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DEPARTMENT OF THE ARMY FIELD MANUAL

OPERATION OF THE GUN DIRECTION COMPUTER M18

CANNON APPLICATION

RESCINDED

HEADQUARTERS, DEPARTMENT OF THE ARMY
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FIELD MANUAL
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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *14 June 1968*

OPERATION OF THE GUN DIRECTION COMPUTER, M18 CANNON APPLICATION

* This manual supersedes FM 6-3-1, 28 April 1964; FM 6-3, 14 March 1963; and FM 6-40-3, 14 September 1964.

CHAPTER 1
GENERAL

Section I. PURPOSE AND SCOPE

1–1. Purpose.

a. This manual is a guide for training artillery personnel in the operation of the gun direction computer M18 (FADAC). It is also a guide to assist fire direction personnel in incorporating the gun direction computer M18 into the functions of the Fire Direction Center (FDC).

b. The significant improvement in the accuracy and flexibility in the delivery of surprise fires is the principal advantage gained in using a digital computer, such as FADAC, to solve the gunnery problem. Two primary methods are used in the manual solution for the delivery of surprise fires. The first method, transfer of fire, uses corrections determined from registration. The gun data are based upon the premise that the range correction is directly proportional to the range. Since this assumption is inaccurate for a large shift, limits are placed on the distance and direction that the target should be from the registration point to preclude compounding the inaccuracies to an unacceptable degree. As the weather and other ballistic conditions change, the accuracy is further degraded. The second method, met plus velocity error, incorporates a number of inaccuracies as a result of using approximate mathematical techniques which are required by the need for simplicity. The M18 computer solution has eliminated these inaccuracies since its solution is based upon electronically simulating the trajectory, using ballistic conditions that actually exist. Since there are inaccuracies in the manual solutions, a comparison of the gun data calculated by the manual techniques with that produced by the M18 will not necessarily agree. The magnitude of variance will depend upon the factors that affect the accuracy of manually calculated data. If all the ballistic variables are determined accurately and inserted into the computer, it will determine a significantly accurate direction, fuze setting, and quadrant elevation for any target within the range of the weapon.

1–2. Scope

a. This manual covers the operation of the gun direction computer M18 in the cannon application using the issue 2 program tapes.

b. The material presented herein is applicable, without modification, to both nuclear and nonnuclear warfare.

c. Related publications are listed in appendix A.

d. Instruction for the preparation of the computer meteorological message tape is in appendix B.

e. Appendix C contains ammunition reference data.

f. Appendix D contains a set of sample problems.

1–3. Changes

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Response should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded to the Commandant, U.S. Army Artillery and Missile School, Fort Sill, Oklahoma 73503.

Section II. FIRE DIRECTION ORGANIZATION

1-4. General

The M18 gun direction computer (fig. 1-1) is authorized for issue to all cannon and rocket field artillery units and to the survey information center (SIC) of each division and corps artillery.

1-5. Operator Personnel

a. The assigned personnel in both the battery and battalion fire direction centers operate the computer and its auxiliary equipment. The minimum number of personnel required in sustained operations is four: two computer operators and two generator operators.

b. Even though the M18 computer provides the primary means of generating firing data, a requirement exists for a manual system to supplement the gun direction computer. The manual system is substantially the same as the present system. The manual operation and the computer operation are normally conducted from the same fire direction center (FDC). Centralized fire control at battalion is preferred to decentralization. Communications requirements and systems remain unchanged.

c. If the computer or the generator malfunctions during a mission, the vertical control operator (VCO), the computer operator (HCO), and the computers must be prepared to conclude the mission manually. The requirement for batteries to be capable of assuming the battalion role remains unchanged.

