a project name and press the enter button or select "OK."
2. Download data from the AISI.
   a. Connect the AISI to the computer using the computer/geodimeter cable.
   b. Enter the "GEOCAP" module within the TerraModel Program. From the command line, type GEOCAP.
   c. Type T to transfer data or select the option to transfer a file from the AISI to the computer.
   d. Type JI for job in or select the "JOB-IN" option to transfer a job file from the directory in the AISI.
   e. Select the job file from the directory in the AISI and transfer it to the PC.
   f. Convert the job file. Type "C" or select the option to convert the file to a "TRV," "TXT," or "PTS" file.
3. Open a job file for editing.
   a. Type FILE EDITOR from the command line.
   b. Select "GEOCAP," then "GEO FILE" and "FILE EDITOR."
   c. Open an existing file or create a new file.
   d. Use the basic editing features in the TerraModel user's manual to find, edit, or change the information as needed.
   e. Save the file after editing. Select the "SAVE" option.
   f. Select the "EXIT" option to return to the TerraModel Program.
4. Enter the project control points. Enter the data using one of the following methods:
   a. Input data manually. Use the keyboard to create new points one at a time. Ensure that the point number, name, and coordinates are entered.
   b. Create a file using the editor.
      (1) Create a file named CONTROL.PTS.
      (2) Enter the names and coordinates for each point.
      (3) Use the command PTSIN to transfer the control points to the working project.
      (4) Make a new layer to store the points in. Store and assign the required attributes to the layer.
5. Process the raw data from the AISI.

Performance Steps

a. Enter the traverse editor. From the command line type FIELDT and press the enter button.
b. Type 41 for the number of viewable lines for the traverse editor.
c. Type T or select the "TRAVIN" option.

NOTE: At this point, the editor will compute the coordinates from the azimuth, distance, and difference in elevation data using the AISI observations.

d. Type LIST to list the generated new points to the PC screen or to a printer.

NOTE: If this process fails to work, edit the control-points file and the raw-data file to ensure that they are correct.

6. Manage the processed data.
   a. Identify the objects that are listed and place them in a layer that reflects what is in the layer.
   b. Type or select the "RELAYER" option.
   c. Type or select the by "NAME" option.
   d. Enter the name or point code (P-CODE) of the object.
   e. Enter the new layer name and select a color for the layer.
   f. Repeat steps 6a through e until all new points are relayered and the layer zero is empty.
   g. Isolate one of the newly created layers. Select "LAYER," then "ISOLATE" and the layer name.
   h. Use the "MAPP," "ID," and "LIST" options to assist you in drafting and/or connecting the points.
   i. Use additional commands from the TerraModel user's manual to edit the points and connections to reflect the data collected with the AISI.
   j. Use the "LABEL" option to assign a label to a point.
      (1) Type or select "LABEL."
      (2) Select a point using the mouse.
      (3) Select "D" for the default labels and follow the prompts.
   k. Repeat steps 6g and h until the remaining layers have been drafted.
7. Display the processed data. Select "LAYER," "ON," "ALL," and "REDRAW" to view the processed data.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. Use data collected during a topographic survey (according to task 051-260-1336).

Brief Soldier: Give the soldier a safety briefing before starting the test. Show him the site where the AISI data was collected. Tell him to postprocess the AISI data.

Performance Measures	**GO**	**NO GO**
1. Opened a project directory.	____	____
2. Downloaded data from the AISI.	____	____
3. Opened a job file for editing.	____	____
4. Entered the project control points.	____	____
5. Processed the raw data from the AISI.	____	____
6. Managed the processed data.	____	____
7. Displayed the processed data.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS ST 648	

Subject Area 3: Traverse

Check Horizontal Field Data

052-260-2487

Conditions: As a topographic surveyor, given a completed Department of the Army (DA) Form 1916, the project directive, Defense Mapping School (DMS) Special Text (ST) 031, and a scientific calculator.

Standards: Check DA Form 1916 to ensure that all entries recorded during a traverse are complete, neat, legible, and correct. All entries must conform to third-order specifications and the unit's standing operating procedure (SOP). Correct any errors or omissions that are found.

Performance Steps

1. Check DA Form 1916 to ensure that all entries are complete, neat, legible, and correct; in addition, check the following items:
   a. An index of the control points.
   b. A description of the network.
   c. A sketch of the work completed.
   d. A list of the survey-party personnel.
   e. The instrument data.
2. Check DA Form 1916 to ensure the accuracy of angles turned and that--
   a. All administrative items are entered on each page.
   b. The observer and recorder blocks are complete and accurate.
   c. The project name and organization blocks are complete and accurate.
   d. The height of instrument (HI), height of target (HT), eccentricity, and instrument/target numbers are complete and accurate.
   e. Any circle settings are correct.
   f. The sums and means are accurately computed.
   g. The concluded angle is computed and entered for each position turned.
   h. The mean angle is computed and entered.
   i. The closure specifications are met.
   j. All entries are accurate.
   k. All measurements meet project requirements.
   l. Any errors and/or omissions are noted.
   m. All entries are neat and legible.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. The project directive should make reference to third-order specifications.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to check the horizontal field data.

Performance Measures	**GO**	**NO GO**
1. Checked DA Form 1916 to ensure that all entries were complete, neat, legible, and correct.	____	____
2. Checked DA Form 1916 to ensure the accuracy of angles turned.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1916	
DMS ST 031	

Check Vertical-Angle (VA)/Zenith-Distance (ZD) Field Data

052-260-2488

Conditions: As a topographic surveyor, given a completed Department of the Army (DA) Form 5817, abstracts for VAs/ZDs, a completed DA Form 1943, the project directive, Defense Mapping School (DMS) Special Text (ST) 031, and a scientific calculator.

Standards: Check DA Form 5817 to ensure that all entries recorded during VA/ZD observations are complete, neat, legible, and correct. All entries must conform to third-order specifications and the unit's standing operating procedure (SOP). Correct any errors or omissions that are found.

Performance Steps

1. Check DA Form 5817 to ensure that all entries are complete, neat, legible, and correct; in addition, check the following items:
   a. An index of control points.
   b. A description of the network.
   c. A sketch of the work completed.
   d. A list of the survey-party personnel.
   e. The instrument data.
2. Check DA Form 5817 to ensure the accuracy of angles observed and that--
   a. All administrative items are entered on each page.
   b. The sums, means, and differences are accurately computed.
   c. The concluded angle is computed and entered for each position turned.
   d. The mean angle is computed and entered for each setup.
   e. The spread of seconds meets project specifications.
   f. DA Forms 1943 are accurate.
   g. All entries are neat and legible.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. For testing purposes, use automated integrated surveying instrument (AISI) VA/ZD field data. Make at least three pairs of reciprocal observations or two nonreciprocal observations. Use DA Form 5817 for recording purposes. The project directive should make reference to third-order specifications.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to check VA/ZD field data.

Performance Measures	**GO**	**NO GO**
1. Checked DA Form 5817 to ensure that all entries were complete, neat, legible, and correct.	____	____
2. Checked DA Form 5817 to ensure the accuracy of angles observed.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1943	
DA FORM 5817	
DMS ST 031	

Check Distance Data

052-260-2489

Conditions: As a topographic surveyor, given Department of the Army (DA) Form 5819 or National Imagery and Mapping Agency (NIMA) Form 8900-2, the project directive, a scientific calculator, and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Check distance data. All entries on DA Form 5819 or NIMA Form 8900-2 must be complete, neat, and legible and conform to third-class specifications and the unit's standing operating procedure (SOP). Correct any errors or omissions that are found.

Performance Steps

1. Check DA Form 5819 or NIMA Form 8900-2 to ensure that all entries are complete, neat and legible and that the--
   a. Project name and organization blocks are complete and accurate.
   b. Date and approximate distance blocks are complete and accurate.
   c. Azimuth of line, mean latitude, and calibration date blocks are complete and accurate.
   d. Observer and recorder blocks are complete and accurate.
   e. Master/remote or instrument/target blocks are complete and accurate.
   f. Height of instrument (HI), height of target (HT), eccentricity, and instrument/target numbers blocks are complete and accurate.
2. Check DA Form 5819 or NIMA Form 8900-2 to ensure the accuracy of distances measured. Note any errors or omissions. Ensure that--
   a. Sums, means, and differences are accurately computed and entered.
   b. Uncorrected distances are accurately resolved and entered.
   c. Distance measurements meet project requirements.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. The project directive should make reference to third-order specifications.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to check distance data.

Performance Measures	**GO**	**NO GO**
1. Checked DA Form 5819 or NIMA Form 8900-2 to ensure that all entries were complete, neat and legible.	____	____
2. Checked DA Form 5819 or NIMA Form 8900-2 to ensure the accuracy of distances measured. Noted any errors or omissions.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5819	
DMS ST 031	
NIMA FORM 8900-2	

Compute a Geodetic Traverse

052-260-2490

Conditions: As a topographic surveyor in a secure field environment, given a sketch of the traverse on Department of the Army (DA) Form 1962, starting and closing geodetic azimuths, all observed field angles for the traverse, all geodetic distances, geographic coordinates of the starting and closing stations, instructions on how to compute a geodetic traverse, Defense Mapping School (DMS) Special Text (ST) 031, DA Forms 1923 and 1962, and a scientific calculator.

Standards: Demonstrate the ability to correctly compute and adjust the geodetic positions of the unknown traverse stations to the nearest 0.001" of arc. Enter all computations on DA Forms 1923 and 1962. All entries must be accurate, neat, and legible.

Performance Steps

1. Perform the preliminary and final position computations on DA Form 1923 using the information given on DA Form 1962 (Figures 052-260-2490-1, 052-260-2490-2, and 052-260-2490-3).