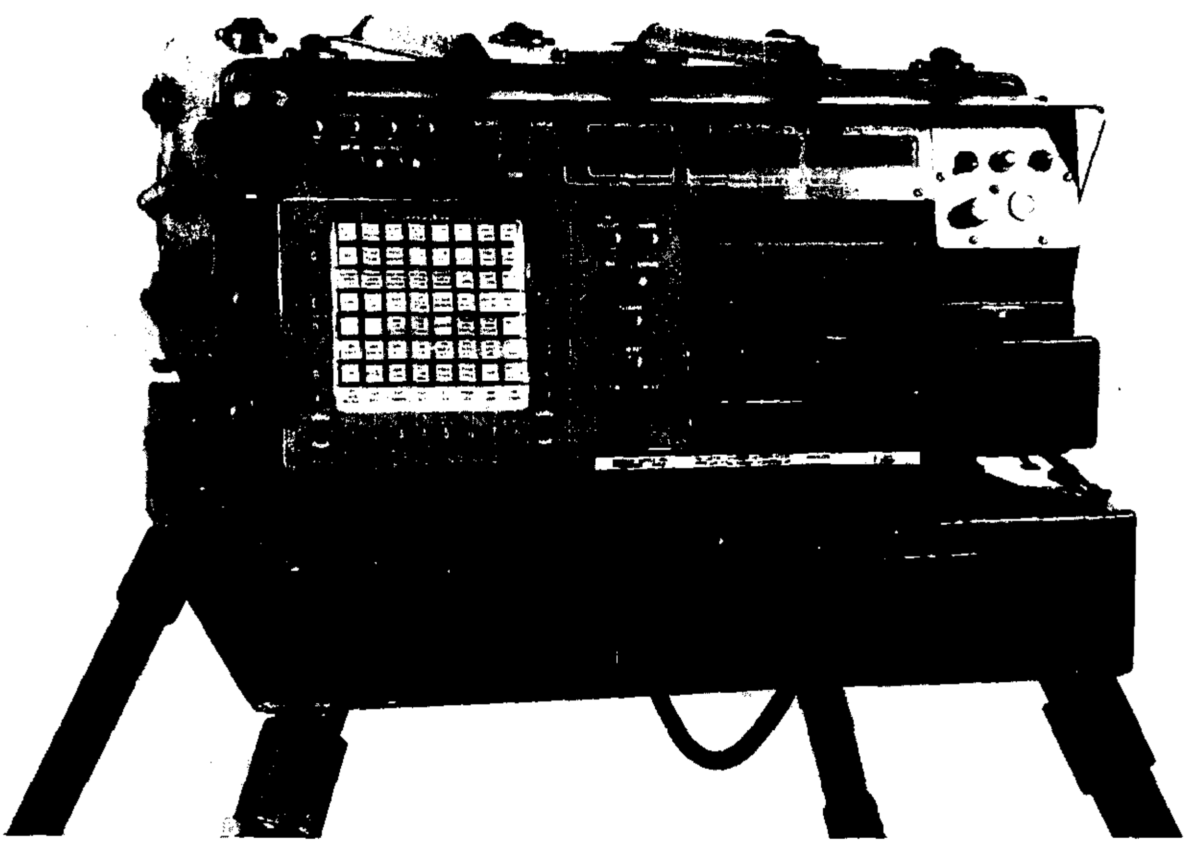


Figure 1-1. M18 gun direction computer.

1–6. Duties of Personnel

a. Computer Operator. The computer operator is responsible for the emplacement, march order, operation, and operator maintenance of the computer and its associated equipment. His duties are to—

(1) Insure that the correct procedures are followed in setting up the computer and its associated equipment.

(2) Insure that the correct procedures are followed in the operation and maintenance of the equipment.

(3) Transmit and record data in accordance with the unit standing operating procedures.

(4) Report discrepancies in computer or associated equipment maintenance.

(5) Perform operator maintenance at regular intervals. Perform only the maintenance authorized in the maintenance allocation charts in TM 9–1220–221–20/1. For other details, read chapter 3, TM 9–1220–221–10/1.

b. Generator Operator. The duties of the generator operator are normally performed as additional duties by a member of the fire direction center. In addition to his regular duties, the person assigned the duties of the generator operator is responsible for—

(1) The proper emplacement of the generator.

(2) Starting, stopping, and monitoring the operation of the generator on a standby basis.

(3) Insuring that the generator is providing the proper current.

(4) Performing operator maintenance and reporting discrepancies in maintenance to the chief of section.

(5) Maintaining the prescribed records on generator operation.