Performance Steps

POSITION COMPUTATION, 1b **ORDER TRIANGULATION (For calculating machine computation)**
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

PROJECT 1a		
LOCATION 1a	ORGANIZATION 1a	DATE (YYYYMMDD)

			° 1a	′	″				° 1a	′	″
a	2 1c	To 3 1c	1e			*a*	3	To 2			
$2^d\angle$		&	+ 1f			$3^d\angle$		&	—		
a	2 1c	To 1 1c	1g			*a*	3	To 1			
Δ *a*			1aa			Δ *a*					
			180	00	00.00				180	00	00.00
a′	1	To 2	1ab			*a′*	1	To 3			

°	′	″	First Angle of Triangle		°	′	″	°	′	″			°	′	″
φ	1d		2 1c	λ	1d			φ			3	λ			
	1t		s= 1d	Δλ	1w						s=	Δλ			
φ′	1s		1 1c	λ′	1x			φ′			1	λ′			

Δφ 1u	(log s= b=(y/10,000) 2)	Δφ	(log s= b=(y/10,000) 2)
sin *a* 1h	x cor.= $-\frac{1}{2}$ fb	sin *a*	x cor.= $-\frac{1}{2}$ fb
cos *a* 1h	x′ 1k	cos *a*	x′
x=s sin *a* 1i	H 1v	x=s sin *a*	H
y= −s cos *a* 1j	Hx′=(approx. Δλ″) 1w	y= −s cos *a*	Hx′=(approx. Δλ″)
a=(x′/10,000) 2 1l	Arc − sin cor =+ $\frac{V (Va)}{15}$	a=(x′/10,000) 2	Arc − sin cor =+ $\frac{V (Va)}{15}$
y cor.=+fa	Δλ″	y cor.=+fa	Δλ″
y_o 1n	sin φ	y_o	sin φ
y′ 1m	sin φ′	y′	sin φ′
y_1 1o	1+ cos Δφ	y_1	1+ cos Δφ
Va — 1q	$\frac{\sin\phi + \sin\phi'}{1+\cos\Delta\phi}$ or sin ϕ_m 1y	Va —	$\frac{\sin\phi + \sin\phi'}{1+\cos\Delta\phi}$ or sin ϕ_m
y_2 1r	− Δ*a*″ (approx.) 1z	y_2	− Δ*a*″ (approx.)
V 1p	+ F (Δλ″) 3	V	+ F (Δλ″) 3
K (Va/1,000)^2 +	− Δ*a*″	K (Va/1,000)^2 +	− Δ*a*″

COMPUTED BY 1ac	DATE (YYYYMMDD)	CHECKED BY	DATE (YYYYMMDD)	NOTE: For *s*. under 8,000 meters omit terms under the heavy *black line not in heavy bold type or underlined.*

DA FORM 1923, FEB 57 USAPA V1.00

Figure 052-260-2490-1
Sample of DA Form 1923 With Block Numbers

Performance Steps

PROJECT: Sample

TABULATION OF GEODETIC DATA

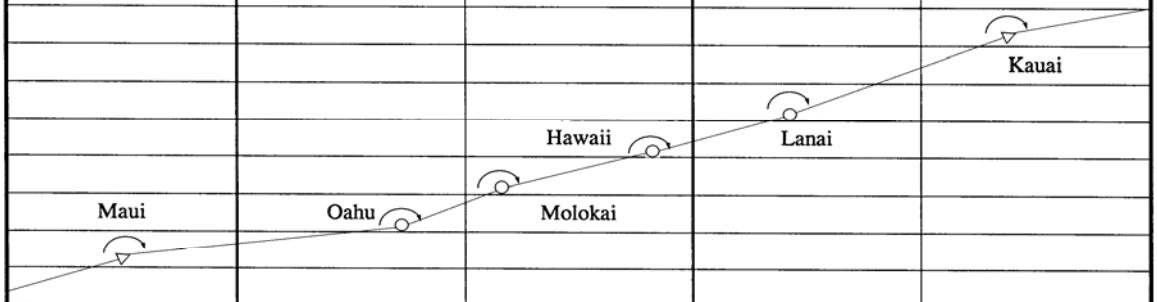
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION: Anywhere

ORGANIZATION: Anyone

STATION	Fixed Latitude	Fixed Longitude	Fixed Azimuth to Reference Mark	Reference Mark
Maui	32 42 ′ 06.397 ″	-114 00 ′ 44.140 ″	253 56 ′ 41.07 ″	Niihau
Kauai	32 50 ′ 38.641 ″	113 21 ′ 38.157 ″	77 40 ′ 44.33 ″	Kahoolawe
	Field Angles	Geodetic Distribution		
Maui	193 29 ′ 30.28 ″	11173.740		
Oahu	160 32 ′ 12.28 ″	13369.798		
Molokai	197 59 ′ 37.12 ″	11402.707		
Hawaii	168 09 ′ 29.31 ″	15074.201		
Lanai	170 21 ′ 07.36 ″	12829.542		
Kauai	192 50 ′ 55.51 ″	----------		

Sample



TABULATED BY: SSG Zambrano

DATE (YYYYMMDD): 2001/05/25

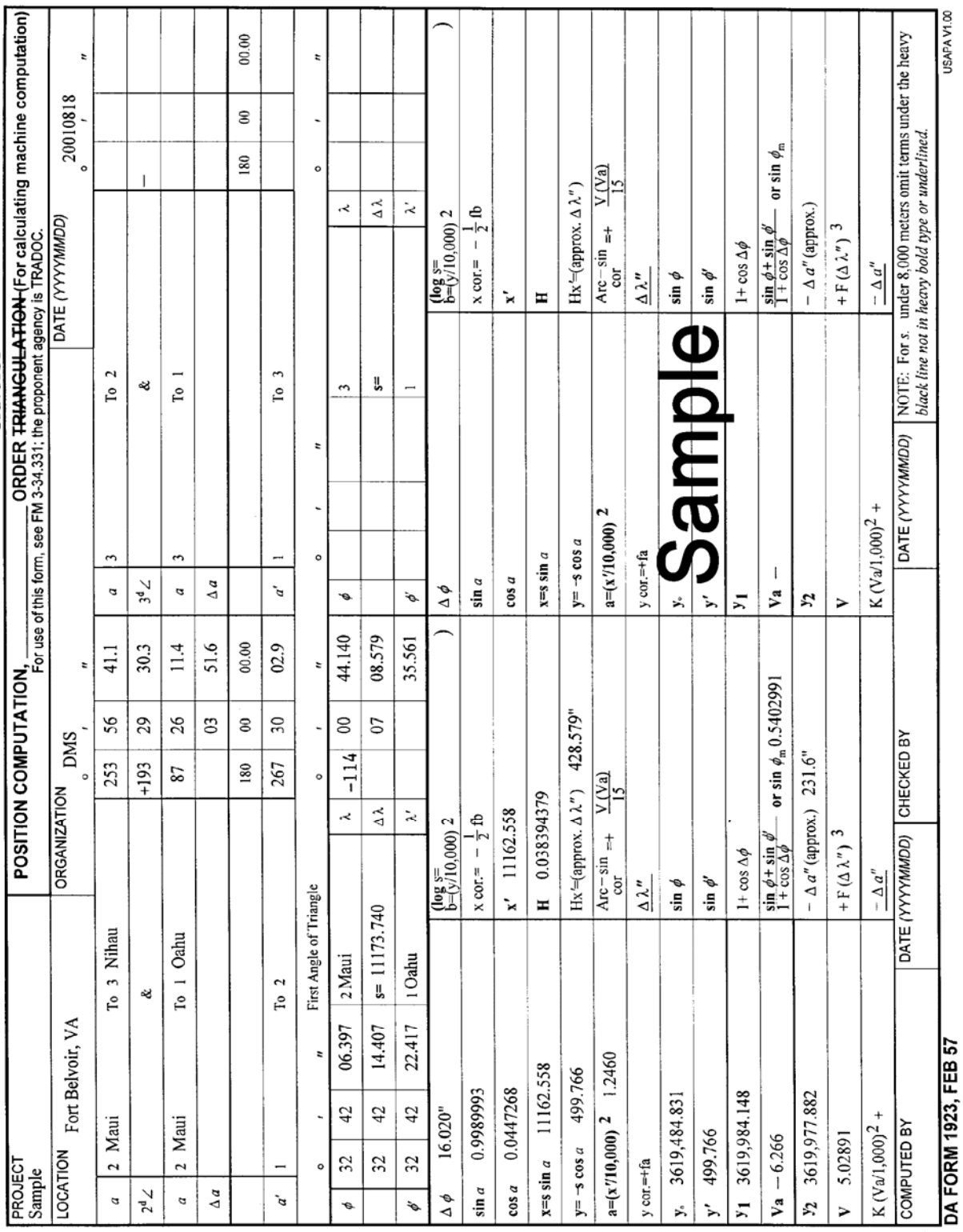
CHECKED BY:

DATE (YYYYMMDD):

DA FORM 1962, FEB 57 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.01

Figure 052-260-2490-2
Completed Sample of DA Form 1962

Performance Steps



Traverse

PROJECT: Sample

POSITION COMPUTATION, ~~**ORDER TRIANGULATION**~~ (For calculating machine computation)
For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION: Fort Belvoir, VA

ORGANIZATION

DATE (YYYYMMDD): 20010818

		DMS °	′	″			DMS °	′	″			DMS °	′	″
a	2 Maui To 3 Nihau	253	56	41.1	*a*	3 To 2								
2d ∠	&	+193	29	30.3	3d ∠	&					—			
a	2 Maui To 1 Oahu	87	26	11.4	*a*	3 To 1								
Δ *a*			03	51.6	Δ *a*									
		180	00	00.00								180	00	00.00
a′	1 To 2	267	30	02.9	*a′*	1 To 3								