CHAPTER 2
EQUIPMENT

Section I. DESCRIPTION

2-1. General

a. The gun direction computer M18 (fig. 1-1) is a general purpose, electronic, solid state, nonvolatile digital computer especially designed to solve the gunnery problem. However, as a general purpose computer, it will perform any computational task for which a program has been written and inserted into memory. It is limited only by the size of the rotating magnetic disc memory of 8,192 words. In the cannon application, the computer will solve for the optimum charge, deflection, time of flight or fuze setting, and quadrant elevation. In addition to these firing data, it will compute three types of survey problems: traverse, intersection, and observer orientation. Solutions are displayed on Nixie tubes on the front panel of the computer.

b. Programs are coded on punched paper tape and are inserted into memory by the signal data reproducer, an item of equipment designed for this purpose. The program, once loaded, cannot be changed by normal operator actions. Information required in the solution of problems is entered by the operator using an input selection matrix and a keyboard or using a mechanical tape reader.

2-2. Components and Associated Equipment

a. The computer is of modular construction, consisting of four major categories of components; the power supply chassis, the magnetic disc memory, the control panel assembly, and the circuit boards. The computer is housed in a watertight case with removable front and rear covers. Computer parts are cooled by two blowers which draw air through replaceable filters and exhaust it through louvers in the rear of the computer.

b. Associated equipment consists of a computer table with an integral power connection panel; a power cable and reel assembly; and a 3-kw, 120/208-volt, 400-cycle, 3-phase, 4-wire generator.

c. Auxiliary equipment consists of the signal data reproducer (SDR) AN/GSO-64 and the computer logic unit test set (CLUT) AN/GSM-70.

d. Detailed nomenclature, technical characteristics, and other operational information are discussed in detail in the references listed in appendix A.

Section II. PREPARATION FOR OPERATION AND MARCH ORDER

2-3. General

A minimum of four men are required to set up and prepare the gun direction computer M18 for operation or to march order the equipment. The computer weighs approximately 210 pounds and should be handled with care to prevent damage to the equipment or injury to personnel. The computer table weighs 58 pounds and at least two men are required to set it up or march order it.

2-4. Preparation for Operation

a. The computer is prepared for operation as follows:

(1) Turn the field table upside down and release the screw-lock fasteners on the legs.

(2) Unfold and extend each leg so that the height is comfortable for the operator and the top is level.

(3) Secure each leg in position by tightening the locking ring, and place the table in an upright position.

(4) Have two men place the computer on the table.

(5) Depress the core of the pressure release valve and allow the pressure in the case to equalize.

(6) Remove the front and rear covers.

(7) Fasten the four latches on the table over the four hooks on the computer case.

(8) Remove the cap from receptacle J11 and connect cable P11 from the table to the receptacle J11.

(9) Connect the power cable to receptacle J5 on the table and insure that the circuit breaker is in the OFF position.

(10) Start the generator and insure that it is producing the correct voltage.

(11) Check the air intake beneath the control panel of the computer for obstructions and insure that the air will flow freely into the computer.

(12) Place the circuit breaker in the ON position.

(13) Turn the POWER switch on the power panel to the POWER ON position. When the POWER READY indicator lights, the computer is ready to operate.

b. When the computer is semipermanently mounted in a vehicle, the procedures in *a*(5) through (13) above are applicable.

c. For further details on handling the equipment, see TM 9-1220-221-10/1.

2-5. March Order

a. The computer is prepared for traveling as follows:

(1) Move the POWER switch and the circuit breaker to their OFF positions.

(2) Stop the generator and disconnect the power cable; replace the cable on the cable and reel assembly.

(3) Disconnect all other cables from the computer and replace the front and rear covers.

(4) Unfasten the four latches and remove the computer from the table.

(5) Secure the plug of the computer power cable to the clamp under the table and make sure that all receptacle covers are in place.

(6) Turn the table upside down and release the telescoping portion of each leg by turning the locking ring counterclockwise.

(7) Retract and fold the legs.

(8) Place the computer, the field table, and the cable and reel assembly in the transport vehicle.

b. To march order equipment that is semipermanently mounted in a vehicle, perform the steps in *a*(1) and (2) above, and then replace the covers on the computer.

Section III. OPERATOR CONTROLS

2-6. General

The M18 gun direction computer is controlled through the use of buttons, switches, and keys. The controls and indicators are located on the front panel or near the front of the computer within easy reach of the operator.