First Angle of Triangle

	°	′	″			°	′	″			°	′	″
ϕ	32	42	06.397	2 Maui	λ	−114	00	44.140	*ϕ*	3	λ		
	32	42	14.407	s= 11173.740	Δ λ		07	08.579	s=		Δ λ		
ϕ′	32	42	22.417	1 Oahu	λ′			35.561	*ϕ′*	1	λ′		

Δ *ϕ* 16.020″

sin *a* 0.9989993

cos *a* 0.0447268

x=s sin *a* 11162.558

y= −s cos *a* 499.766

$a=\frac{(x'/10{,}000)^2}{\text{cor}}=+\frac{V(Va)}{15}$ 1.2460

y cor.=+fa

y. 3619,484.831

y′ 499.766

Y1 3619,984.148

Va −6.266

Y2 3619,977.882

V 5.02891

K (Va/1,000)2 +

$\log \frac{s=}{b=(y/10{,}000)\ 2}$

x cor.= $-\frac{1}{2}$ fb

x′ 11162.558

H 0.038394379

Hx′=(approx. Δ λ″) 428.579″

$\frac{\Delta\lambda''}{\text{cor}}=+\frac{V(Va)}{15}$ 1.2460

y cor.=+fa

$\frac{\sin\phi}{1+\cos\Delta\phi}$ or sin ϕ_m 0.5402991

− Δ *a*″ (approx.) 231.6″

+ F (Δ λ″) 3

$-\frac{\Delta a''}{\text{K (Va/1,000)}^2+}$

$\log \frac{s=}{b=(y/10{,}000)\ 2}$

x cor.= $-\frac{1}{2}$ fb

x′

H

Hx′=(approx. Δ λ″)

$\frac{\Delta\lambda''}{\text{cor}}=+\frac{V(Va)}{15}$

$\frac{\sin\phi}{1+\cos\Delta\phi}$ or sin ϕ_m

− Δ *a*″ (approx.)

+ F (Δ λ″) 3

$-\frac{\Delta a''}{\text{K (Va/1,000)}^2+}$

COMPUTED BY | DATE (YYYYMMDD) | CHECKED BY | DATE (YYYYMMDD)

NOTE: For *s* under 8,000 meters omit terms under the heavy black line not in heavy bold type or underlined.

DA FORM 1923, FEB 57 USAPA V1.00

Figure 052-260-2490-3
Completed Sample of DA Form 1923

Performance Steps

NOTE: This computation is for lines under 8,000 meters.

a. Fill in the project name, location name, organization, and date and label as a preliminary or final position computation in blocks 1a.
b. Strike out the word "triangulation" and write in "traverse", insert "class and order" in the blank in block 1b.
c. Fill in the station designations as follows (blocks 1c):
   (1) Occupied station.
   (2) Rear station.
   (3) Forward station.

NOTE: On the first position computation, the occupied station is the first occupied traverse station. The rear station is the azimuth control station and the forward station is the second traverse station. On the next computation, the first forward station becomes the occupied station and the other stations change accordingly.

d. Record the latitude and longitude of the occupied station and the geodetic distance from the occupied station to the forward station in blocks 1d to three decimal places with the sign.
e. Record the geodetic azimuth from the occupied station to the rear station in block 1e to one decimal place.
f. Record the angle at the occupied station in block 1f to one decimal place. Cross out the preprinted plus or minus sign.

NOTE: On the preliminary computations, use the observed field angles. On the final computation, use the adjusted field angles from the azimuth closure and adjustment computations.

g. Compute the forward azimuth. Add the angle at the occupied station to the azimuth for the rear station. If the sum exceeds 360°, subtract 360° and record it in block 1g to one decimal place.
h. Record the sine and cosine of the forward azimuth in blocks 1h to seven decimal places with the sign.
i. Compute X (difference applied to longitude) using the following formula and record it in block 1i to three decimal places with the sign.

   X = geodetic distance x sine of the forward azimuth.

j. Compute Y (difference applied to latitude) using the following formula and record it in block 1j to three decimal places with the sign.

   Y = geodetic distance x cosine of the forward azimuth.

NOTE: Each spheroid requires a different set of tables for position computation.

k. Compute X' and record it in block 1k to three decimal places with the sign.

   X' = X

   where--
   X = Difference applied to longitude.

l. Compute a (constant for the reference ellipsoid) using the following formula and record it in block 1l to four decimal places with the sign. The sign is always positive.

   a = (X'/10,000)squared

   where--
   X' = X
   X = Difference applied to longitude.

Performance Steps

m. Compute Y' using the following formula and record it in block 1m to three decimal places with the sign.

Y' = Y

where--
Y = Difference applied to latitude.

n. Interpolate for Yo (meridional arc value) from Special Publication (SP) 241. The argument is the latitude of the occupied station. Record this value in block 1n to three decimal places with the sign. The sign is the same as the latitude sign.

o. Compute Y1 (modified meridional arc value) using the following formula and record it in block 1o to three decimal places with the sign.

Y1 = Yo + Y'

where--
Yo = Meridional arc value.
Y' = Y
Y = Difference applied to latitude.

p. Interpolate from SP 241 for V (correction to the observed angle). The argument is Y1. Be sure to apply the correction for V. The argument for the correction is the rounded thousands of meters of Y1. Record this value in block 1p to five decimal places with the same sign as the latitude of the occupied station.

q. Compute V times a. Delete the preprinted (-) sign. Record this value in block 1q to three decimal places with the sign.

V = Correction to the observed angle.
a = Constant for the reference ellipsoid.

r. Compute Y2 (final meridional arc value) using the following formula and record it in block 1r to three decimal places with the sign.

Y2 = Y1 - Va

where--
Y1 = Modified meridional arc value.
V = Correction to the observed angle.
a = Constant for the reference ellipsoid.

s. Interpolate for the latitude of the forward station. The argument is Y2. Record as degrees, minutes, and seconds and record the seconds to three decimal places in block 1s with the sign.

t. Compute the mean latitude using the following formula and record it in block 1t to three decimal places with the sign.

Mean latitude = (latitude + the latitude of the forward station) divided by 2.

u. Compute the difference in latitude using the following formula and record it in block 1u.

Difference in latitude = the latitude of the forward station - the latitude of the occupied station.

v. Use SP 241 to determine H and record this value in block 1v to nine decimal places. Enter the degrees and minutes of the latitude of the forward station as the argument.

Performance Steps

w. Compute the difference in longitude using the following formula and record it in blocks 1w to three decimal places with the sign. Convert to degrees, minutes and seconds and record it in the delta longitude block of the occupied station.

Difference in longitude = HX'

where--
H = Correction applied to the difference in longitude.
X' = X
X = Difference applied to longitude.

x. Compute the longitude prime using the following formula and record it in block 1x.

Longitude prime = longitude + the difference in longitude.

y. Derive the sine of the mean latitude and record it in block 1y to seven decimal places with the sign.

z. Compute the difference in sigma using the following formula and record it in block 1z to one decimal place with the sign. Delete the preprinted (-) before the difference-in-sigma character.

Difference in sigma = (sine of the mean latitude) x (difference in longitude)

aa. Convert the difference in sigma to degrees, minutes, and seconds and record it in block 1aa to one decimal with the sign.

NOTE: The sign of the value may be checked as follows--in the northern hemisphere, convergence is positive when the forward azimuth is between 0° and 180° and negative when the forward azimuth is between 180° and 360°.

ab. Compute the back azimuth. Algebraically add the forward azimuth, the convergence, and 180°. If necessary, subtract 360° and record this value in block 1ab to one decimal place.

ac. Sign and date the form in block 1ac.

2. Compute the azimuth closure and adjustment on DA Form 1962 (Figures 052-260-2490-4 and 052-260-2490-5).

Performance Steps

PROJECT 2a		TABULATION OF GEODETIC DATA For use of this form, see FM 3-34.331; the proponent agency is TRADOC.		
LOCATION 2a		ORGANIZATION 2a		
STATION				
2a	2b			
			2c	
			2d	
			2e	
			2f	
			2g	
2a	2h	2i		
TABULATED BY 2j		DATE (YYYYMMDD) 2j	CHECKED BY	DATE (YYYYMMDD)

Sample

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Figure 052-260-2490-4
Sample of DA Form 1962 With Block Numbers

Performance Steps

PROJECT: Sample

TABULATION OF GEODETIC DATA

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION: Anywhere

ORGANIZATION: Anyone

STATION	Field Angles	Back Azimuths	Computed Azimuth	
Maui	193° 29′ 30.28″	253° 56′ 41.07″		
Oahu	160° 32′ 12.28″	267° 30′ 02.91″		
Molokai	197° 59′ 37.12″	248° 06′ 32.72″		
Hawaii	168° 19′ 29.31″	266° 10′ 06.29″		
Lanai	170° 21′ 07.36″	254° 24′ *37.57″*		
Kauai	192° 50′ 55.51″	244° 49′ 46.43″	77° 40′ 41.94″	
		Fixed azimuth	77° 40′ 44.33″	
		Error =	-0.6″	
		AE =	10″ * SQ RT (N)	N = number of dists
		AE =	22.4″	
		Correction per sta =	0.1″	
	Corrections	Adjusted Field Angles		
Maui	0.1″	193° 29′ 30.4″		
Oahu	0.1″	160° 32′ 12.4″		
Molokai	0.1″	197° 59′ 37.2″		
Hawaii	0.1″	168° 19′ 29.4″		
Lanai	0.1″	170° 21′ 07.5″		
Kauai	0.1″	192° 50′ 55.6″		
Sum	0.6″			

Sample

TABULATED BY: SSG Zambrano

DATE (YYYYMMDD): 2001/05/25

CHECKED BY:

DATE (YYYYMMDD):

DA FORM 1962, FEB 57 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.01

Figure 052-260-2490-5
Completed Sample of DA Form 1962

Performance Steps

NOTE: This adjustment is performed after the preliminary position computations have been completed for the entire traverse.

a. Fill in administrative data and list the traverse stations in order from first to last in blocks 2a.
b. List the observed field angles next to the appropriate station in block 2b.
c. Compute the azimuth from the final traverse station to the azimuth control mark by adding the last back azimuth and the observed field angles at the last traverse station. If necessary, subtract 360° and record this value in block 2c to one decimal place.
d. Record the fixed azimuth from the last traverse station to the azimuth control mark and record this value in block 2d to one decimal place. This is the "known" or previously surveyed azimuth over the line.
e. Compute the error in azimuth closure using the following formula and record it in block 2e to one decimal place with the sign.

   (error = computed azimuth - fixed azimuth).
f. Compute the allowable error (AE) and record it in block 2f.

NOTE: Refer to DMS ST 031 for the accuracy specifications of the AE.

g. Compute the correction per station using the following formula and record it in block 2g.

   Correction per station = -(error divided by the number of stations).

NOTE: The correction has the opposite sign of the error.

h. Compute the corrections for each individual station and record this sum in block 2h. The sum of the corrections must exactly equal the error but have the opposite sign. When the error is not evenly divisible by the number of stations, the larger corrections are applied to the larger angles for uniformity.
i. Compute the adjusted field angles. Algebraically combine the corrections to the observed field angles and record this value in block 2i to one decimal place.
j. Sign and date the form in blocks 2j.

NOTE: These adjusted field angles are now used in the final set of position computations on DA Form 1923 instead of the observed field angles. Label a new DA Form 1923 as "final" and repeat step 1.

3. Compute the position closure and adjustment on DA Form 1962 (Figures 052-260-2490-6 and 052-260-2490-7).

Performance Steps

PROJECT 3a		TABULATION OF GEODETIC DATA For use of this form, see FM 3-34.331; the proponent agency is TRADOC.		
LOCATION 3a		ORGANIZATION 3a		
STATION				
3a	3b			
	3c			
		3c		3c
	3d 3q	3r	3d 3q	3r
		3c		3c
	3f	3f		
	3g	3g		
	3h	3h		
	3i			
	3j			
	3k			
	3l			
	3m			
	3n			
	3o			
	3p			
TABULATED BY 3t	DATE (YYYYMMDD) 3t	CHECKED BY	DATE (YYYYMMDD)	

DA FORM 1962, FEB 57 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.01

Figure 052-260-2490-6
Sample of DA Form 1962 With Block Numbers

Performance Steps

PROJECT: Sample

TABULATION OF GEODETIC DATA

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

LOCATION: Anywhere

ORGANIZATION: Anyone

STATION				
	Distance			
Maui				
Oahu	11173.740			
Molokai	13369.798			
Hawaii	11402.707			
Lanai	15074.201			
Kauai	12829.542			
Sum	63849.988			
	Difference Correction	Latitude	Difference Correction	Longitude
Maui		32° 42′ 06.397″		-114° 00′ 44.140″
Oahu	0′ 16.020″ -0.001	32° 42′ 22.416″	7′ 08.579″ 0.001	-113° 53′ 35.560″
Molokai	1′ 57.839″ -0.002	32° 44′ 20.253″	6′ 41.913″ 0.001	-113° 46′ 53.646″
Hawaii	1′ 34.578″ -0.001	32° 45′ 54.830″	9′ 52.112″ 0.001	-113° 37′ 01.533″
Lanai	2′ 07.431″ -0.002	32° 48′ 02.259″	7′ 34.557″ 0.002	-113° 29′ 26.974″
Kauai	2′ 36.384″ -0.002	32° 50′ 38.641″	7′ 48.816″ 0.001	-113° 21′ 38.157″
	Latitude	Longitude		
Computed difference	08′ 32.252″	39′ 45.959″		
Fixed difference	08′ 32.244″	39′ 45.965″		
Error arc	0.008	-0.006		
Difference/second	30.804717			
H	0.038420300			
Latitude error dist	0.246			
Longitude error dist	-0.156			
LEC	0.2913	Square root (latitude	error squared + longitude	error squared)
RC	1:217958.697	1:(sum of dist/LEC)		
AE	3.196			
Corrected latitude	-0.00000013			
Corrected longitude	+0.00000010			

TABULATED BY: SSG Zambrano

DATE (YYYYMMDD): 2001/05/25

CHECKED BY:

DATE (YYYYMMDD):

DA FORM 1962, FEB 57 EDITION OF FEB 57 IS OBSOLETE. USAPA V1.01

Figure 052-260-2490-7
Completed Sample of DA Form 1962

Performance Steps

NOTE: This adjustment is performed after the completion of the final position computations. All values are recorded to three decimal places unless otherwise noted.

a. Fill in administrative data and list the traverse stations in order from first to last in blocks 3a.

NOTE: Before beginning this adjustment, recompute the azimuth check as in the azimuth closure computation (step 2c) by using the last (final computation) back azimuth and adjusted field angles (step 2i). If the computed forward azimuth to the azimuth mark from the last traverse station does not exactly match the fixed azimuth, then the computations are invalid because of a math error.

b. List the geodetic distance of each leg next to the forward station of that leg in block 3b.
c. Record the known latitude and longitude of the starting and ending traverse stations in blocks 3c.
d. List the difference in latitude and the difference in longitude in seconds for each leg (obtained from DA Form 1923 [final position computations]) in blocks 3d.

NOTE: All differences, errors, and corrections require an algebraic sign.

e. Sum the distances and record this value in block 3e.
f. Algebraically sum the difference in latitude and the difference in longitude and record these values in blocks 3f with the sign.
g. Compute the fixed difference in latitude and longitude for the traverse using the following formulas. Convert the difference for latitude and longitude to seconds and record these values in blocks 3g with the sign.

   Fixed difference in latitude = the latitude of the ending station - the latitude of the starting station.

   Fixed difference in longitude = the longitude of the ending station - the longitude of the starting station.
h. Compute the error in arc for latitude and longitude using the following formulas. Record these values in blocks 3h.

   Error in arc = (computed difference in latitude) - (fixed difference in latitude).

   Error in arc = (computed difference in longitude) - (fixed difference in longitude).
i. Extract the difference per second for the meridional arcs (meters) from SP 241. The argument is the degrees and minutes of the mean latitude for the traverse. Sum and mean the latitudes of the starting, ending, and all intermediate stations (unadjusted). Round the mean latitude to the nearest minute and record the value in block 3i to the number of places as in SP 241.
j. Extract H from SP 241. The argument is the same as the mean latitude in step 3i above. Record the value in block 3j to nine decimal places.
k. Compute the latitude error (distance) using the following formula and record it in block 3k to three decimal places with the sign.

   Latitude error (distance) = (latitude error [arc]) x (difference per second).
l. Compute the longitude error (distance) using the following formula and record it in block 3l to three decimal places with the sign.

   Longitude error (distance) = (longitude error [arc]) divided by H.
m. Compute the liner error of closure (LEC) using the following formula and record it in block 3m to four decimal places.

   LEC = square root of (latitude error distance squared) + (longitude error distance squared).
n. Compute the ratio of closure (RC) using the following formula and record it in block 3n.

   RC = 1:length of the traverse divided by the LEC (for example 1:10,000).

Performance Steps

o. Compute the allowable error (AE) of the position closure and record it in block 3o. The LEC must be less than the LEC for the traverse to meet specifications. If the traverse does not meet specifications, no further computations are required.

NOTE: Refer to DMS ST 031 for the required accuracy specifications and formulas.

p. Compute the correction in latitude per meter using the following formula and record this value in block 3p to eight decimal places with the sign.

Correction = - (latitude error arc) divided by (total length of the traverse).

NOTE: The sign will always be opposite the sign of the error.

q. Compute the latitude correction per station using the following formula and record it in blocks 3q with the sign.

Correction per station = (correction of latitude per meter) x (length of the traverse leg).

NOTE: After all corrections are recorded, sum the column. The sum of the correction must equal the error (arc) with the opposite sign. If, because of round-off errors, the sum does not exactly equal the error (arc), the difference must be distributed. For uniformity, the largest corrections are changed by one in the third decimal place until the correct sum is obtained.

r. Compute the adjusted latitude for each station and record it in block 3r. The adjusted latitude of each station is obtained by algebraically adding the difference in latitude and latitude correction per station to the latitude of the proceeding station.

NOTE: As a math check, the sum of the last difference, last correction per station, and latitude of the proceeding station must equal the fixed latitude of the closing station.

s. Compute the corrections and adjusted longitude by repeating steps 3p through r as specified for latitude.

t. Sign and date the form in blocks 3t.

NOTE: To obtain a final azimuth and distance between any two stations along the traverse, an inverse computation must be made since the position adjustment will change the azimuth and distance used in the computation.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to compute a geodetic traverse.

Performance Measures	**GO**	**NO GO**
1. Performed the preliminary and final position computations on DA Form 1923 using the information given on DA Form 1962.	____	____
NOTE: This computation is for lines under 8,000 meters.		
2. Computed the azimuth closure and adjustment on DA Form 1962.	____	____
3. Computed the position closure and adjustment on DA Form 1962.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 1923	
DA FORM 1962	
DMS ST 031	

References

Required	**Related**
SP 241	

Subject Area 4: Level

Perform Operator Maintenance on a Leveling Instrument
052-260-2332

Conditions: As a topographic surveyor, given a level (with all accessories and Technical Manual [TM] 5-6675-329-13&P), level rods, appropriate cleaning materials, two copies of Department of the Army (DA) Form 2404, two turning pins, two 2-pound hammers, and two rod levels.