2-7. Control Panel Description

The computer control panel (fig. 2-1) consists of seven sections each section may be considered a functional area and is identified by its principal use as follows:

a. Power Panel. The power panel, on the upper right section of the control panel, has a toggle switch to turn the computer on and off, a toggle switch to control two night lights, a POWER READY indicator light, and an-

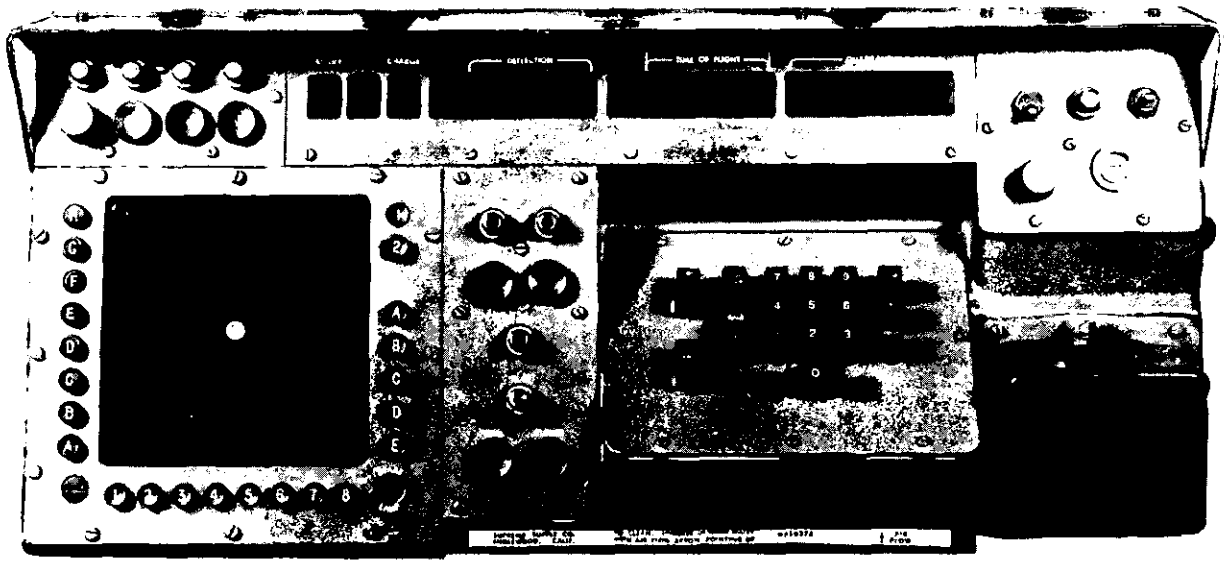


Figure 2-1. Computer control panel.

elapsed time meter to indicate the cumulative hours of operation.

b. Trouble Indicator Panel. The trouble indicator panel, in the upper left corner of the control panel, has four trouble indicator lights, a night light, and three buttons: SET UP; PROG TEST, and RESET.

c. Operator Panel. The operator panel, in the lower center of the control panel, has four buttons: TRIG, COMPUTE, SEND, and RECEIVE—and four indicators which show the operator when the computer is in the compute or input-output mode or when a problem has no solution.

d. Matrix Panel. The matrix panel, on the left side of the control panel, is a selection device which allows the operator to control the data that are entered, recalled, or computed in the solution of a problem. Details describing the use of the matrix panel are contained in table 2-1.

e. Keyboard. The keyboard, on the right of the operator panel, is a standard arrangement of control, sign, and digital keys which are used to enter numerical data.

f. Mechanical Tape Reader. The mechanical tape reader, in the lower right portion of the control panel, is a mechanical device capable of reading five-hole punched paper tape as input data. Its primary function is to read the meteorological message tape.

g. Display Panel. The display panel (fig. 2-1), located in the upper center section of the control panel, consists of a series of Nixie tube indicators which provide numerical, sign, and designation information as it is entered in the computer or as an output display of the solution to a problem. In most instances, the data entered through the keyboard are displayed on this panel and erased when the ENTER key is depressed. The panel is divided into six windows.

2-8. Description of Display Panel

The display panel is the primary output device of the M18 in the cannon application. The six windows contain the Nixie indicator tubes which display the firing data solution.