Standards: Perform operator maintenance on a level according to TM 5-6675-329-13&P or the manufacturer's manual and record deficiencies on DA Form 2404.

Performance Steps

1. Inspect the instrument for damage or wear.
    a. Visually inspect the instrument for broken or missing parts.
    b. Check for cracked or scratched lenses.
2. Clean the level with a dry, lint-free cloth.
    a. Take the instrument indoors after use in moist weather.
    b. Open the transport case and remove the instrument.
    c. Allow the instrument to dry naturally.
    d. Allow condensation on the lenses to evaporate naturally.
3. Clean all glass surfaces with lens tissue and solution.
    a. Use caution when removing dust or sand from lenses.
    b. Use an antistatic lens paper, cotton wad, or lens brush, if possible.
    c. Never use a coarse or dirty cloth or hard paper.
4. Inspect the level and controls for damage and proper function.
    a. Inspect the horizontal traversing and slow-motion mechanism for proper operation.
    b. Inspect the reticle for smooth operation.
    c. Inspect the telescope focusing mechanism for smooth operation.
    d. Rotate the three leveling foot screws and inspect for rough travel and instability.
5. Clean the level accessories and the hand levels, turning pins, and hammers with mild detergent and warm water. Wipe them dry immediately.
6. Record uncorrectable faults on DA Form 2404 (see Figure 052-260-2332-1).

Performance Steps

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

For use of this form, see DA PAM 738-750 and 738-751; the proponent agency is DCSLOG

1. ORGANIZATION	2. NOMENCLATURE AND MODEL
70th Eng Co, 29th Eng Bn Ft. Shafter, HI	Wild Heerbrugg Na2-80 Level

3. REGISTRATION/SERIAL/NSN	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION
SN 02153					06 Dec 99	Monthly

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
TM 5-6675-329-13&P	25 Feb 82		

COLUMN a – Enter TM item number.
COLUMN b – Enter the applicable condition status symbol.
COLUMN c – Enter deficiencies and shortcomings.
COLUMN d – Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e – Individual ascertaining completed corrective action initial in this column.

STATUS SYMBOLS

"X" – Indicates a deficiency in the equipment that places it in an inoperable status.

CIRCLED "X" – Indicates a deficiency, however, the equipment may be operated under specific limitations as directed by higher authority or as prescribed locally, until corrective action can be accomplished.

HORIZONTAL DASH "(-)" – Indicates that a required inspection, component replacement, maintenance operation check, or test flight is due but has not been accomplished, or an overdue MWO has not been accomplished.

DIAGONAL "(/)" – Indicates a material defect other than a deficiency which must be corrected to increase efficiency or to make the item completely serviceable.

LAST NAME INITIAL IN BLACK, BLUE-BLACK INK, OR PENCIL - Indicates that a completely satisfactory condition exists.

FOR AIRCRAFT - Status symbols will be recorded in red.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
1		EXTERNAL SURFACE DIRTY	WIPED DOWN	
2		FOOTSCREW STICKS	OILED IT	
6	X	CIRCULAR LEVEL DOES NOT LEVEL		
10		BOLT ON TRIPOD LOOSE	TIGHTEN IT UP	
		Sample		

DA FORM 2404, APR 79 — Replaces edition of 1 Jan 64, which will be used — USAPPC V1.10

Figure 052-260-2332-1
Completed Sample of DA Form 2404

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Identify all equipment and materials to be used by the soldier. Give him a safety briefing before starting the test. Explain to him that scoring will be based on the proper cleaning, inspection, and maintenance of the leveling equipment. Tell him to perform operator maintenance on a leveling instrument.

Performance Measures	**GO**	**NO GO**
1. Inspected the instrument for damage or wear.	____	____
2. Cleaned the level with a dry, lint-free cloth.	____	____
3. Cleaned all glass surfaces with lens tissue and solution.	____	____
4. Inspected the level and controls for damage and proper function.	____	____
5. Cleaned the level accessories and the hand levels, turning pins, and hammers with mild detergent and warm water. Wiped them dry immediately.	____	____
6. Recorded uncorrectable faults on DA Form 2404.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 2404	
TM 5-6675-329-13&P	

Check Level Data

052-260-2333

Conditions: As a topographic surveyor, given leveling field notes recorded on Department of the Army (DA) Form 5820 or other appropriate media, a scientific calculator, the project directive, and Defense Mapping School (DMS) Special Text (ST) 031.

Standards: Check DA Form 5820 to ensure that the field notes recorded during differential level-line measurements are complete, neat, legible, and correct. The field notes must conform to the third-order specifications and the unit's standing operating procedure (SOP). Correct any errors or omissions that are found.

Performance Steps

1. Check DA Form 5820 to ensure that all entries are complete, neat, legible, and correct; in addition, check the following items. Note any errors or omissions.
   a. An index of the control points.
   b. A description of the level line or network.
   c. A continuous sketch of the fieldwork.
   d. A list of level-party personnel.
   e. The instrument data.
2. Check DA Form 5820 to ensure the accuracy of level-line runs. Note any errors or omissions. Ensure that--
   a. All administrative items are entered on each page.
   b. The differences in rod intervals are three or less.
   c. The length of the sights is less than the maximum allowed.
   d. Individual backsights (BSs) and foresights (FSs) are balanced to within ± 10 meters.
   e. Total BSs and FSs are balanced to within ± 10 meters.
   f. Page checks are performed.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. There should be at least 2 kilometers of leveling field notes with at least three temporary benchmarks included. DA Form 5820 should be used for recording purposes. The project directive should make reference to third-order specifications.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to check level data.

Performance Measures	**GO**	**NO GO**
1. Checked DA Form 5820 to ensure that all entries were complete, neat, legible, and correct. Noted any errors or omissions.	____	____
2. Checked DA Form 5820 to ensure the accuracy of level-line runs. Noted any errors or omissions.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DA FORM 5820	

References

Required

DMS ST 031

Related

Subject Area 5: Differential Global Positioning System

Download Data From the Differential Global-Positioning-System (DGPS) Receiver
052-260-2334

Conditions: As a topographic surveyor, given a DGPS receiver with a session of collected DGPS data, the appropriate accessories, a desktop personal computer (PC) with the DGPS processing and adjustment software, Defense Mapping School (DMS) Special Text (ST) 096 and 097, and instructions on how to download DGPS data.

Standards: Download the DGPS data into the DGPS processing and adjustment software. Download the data according to DMS ST 096 and 097 or the appropriate manufacturer's manuals.

Performance Steps

1. Prepare the DGPS receiver for downloading.
    a. Check and/or set the DGPS receiver configuration.
        (1) Turn on the receiver.
        (2) Locate the screen that displays the transfer controls.
        (3) Ensure that the baud rate, data bits, stop bits, parity, and flow control are properly set. The settings must be the same as those in the computer.
    b. Connect the receiver to the computer.

NOTE: Connect the receiver using the RS-232 cable or other appropriate cables according to the manufacturer's manuals.

2. Start the DPGS downloading program on the PC.

NOTE: Select or create a project file.

3. Check and configure the DGPS downloading program.
    a. Select the "LOAD FROM RECEIVER" option.
    b. Set the processing mode.
    c. Set the communication configuration to match the receiver configuration.
        (1) Set the communication port to match the connection between the receiver and the PC.
        (2) Set the port setting to match the baud rate, data bits, stop bits, parity, and flow control that the receiver is set to.
        (3) Check the "OPTIONS" settings.

4. Establish the connection between the DGPS receiver and the PC with the DGPS processing program.
    a. Select the CONNECT option.
    b. Check the status of the connection.

NOTE: If the connection is successful, a status line will display "CONNECT AT =" and/or the files on the DGPS receiver will be displayed. If not, recheck the communication settings.

5. Transfer the DGPS data.
    a. Select the files for transfer. Select the "ADD ALL" option or highlight each file individually and select the "ADD" option.
    b. Select the "TRANSFER" option.

NOTE: At this point a file transfer message box will appear displaying the transfer progress.

6. Disconnect the DGPS receiver.
    a. Select the "DISCONNECT" option when all of the required files have been transferred from the receiver.
    b. Attach the next receiver to the computer and repeat steps 1 through 5.
    c. Select the "CLOSE" option after the last receiver has been downloaded.
    d. Disconnect the receiver-PC cables and properly store the DGPS receiver.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to download data from the DGPS receiver.

Performance Measures	**GO**	**NO GO**
1. Prepared the DGPS receiver for downloading.	____	____
2. Started the DGPS downloading program on the PC.	____	____
3. Checked and configured the DGPS downloading program.	____	____
4. Established the connection between the DGPS receiver and the PC with the DGPS processing program.	____	____
5. Transferred the DGPS data.	____	____
6. Disconnected the DGPS receiver.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DMS ST 096	
DMS ST 097	

Process Differential Global-Positioning-System (DGPS) Data

052-260-2335

Conditions: As a topographic surveyor, given downloaded DGPS data, DGPS-session field notes, a desktop personal computer (PC) with the DGPS processing and adjustment software, DGPS-software user's manuals, Defense Mapping School (DMS) Special Text (ST) 096 and 097, DGPS operator's manual, and instructions on how to process DGPS data.

Standards: Process DGPS data using the DGPS processing and adjustment software. Process the data according to DMS ST 096 and 097 or the DGPS operator's manual.

Performance Steps

1. Enter the DGPS processing program.
2. Check the data.
   a. Select the project.
   b. Select "LOAD."
   c. Select "FROM DAT FILE."
   d. Select the individual files you wish to check or the "ADD ALL" option.
   e. Select "LOAD DATA."
3. Load the baselines.
   a. Select "PROCESS."
   b. Select "BASELINES."
   c. Select "ADD ALL." After the files are added, click "OK."
4. Select the processing options.
   a. Select "OPTIONS."
   b. Enable the "NOTIFY ON COMPLETION" option.
   c. Select "LOG ACTIVITY" and choose the "STANDARD" option.
   d. Select "TIME DISPLAY" and enable the "LOCAL" option.
   e. Select "SOLUTION DISPLAY" and "BEST."
5. Set up the processing session.
   a. Select "PROCESS" and "SETUP."
   b. Select "USER DEFINED" and click "OK."
6. Edit the occupations.
   a. Select "EDIT" and "OCCUPATIONS."
   b. Highlight the occupation to edit and click "EDIT."
   c. Use the drop-down lists for the station, antenna type, and measurement method to make the necessary edits and click "OK" when finished.
7. Enter the precise station coordinates.
   a. Select "EDIT" and "STATION POSITION."
   b. Use the drop-down list to select the stations.
   c. Enter the precise coordinates for latitude, longitude, and height and include the hemisphere attribute.
   d. Choose the position quality that best suits the coordinates.
8. Select the baseline sets and set the reference coordinates.
   a. Select "EDIT," "NETWORK," and "STATIC."
   b. Select the baseline sets
      (1) Click on the "ADD" option.
      (2) Use the drop-down list to select "FROM" and "TO" stations.
      (3) Select the start time for the session of baseline to be observed and click "OK."
   c. Set the reference coordinates.

Performance Steps

(1) Highlight the first baseline set.
(2) Use the drop-down list to select the reference station for the first baseline set.
(3) Repeat steps 1 and 2 for each baseline set.
(4) Repeat steps 8b and c to add additional independent baseline sets.

d. Click "OK" after completing the selection of all independent baselines.
e. Use the scroll bar to check the list of the baselines selected.

9. Process the baselines.
   a. Select "PROCESS" and "BASELINES."
   b. Check the number of baselines processing to match the number of independent baselines selected.
   c. Select "RESULTS" and "SOLUTION SUMMARY" to view the processing session.
   d. Click "OK" to exit the processing menu once the processing is complete.
   e. Review the detailed summary associated with each individual baseline.
      (1) Check the solution types.
      (2) Check the ratio.
      (3) Check the reference variance.

10. Save the processing session.
    a. Select "FILE" and "SAVE."
    b. Enter comments in the dialog box and click "OK."

11. Check the results.
    a. Select "VIEW" and "NETWORK MAP" to view a map of the network from the main GPSurvey menu.
    b. Select "REPORTS" and "CLOSURE LOG" to view loop-closure information.
    c. Select "REPORTS" and "BASELINE LOG" to view baseline information.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met. For the purpose of this evaluation, use static global positioning system (GPS) observation sessions.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to process DGPS data.

Performance Measures	**GO**	**NO GO**
1. Entered the DGPS processing program.	____	____
2. Checked the data.	____	____
3. Loaded the baselines.	____	____
4. Selected the processing options.	____	____
5. Set up the processing session.	____	____
6. Edited the occupations.	____	____
7. Entered the precise station coordinates.	____	____
8. Selected the baseline sets and set the reference coordinates.	____	____
9. Processed the baselines.	____	____
10. Saved the processing session.	____	____

Performance Measures	GO	NO GO
11. Checked the results.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	Related
DGPS OPERATOR´S MANUAL	
DMS ST 096	
DMS ST 097	

Adjust Differential Global-Positioning-System (DGPS) Networks

052-260-2504

Conditions: As a topographic surveyor, given processed DGPS data, a desktop personal computer (PC) with the DGPS processing and adjustment software, DGPS-software user's manual, Defense Mapping School (DMS) Special Text (ST) 096 and 097, DGPS operator's manual, and instructions on how to adjust a DGPS network.

Standards: Adjust a DGPS network using the DGPS processing and adjustment software. Adjust the data according to DMS ST 096 and 097 or the DGPS operator's manual.

Performance Steps

1. Enter the adjustment module.
   a. Select "ADJUST" from the GPSurvey main menu.
   b. Select the global-positioning-system (GPS) network icon and double click on it.

2. Build the network from the TRIMVEC directory.
   a. Select "BUILD THE GPS NETWORK."
   b. Clear the current network before adding vectors.
   c. Check the network status display. Ensure that the following information is correct:
      (1) Network (the name of the network).
      (2) Datum (the current datum).
      (3) Solutions (the number of solution files loaded).
      (4) Baselines (the number of GPS vectors in the network).
      (5) Unique vectors (the total baselines minus the number of redundant measurements).
      (6) Stations (the number of stations in the network).
   d. Select "VIEW VECTORS." Inspect the result to see if the vectors are reasonable for the equipment and techniques used. For example, when observing a static session, expect an error of ± 5 millimeters + 1 parts per million (ppm) for each kilometer of the baseline length.
   e. Press the escape (ESC) button to exit the network map.

3. Summarize the network.
   a. Check the "APPARENTLY DUPLICATED STATIONS" (look for naming problems).
   b. Check the "REDUNDANT BASELINES" (look for redundancy and for errors).
   c. Check the "GLOBAL NETWORK CLOSURES" (look for decimeter or greater errors).

NOTE: List any problems found by solution number and by station or stations.

4. Save the GPS network to a disk.

5. Enter the network adjustment module. Select "NETWORK ADJUSTMENT."

6. Set the adjustment controls.
   a. Set the "WEIGHTING STRATEGY/GPS/STATION WEIGHTING" (set realistic errors for the height of instrument [HI] and plumbing).
   b. Set the "UNIVARIANT AND BIVARIANT SIGMA SCALARS" to 1.96 and 2.447. Also set "DELUTION OF PRECISION" to display a covariance at 2 sigma.
   c. Fix one known point (latitude and longitude [set the X and Y in the fix column]).

7. Adjust the network by selecting the "ADJUST NETWORK" option.

8. Display and check the adjustment results as follows:

NOTE: Ensure that the steps are within these guidelines in order to have a good network.

   a. Network reference factor is near 1 (correctly estimate the standard error of unit weight). If this value is greater than 1, the error is underestimated. If the error is less than 1, the error is overestimated.
   b. The chi-square test passes.
   c. Each reference factor is around 1 (± 1, not all 0s).

Performance Steps

d. Various component groups' reference factor is near 1.
e. Largest standard residual equals sigma at 2 sigma or 1/2 sigma at 1 sigma.
f. Residual is realistic for the method used.
g. Histogram has a normal distribution.

NOTE: Ensure that 1 sigma equals 68 percent and 2 sigma equals 95 percent.

9. Edit the network adjustment results.
   a. Look for outliers either in the reference factors or in the histograms.

NOTE: If outliers exist, they will be at the top of the largest standard residuals.

   b. Disable an observation if you determine it to be a blunder or unacceptable (only after you have attempted to estimate the standard error of unit weight [scalar]).

NOTE: If you disable an observation and the scalar is set to alternative, set it back to default and readjust.

   c. Return and reset the adjustment controls ("ADJUSTMENT/STATION WEIGHTING/GPS/SCALAR"). Set the scalar to alternative.

10. Readjust the network. Repeat steps 6 and 7 until you pass steps 8a through g. Do not overscale step 6. This is an area to watch.

11. Complete a minimally constrained adjustment. Once you have passed steps 8a through g, set the scalar to "USER DEFINED" and enter the value used on the last adjustment.

NOTE: You have completed a minimally constrained adjustment and are ready to get the geoid heights for the points.

12. Save the network to disk.

Evaluation Preparation: Setup: Provide the soldier with the items that are listed in the conditions statement. Ensure that all safety precautions are followed. The evaluator will prepare the field area and equipment in advance to ensure that the task standards can be met.

Brief Soldier: Give the soldier a safety briefing before starting the test. Tell him to adjust a DGPS network.

Performance Measures	**GO**	**NO GO**
1. Entered the adjustment module.	____	____
2. Built the network from the TRIMVEC directory.	____	____
3. Summarized the network.	____	____
4. Saved the GPS network to disk.	____	____
5. Entered the network adjustment module.	____	____
6. Set the adjustment controls.	____	____
7. Adjusted the network.	____	____
8. Displayed and checked the adjustment results.	____	____
9. Edited the network adjustment results.	____	____
10. Readjusted the network.	____	____
11. Completed a minimally constrained adjustment.	____	____
12. Saved the network to disk.	____	____

Evaluation Guidance: Score the soldier GO if all steps are passed (P). Score the soldier NO-GO if any step is failed (F). If the soldier fails any step, show him how to do it correctly.

References

Required	**Related**
DGPS OPERATOR´S MANUAL	
DMS ST 096	
DMS ST 097	

APPENDIX A - DEPARTMENT OF THE ARMY (DA) FORM 5164-R (HANDS-ON EVALUATION)

A-1. This appendix provides a copy of DA Form 5164-R. Locally reproduce DA Form 5164-R on 8 1/2- by 11-inch paper.

A-2. The use of this form is optional, but highly encouraged. This evaluation allows you to maintain and track the soldier's proficiency at the performance level.

A-3. Use the following instructions to complete DA Form 5164-R. Enter the title and number of the task to be evaluated at the top of the form.

- Enter in column "a" the number of each performance step from the evaluation guide.
- Enter in column "b" each performance step from the evaluation guide that corresponds to the number in column "a." Abbreviate information, if necessary.
- Locally reproduce the partially completed DA Form 1564-R if more than one soldier will be evaluated on the specific task or the same soldier will be evaluated more than once.
- Enter the date, the evaluator's name, and the soldier's name and unit before starting the evaluation.
- Enter a check in column "c" (PASS) or column "d" (FAIL) for each performance step evaluated, as appropriate.
- Check the status block GO or NO-GO.