2-9. Functions of Controls and Indicators

The function of each control and indicator on the computer control panel (fig. 2-1) is described in *a* through *s* below.

a. POWER ON-OFF Switch. The POWER ON-OFF switch is a momentary contact, center-return switch. In the ON position, the power supply, blowers, and memory are energized. In the OFF position, the computer is deenergized.

b. POWER READY Indicator. The POWER READY indicator lights approximately 20 seconds after the computer is turned on. The indicator blinks when the computer is in the marginal test mode or when the lower blower motor is not operating. This indicator will blink when the back cover is left on for cold weather operations. If the indicator blinks when the cover has been removed and the MARGINAL TEST switch is off, a malfunction of the lower blower is indicated.

c. LIGHTS ON-OFF Switch. The LIGHTS ON-OFF switch lights the panel lamps for night operation.

d. Time Meter. The time meter records the cumulative hours the computer has been in operation.

e. TEMP Indicator. The TEMP indicator lights when the internal operating temperature is correct. The indicator blinks when the operating temperature is not correct.

f. TRANSIENT Indicator. The TRANSIENT indicator lights when the line voltage is correct. The indicator blinks when the power supply voltages fluctuate or approach operating limits.

g. PARITY Indicator. The PARITY indicator is normally lighted. It blinks when an error occurs during computation, when an internal data transfer is made, or when incorrect data are transferred from an input device to memory or from memory to an output.

h. ERROR Indicator. The ERROR indicator is normally lighted. It blinks when there is an internal overflow or an error verification. Blinking may also be caused by entering a number too large for the computer.

i. PROG TEST Button. When the PROG TEST button is depressed and the key numbered 1 or 2 is depressed, the computation of a stored test begins. The validity of the program entered in memory is tested. If the 3 key is depressed the Nixie tubes are tested.

j. SET UP Button. In the cannon programs, the SET UP button is used to associate the program information for the caliber and type with selected batteries. This button is controlled by an interlock matrix position E-2 (SET UP). When the SET UP button is depressed, all constants pertaining to a given caliber are set to standard.

k. RESET Button. The RESET button is depressed to terminate the mode, for example, the computations being made or the input mode after the entry of met data. This button will also terminate a blinking PARITY, ERROR, or TRANSIENT indicator, if the indicated malfunction is not recurring.

l. COMPUTE indicator. The COMPUTE indicator lights while the computer is in the compute mode.

m. TRIG Button. Depressing the TRIG button causes the computer to apply a trigonometric shift to a previously computed trajectory solution. The solution is computed without simulating the trajectory as described in paragraph 2-26. It provides a rapid solution during an adjustment of fire mission, but its use is limited as follows:

(1) If a ballistic trajectory has not been computed subsequent to END OF MISSION instructions, depressing the TRIG button automatically causes a trajectory solution.

(2) If changes are made in input data, such as muzzle velocity, powder temperature, or projectile weight, a trajectory solution will automatically be performed.

(3) If an observer shift greater than ±400 meters in range or deviation or ±50 meters in height is made, depressing the TRIG button automatically causes a trajectory computation.

n. COMPUTE Button. The COMPUTE button, when depressed, causes the computer to compute the trajectory for the ballistic problem only.

o. NO SOLUTION Indicator. The NO SOLUTION indicator is normally lighted and blinks if the data entered for a particular problem produces no solution. A numerical display defines the cause (para 2-25).

p. KEYBOARD Indicator. The KEYBOARD indicator lights when a keyboard entry is required.

q. IN/OUT Indicator. The IN/OUT indicator lights when information is being transferred to or from an input-output device. This indicator as well as the KEYBOARD indicator must light before the keyboard is used to enter data.

r. SEND Button. The SEND button is not used in the cannon program.

s. RECEIVE Button. The RECEIVE button, when depressed, erases the zeros that precede the displayed gun data or recalls the last gun data computed.

2-10. Keyboard Assembly

a. SM and RECALL Keys. The SM (sample matrix) key, when depressed, causes the computer to use the instructions in the portion of the program selected on the matrix position. Normally the instructions require a keyboard entry; therefore, the KEYBOARD indicator lights. The RECALL key is used to recall from memory of the computer the data indicated by the matrix position selected.

b. LEFT, DOWN, DROP, − Key. The LEFT, DOWN, DROP, − key, when depressed, causes a negative sign to be associated with the numercial value entered through the keyboard.

c. RIGHT, UP, ADD, + Key. The RIGHT, UP, ADD, + key, when depressed, causes a positive sign to be associated with the numerical value entered through the keyboard.

d. NUMERICAL Keys 0-9, and. (.) Key. The NUMERICAL keys and decimal point key are used to enter the numerical values including a decimal point. The keys are interlocked to prevent an error from being made by inadvertently depressing two keys simultaneously. The numerical value is displayed as each key is depressed.

e. CLEAR and ENTER Keys. The CLEAR key is used to clear an erroneous keyboard input and to erase the display before the value is permanently entered into memory. After the CLEAR key has been depressed, the correct information can be entered without depressing the SM key again. The ENTER key is used to enter into memory of the computer the values displayed. An entry error that is discovered after the ENTER key has been depressed may be corrected by reselecting the matrix position, depressing the SM key, and typing in the correct data on the keyboard.