HANDS-ON EVALUATION For use of this form, see AR 350-57; the proponent agency is ODCSOPS		DATE	
TASK TITLE		**TASK NUMBER**	
ITEM a	PERFORMANCE STEP TITLE B	SCORE (Check One) PASS c	 FAIL d
		☐P	☐F
		☐ P	☐ F
		☐ P	☐F
		☐ P	☐ F
		☐P	☐F
		☐P	☐ F
		☐ P	☐F
		☐ P	☐F
		☐P	☐F
		☐P	☐ F
		☐P	☐F
		☐P	☐F
		☐P	☐F
		☐P	☐F
EVALUATOR'S NAME		UNIT	
SOLDIER'S NAME		STATUS ☐GO NO GO	☐

DA FORM 5164-R, SEP 85
EDITION OF DEC 82 IS OBSOLETE
USAPPC V2.00

APPENDIX B - DEPARTMENT OF THE ARMY (DA) FORM 5165-R (FIELD-EXPEDIENT SQUAD BOOK)

B-1. This appendix provides a copy of an overprinted DA Form 5165-R for the tasks in this STP.

B-2. Trainers should use the following instructions when completing the DA Form 5165-R that is included in this appendix. Blank reproducible forms may be obtained in AR 350-41. All forms may be reproduced locally on 8 1/2- by 11-inch paper.

- Make all entries in pencil.
- Enter the task number and a short title in the appropriate column or use the preprinted form provided.
- Record the date in the GO block if the soldier demonstrates task proficiency to the SM standards. Keep this form current by always recording the most recent date on which the soldier demonstrated task proficiency.
- Record the date in the NO-GO block if the soldier failed to demonstrate task proficiency to the SM standards. Soldiers who fail to perform the task should be retrained and evaluated until they can do the task. Once the soldier performs the task correctly, enter the date in the GO block and erase the previous entry from the NO-GO block.
- Read down each column (GO/NO-GO) to determine the training status of that individual. This will give the trainer a quick indication of tasks on which a soldier needs to be trained or evaluated.
- Read across the rows for each task to determine the training status of all the soldiers. The trainer can readily see on which tasks training should be focused.
- Add the names of newly assigned soldiers to one of the blank columns.
- Line through the training status column of any soldier who departs from the unit.

NOTE TO THE TRAINING MANAGER: The training status of groups can be maintained (such as team, squad, or platoon) in a key critical military occupational specialty (MOS) at any level by entering the level (such as 1st platoon, 2nd platoon, or 3rd platoon) in the column headings. Simply have the trainers report the percentage of their soldiers who have (GO blocks) and have not (NO-GO blocks) demonstrated proficiency on each task and record this information for each level.

FIELD EXPEDIENT SQUAD BOOK For use of this form, see AR 350-57, the proponent agency is ODCSOPS													**SHEET OF**					
USER APPLICATION									**SOLDIER'S NAME**									
	STATUS																	
TASK NUMBER AND SHORT TITLE	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO	GO	NO-GO
brdrs																		

DA FORM 5165-R, SEP 85 EDITION OF DEC 82 IS OBSOLETE USAPPC V1.00

APPENDIX C - CONVERSION FACTORS (UNITED STATES [US] UNITS AND METRIC)

Table C-1. Metric conversion chart

US Units	Multiplied By	Equals Metric Units
Length		
Feet	0.30480	Meters
Inches	2.54000	Centimeters
Inches	0.02540	Meters
Inches	25.40010	Millimeters
Area		
Square inches	6.45160	Square centimeters
Square feet	0.09290	Square meters
Volume		
Cubic inches	16.38720	Cubic centimeters
Cubic feet	0.02830	Cubic meters
Metric Units	**Multiplied By**	**Equals US Units**
Length		
Centimeters	0.39370	Inches
Meters per second	2.23700	Miles per hour
Millimeters	0.03937	Inches
Meters	3.28080	Feet
Meters	39.37000	Inches
Area		
Square centimeters	0.15500	Square inches
Square meters	10.76400	Square feet
Volume		
Cubic centimeters	0.06100	Cubic inches
Cubic meters	35.31440	Cubic feet

GLOSSARY

Section I
Abbreviations

Long	longitude
/	divided by
+	plus
+/-	plus or minus
=	equal
1SG	first sergeant
1ST	first
2ND	second
A/M	angle measure
A6	Table value A6
ACCP	Army Correspondence Course Program
ADJ	adjust
AE	atomic energy; allowable error
AEC	angular error of closure
AISI	automatic integrated survey instrument
AIT	advanced individual training
AN	annually
ANCOC	Advanced Noncommissioned Officers Course
ANT	Antenna
APPROX	approximate
APR	April
AR	Army regulation; armor
ARTEP	Army Training and Evaluation Program
ATTN	attention
AUG	August

AZ	azimuth
B	width of the T beam; width of the stringers; filler block, backward; bulb
B DIST	backward distance
B6	Table value B6
BA	biannually
BDE	brigade, backward difference in elevation
BM	bimonthly, benchmark
BNCOC	Basic Noncommissioned Officers Course
BS	backsight
BW	biweekly
C6	Table value C6
CHRON	chronological
CI	counterintelligence; coordinating installation; close internal
CL	combat lifesaver; centerline; clear
CM	centimeter(s)
CMF	career management field
Comp	Compressor, computer
CORR	correction
CORR´N	correction
COS	cosine
CPL	corporal
CSM	command sergeant major
D	a common size; deflection; depth of stringers; slab depth; fill depth; depth cover; ratio; direct; difference in elevation
D6	Table value D6
DA Form	Department of the Army Form
DA Pam	Department of the Army Pamphlet
DA.	Department of the Army
DCSOPS	Deputy Chief of Staff for Operations and Plans

DDD.MMSS	degrees, minutes, and seconds
DE	directed energy; difference in elevation; difference in easting
Dec	December
Delta northing	Same as delta easting, only in a north-south line.
DH	difference in the horizontal aim
DIFF	difference
DIST	distance
DMS	Defense Mapping School
DN	difference in northing
DPGS	difference global-positioning system
DV	difference in the vertical aim
E	voltage; exposure; empty; easting; east
E´	easting prime
E1	private 1
E2	private 2
E3	private first class
E4	specialist
E5	sergeant; Table value E5
E6	staff sergeant
E7	sergeant first class
E8	master sergeant; first sergeant
E9	sergeant major; command sergeant major
EC	eccentric correction; error of closure
EDME	electronic distance-measuring equipment
ELEV	elevation
ELEV/TRAV	elevation/traverse
ENT	enter
EPMS	Enlisted Personnel Management System

F	frequency; fail; failed; Fahrenheit; full
F DIST	forward distance
FDE	forward difference in elevation
FE	Facilities Engineering; false easting
FEB	February
FM	field manual; frequency modulated/modulation
FREQ	frequency
FS	fire support; Fort Sill; foresight
ft	foot (feet)
GED	general education development
GP	General Purpose; ground plane
GPS	Global-Positioning System
H	blister agent; mean elevation; horizontal distance; hour
HA	horizontal angle
HC	hydrochloric; horizon closure
Height of target	Same as height of instrument except a target is mounted on the tripod.
HH.MMDD	hour, minutes, and seconds
HI	height of instrument; high
horiz	horizontal
hr.	hour(s).
HT	height of target
I	current; Table value 1
i.e.	that is
II	Table value 2
III	Table value 3
IMEM	internal memory
IN; IN	inch(es); Infantry
Individual task	See "Task."

INST	instrument
Instr	Instruction; instructor
INT	internal; initial
ITEP	Individual Training Evaluation Program
ITP	Individual Training Plan
IV	Table value 4
IX	Table value 9
JAN	January
KM	kilometer
KMS	kilometers
L	left; length; lock
LAT	latitude
LEC	linear error of closure
LEV	level
MEAS	measure
MICRO	micrometer
MID E	middle easting
MID N	middle northing
MIN	minimum
MM	millimeter
MNU	menu
MO	Missouri; monthly
MOS	military occupational specialty
MOSC	military occupational specialty code
MSG	message; master sergeant
MSGR	high-accuracy GPS-receiver system
MTP	mission training plan; MOS training plan
N	nose lift relative to baseline; north; neutral; northings; number

N´	northing prime
NCO	noncommissioned officer
NCOES	Noncommissioned Officer Education System
NCOIC	noncommissioned officer in charge
NIMA	National Imagery and Mapping Agency
NO.	number
NR	number
OCT	October
OPNS	operations
OPORD	operation order
P	pass; passed; barometric pressure; mean radius of curvature
P2	p squared
p3	Prime-Power Program; p cubed
P4	p to the fourth power
P5	p to the fifth power
PAM	pamphlet
PC	personal computer; politically correct
P-CODE	point code
PFC	private first class
PGS	pages
PLDC	Primary Leadership Development Course
PNO	point number
PO	Program 0
PPM	parts per million
PRG	program
PVT	private; point of vertical tangency
PWR	power
Q2	q squared