2-11. Input Selection Matrix

a. The input selection matrix consists of 64 windows. The desired input location on the matrix is selected by depressing two buttons, one numerical button (1-8) in the row below the matrix windows, and one lettered button (A-H) in the column on the left side of the matrix. The use of the input selection matrix (fig. 2-2) is explained in detail for each position in table 2-1.

b. The input selection matrix is divided into seven color-coded sections for ease of identification of functions in the cannon program. The operator may use any section without regard to sequence. The seven sections are color coded as follows:

Section	Location	Color Code
(1) Target information	Row A	Yellow
(2) Fuze, projectile, charge overrides	Row B	Red
(3) Observer and survey information	Rows C and a portion of row D	Gray
(4) Miscellaneous information	Row E and a portion of row D	(*)

Section	*Location*	*Color Code*
(5) Battery information	Portions of rows G and H in upper left corner	Blue
(6) No-fire area data	Portion of row F	Gray
(7) Registration information	Portions of rows F, G and H in upper right corner	Green

* Color code varies according to the nature of the function and contrast with the colors of adjacent sections.

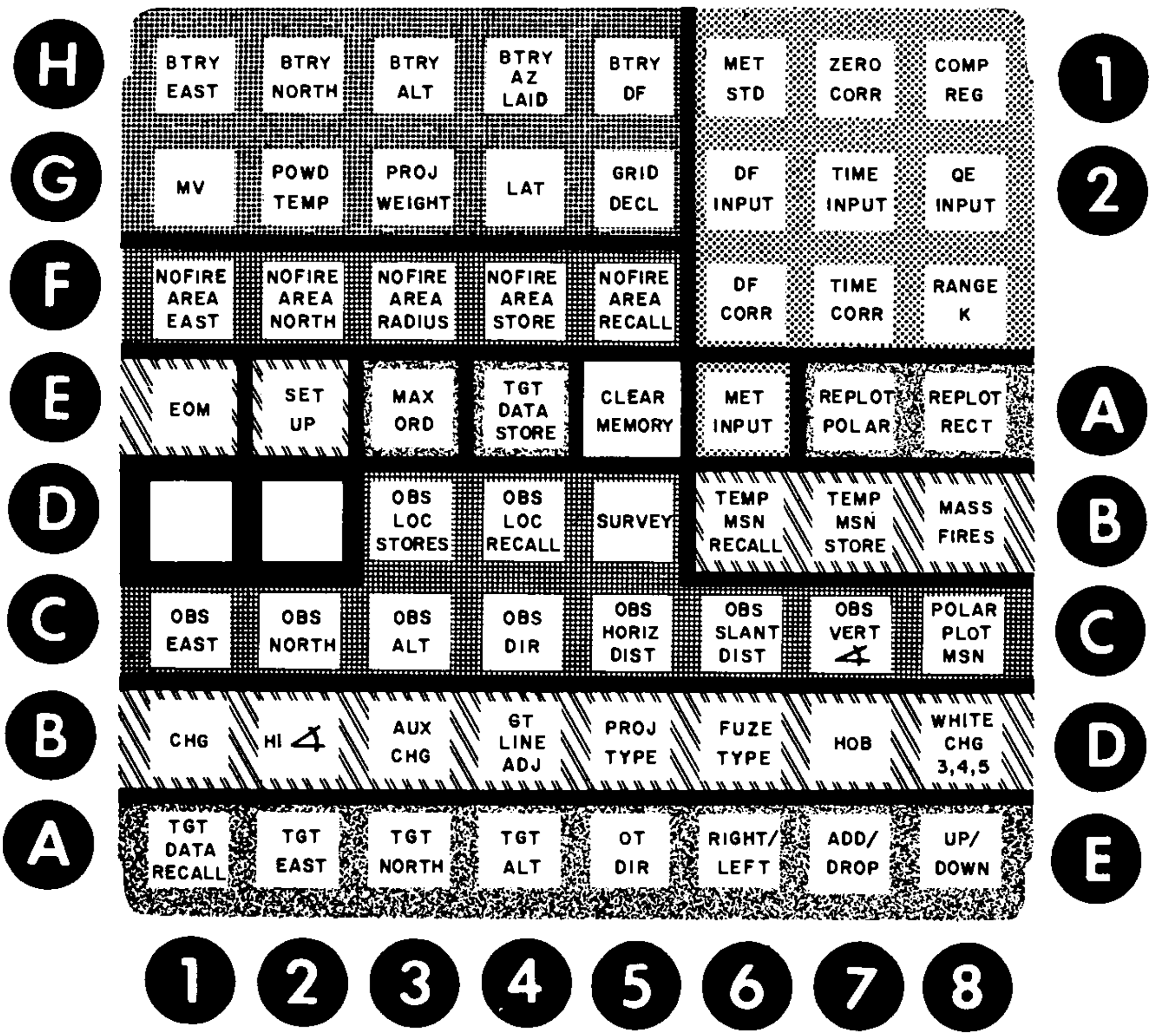


Figure 2-2. Input selection matrix.

2-12. Program Tapes

a. Each program tape for cannon contains instructions for the ballistic trajectory solution for two different calibers of cannon and three survey routines.

b. The specific program entered in the computer's memory is verified during the program tests described in paragraph 2-15. The computer displays the identification of the program entered in memory by the caliber combinations (fig. 2-3). The program security classification revision number and series weapon flags are also displayed as part of the program identification.

2–13. Numbered Buttons and Battery Selector Buttons

a. The two buttons numbered 1 and 2 on the right side of the matrix panel are used to associate either the first or, second caliber portion of the program with a specific battery, depending on which numbered button and which lettered button are depressed simultaneously during setup. For example, the first caliber on the program tape is associated with the batteries set up by depressing the 1 button, and the second caliber is associated with the batteries set up by depressing the 2 button.

b. The battery selector buttons lettered A, B, C, D, and E are depressed to associate a specific battery with its portion of the program or for the computation, entry, or recall of data applicable to a specific battery. Using these buttons enables the computer to compute the firing data for five separate missions, concurrently.

Section IV. TESTS

2–14. General

a. The computer operator should perform the program test to insure that the computer is operating properly and that the program has been correctly entered in memory. These tests are made when the computer is first set up for operation, when there is a loss of power, or when there is reason to believe the computer is not operating properly. The program must be entered in the computer before the tests are run.

b. The marginal test is built into the M18 computer and provides the operator with a means of performing a limited check of the computer's operation under variable voltages. If successful, the test insures the operator that the computer will operate properly under normal conditions.

2–15. Program Tests

a. The procedure for testing the permanent storage of the program is as follows:

(1) Depress the PROG TEST button; the KEYBOARD indicator will light.

(2) Depress the 1 key on the keyboard, and the computer will automatically run a series of tests of the program entered in the permanent part of memory. The Nixie display tubes will flicker while this test is being run. If the test is successful, a series of zeros will be displayed in the DEFLECTION window and in the left three Nixies of the window labeled FUZE SETTING. If the test is unsuccessful, the NO SOLUTION light will blink and a different series of numbers will be displayed. The other numbers in the display indicate the security classification of the program, the program revision number, the series weapon code, and the caliber of the weapon programmed (fig. 2–3).