Q3	q cubed
Q4	q to the fourth power
Q5	q to the fifth power
Q6	q to the sixth power
QT	quarterly
R	reverse; right; radius of curvature; rewind
RC	reserve component
REC	radioelectronic combat (not a United States term); recorder
Reciprocal observations	See reciprocal angles.
REF	reference
reg	Regiment; regulation; register
RHO	radius of curvature (denoted by P)
S	secret; safe; grid distance; geodetic distance; second; slope distance; start
SD	solvent, dry cleaning; self-destruct; special duty; slope distance
sec	second; section
Sep	September
SGT	sergeant
SIN	sine
SL	skill level
SLC	sea-level coefficient
SM	soldier's manual
SMCT	soldier's manual of common tasks
SOP	standing operating procedure
SPHER´L	spheroidal
SPS	Standard Positioning Service
SS	stringer spacing; side shot
SSG	staff sergeant

station angle	Angle measured from the rear station to the forward station in a traverse.
STD	standard; sexually transmitted disease
STN#	station number
STP	soldier's training publication
SUST	sustainment
SV	satellite vehicle
T	trained; slab thickness; deck thickness; crown thickness; geodetic azimuth; grid azimuth; slope distance; telescope above station; time
TAN	tangent
TEL	telescope
TG	trainer's guide
TM	technical manual
TNG	training
TOE	table(s) of organization and equipment
TRADOC	United States Army Training and Doctrine Command
Trk	truck; tracking
UD	uncorrected distance; mean uncorrected slope distance
US	United States
USAPPC	US Army Publications & Printing Command
USASMA	United States Army Sergeants Major Academy
USD	unit structure diagram; user-defined sequence
UTM	universal transverse Mercator
V	nerve agent; volt; Table value V
VA	volt-ampere; Virginia; vertical angle
VAL	value
Vertical angle	See zenith distance.
VII	Table value 7
VIII	Table value 8

WK	weekly
WX	weather
X	all weather; none; by; Table value 10
XII	Table value 12
XIII	Table value 13
XMEM	external memory
YYY.MMDD	year, month, and date
Z	zulu time (Greenwich Mean Time); offset correction
ZD	zenith distance
ZEN	zenith

Section II
Terms

°
degree

Abstract
A summary of the results of recorded field notes used for computational purposes.

Allowable error
The amount of error that can be introduced in a survey measurement of distance, elevation, or position and still meet the prescribed specifications.

Azimuth
The direction of one object from another, usually expressed as an angle in degrees relative to true north (azimuths are usually measured in the clockwise direction, thus an azimuth of 90° indicates that the second object is due east of the first).

Azimuth (grid)
The angle in the plane of projection between a straight line and the central meridian (axis of Y) of a plane-rectangular coordinate system.

Azimuth mark
The azimuth to a marked point or adjacent station that is visible from an occupied station, which is determined for use in dependent surveys.

Backsight (BS)
In traversing, a backsight is a sight on a previously established traverse or triangulation station, which is not the closing sight on the traverse; in leveling, a backsight is a reading on a rod that is held on a point whose elevation has been previously determined and is not the closing sight of a level line.

Central meridian

The longitude of the horizontal center of a coordinate system (this longitude value is often the longitude origin of the coordinate system); in the case of the transverse Mercator projection, the CM is the great circle/geodesic at which the projection surface (the cylinder) touches or is tangent to the earth.

Collimation
The line of sight or aiming line of an instrument when coincident with the physical alignment of the instrument; thus a collimation error is the angle between the line of collimation (line of sight) of a telescope and the collimation axis of the instrument.

Convergence
The degree or point at which lines of longitude merge toward the poles.

Coordinates
Linear and/or angular quantities, which designate the position of a point in relation to a given reference frame; there are two general divisions of coordinates used in surveying--polar and rectangular; these may be further subdivided into three classes--plane coordinates, spherical coordinates, and space coordinates.

Corrected distance
A measured distance that has been adjusted by computation to show its true length.

Cosine (cos)
In a right triangle, the ratio of the side adjacent to a given angle to the hypotenuse; the sine of the complement of a given angle or arc.

Declination
In a system of polar or spherical coordinates, the angle at the origin between a line to a point and the equatorial plane, measured in a plane perpendicular to the equatorial plane; the arc between the equator and the point measured on a great circle, which is perpendicular to the equator; as it relates to astronomy, the angular distance to a body on the celestial sphere that is measured north or south through 90° from the celestial equator along the hour circle of the body. Comparable to latitude on the terrestrial sphere and often used as a shortened term for magnetic declination.

Delta easting
The difference in distance from a known point to an unknown point using distance and azimuth to determine it, in an east-west line.

Direct reading
The reading of the horizontal or vertical circle of a theodolite or engineer transit with the telescope in the direct position. In field notes, a direct reading is indicated with a letter D preceding the observed value.

Distance angle
An angle in a triangle opposite a side used as a base in the solution of the triangle or a side whose length is to be computed.

Distance, horizontal
The distance measured in a horizontal plane, as distinguished from a distance measured on a slope. Horizontal distance refers primarily to taped distances or to distances reduced to horizontal by computations.

Eccentric station
A survey point which is offset from the station it represents due to a lack of visibility at the real station or due to other obstacles making it impractical to occupy. An adjustment is always computed to correct for this offset.

Electronic distance-measuring equipment (EDME)

Any measuring device which employs electronics to measure distances, such as microwave and infrared.

Elevation
Vertical distance from a datum, usually mean sea level, to a point or object on the earth's surface. Not to be confused with altitude which refers to points or objects above the earth's surface.

Error
1. The difference between an observed value and the true value of a quantity. 2. A class of small inaccuracies due to imperfections in equipment or techniques, surrounding conditions, or human limitations; not to be confused with blunders or mistakes.

Explement angle
An angle measured from the forward observed station to the rear observed station in a clockwise manner.

Foresight (FS)
An observation of the distance and direction to the next instrument station. In traversing, a foresight is a point set ahead to be used for reference when resetting the transit or line or when verifying the alignment. In leveling, a foresight is the reading on a rod that is held at a point whose elevation is to be determined.

Forward station
The station being observed, such as in a traverse, which would be the next station occupied as work progresses.

Geodetic distance
The distance between two points obtained by computations and adjusted by a scale factor to mean sea level.

Grid coordinates
A network of uniformly spaced horizontal and perpendicular lines (as for locating points on a map).

Grid distance
The distance between two points obtained by computations from grid coordinates of the points.

Height of instrument
In spirit leveling, it is the height of the line of sight of a leveling instrument above the adopted datum. In stadia surveying, it is the height of the center of the telescope (horizontal axis) of the transit or telescopic alidade above the ground or station mark. In trigonometric leveling, it is the height of the center of the theodolite (horizontal axis) above the ground or station mark.

Horizon closure
A control point that determines horizontal positions only, with respect to parallels and meridians or to other lines of reference.

Horizontal control
The survey control points on which the horizontal coordinates have been determined. The coordinates may be either geographic (latitude and longitude) or grid.

Interpolate
To estimate or find an intermediate value by use of computation.

Latitude
The angular distance for a specific spot on the earth's surface from 0° to 90° north or south of the equator.

Line of sight

The straight line between two points (this line is in the direction of a great circle but does not follow the curvature of the earth); also, the line extending from an instrument along which distance objects are seen when viewed with a telescope or another sighting device.

Longitude
The angular distance for a specific spot on the earth's surface from 0° to 90° north or south of the Equator.

micrometer
A precision instrument used for measuring the thickness of the plate and blanket.

Occupied station
A traverse or triangulation station over which a theodolite or an engineer transit is set up for the measurement of angles. Also, a station at which angles have been measured.

OPORD (operation order)
A directive issued by a commander to subordinate commanders for the purpose of effecting the coordinated execution of a plan of action.

P.
.0001 times the difference in longitude or the difference in longitude divided by 10,000.

Parallax
The apparent displacement of the position of a body, with respect to a reference point or system, caused by a shift in the point of observation.

pass/fail
A pass/fail standard of evaluation whereby the soldier either does or does not meet the standard.

Q
easting prime divided by 1,000,000

Reciprocal angles
An angle measured over a line at both ends in trigonometric leveling to eliminate (at least partly) the effects of curvature and refraction. Measurements must be made as close together as possible to eliminate error caused by changing refractive conditions.

References
FMs, SMs, TCs, TMs, GTAs, TECs, ARs, and other publications that support training and provide additional information. A complete list of references is located in the REFERENCE Section.

Spheroid
In general, it is any figure differing slightly from a sphere; in geodesy, it is a mathematical figure closely approaching the geoid in form and size and used as a surface of reference for geodetic surveys.

standing operating procedure (SOP)
a set of instructions covering those features of operations which lend themselves to a definite or standardized procedure without loss of effectiveness. the procedure is applicable unless ordered otherwise.

station
a specific geographic location, normally used in context of the layout of horizontal construction.

Tangent
A line that is tangent; specifically : a straight line that is the limiting position of a secant of a curve through a fixed point and a variable point on the curve as the variable point approaches the fixed point.

Target
Any object or point toward which something is directed; also an object which reflects a sufficient amount of a radiated signal to produce an echo signal on detection equipment.

Target station
The survey point being observed on which a target has been erected.

task title
the title defines the action to be performed.

T-O
Height of target observed minus height of observer's instrument. May be either a plus or minus value.

Traverse
To turn a weapon to the right or left on its mount; a method of surveying in which lengths and directions of lines between points on the earth are obtained by or from field measurements and used in determining positions of the points.

Universal transverse Mercator (UTM)
A series of 120 coordinate systems that are based on the transverse Mercator projection which was originally developed by the US Army for a worldwide mapping project. Sixty zones are used to map the northern hemisphere, and the remaining zones apply to the southern hemisphere. Each zone is 6° wide and is numbered. Zone 1 covers longitudes of 180° W through 174° W. The remaining zones are numbered sequentially as they move east. All zones have their origin at the equator, use the meter as the system unit, and have a false easting of 500,000 meters and a false northing of zero. A scale reduction factor of 0.9996 is used on all zones. Zones for the southern hemisphere are identical to their northern counterpart except that the false northing is set to 10,000,000 to eliminate negative Y coordinates.

Vertical control
The survey control points for which the elevation of the point has been determined by leveling.

Zenith distance
The vertical angle between the zenith and the object which is observed or defined.

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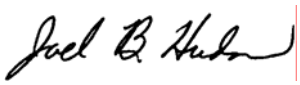

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