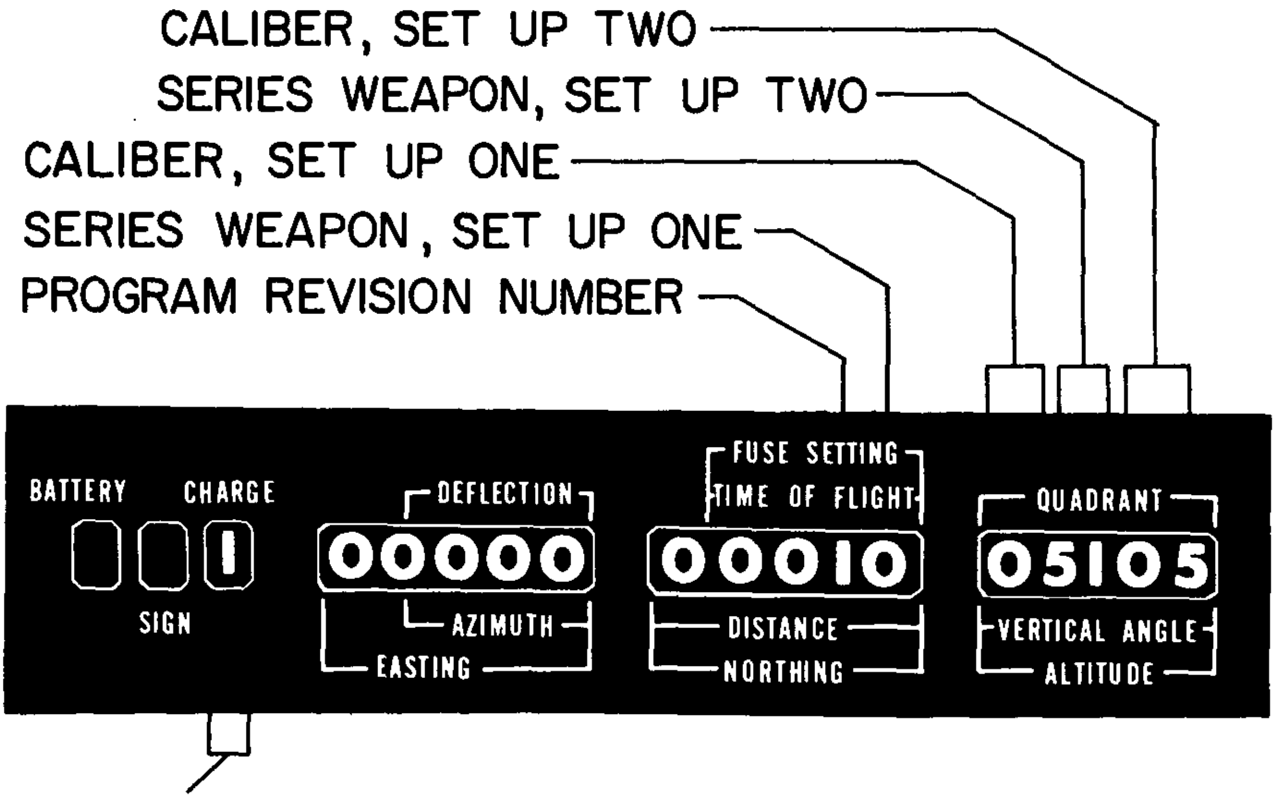
(3) Repeat the test if the first attempt is not successful. It may be successful on the second or third attempt. The cause of an initial test failure and subsequent success is ordinarily the aging of parts in the computer. If this condition occurs frequently, maintenance checks should be performed to determine the specific cause.

b. The procedure for testing the working storage is as follows:

(1) Depress the PROG TEST button, the KEYBOARD indicator will light.

(2) Depress the 2 key on the keyboard. The computer will automatically run a test of the working storage portion of memory. During the test, the rightmost Nixie tubes on the display panel will rapidly display the channel numbers being checked, and, if the test is successful, will stop at number 136. If the test is not successful, the PARITY indicator will flicker and the channel number in which the error occurred will be displayed. The channel numbers allocated to working storage are shown in figure 2–7, memory map of working storage.

(3) If the test is unsuccessful, the incorrect channel must be cleared by using the procedure described in table 2–1 for matrix



SECURITY CLASSIFICATION CODES

0 - For Official Use Only
1 - Unclassified
2 - Confidential
3 - Secret
4 - Top Secret

PROGRAM REVISION NUMBERS

0 - Original program
1 - 1st revision
2 - 2d revision
3-9 - 3d thru 9th revision

SERIES WEAPONS CODES

105-mm howitzer
- 0 - M101AQ (M2A2), M101 (M2A1), M52 (M49)
- 1 - M108 (XM103)

155-mm howitzer
- 0 - M114A1 (M1), M44A1 (M45)
- 1 - M109 (T255E2)

8-inch howitzer
- 0 - M115 (M2), M55 (M47), M110 (M2A1)

175-mm gun
- 0 - M107

CALIBER CODES

05 - 105-mm howitzer
55 - 155-mm howitzer
08 - 8-inch howitzer
75 - 175-mm gun

Figure 2-3. Program test 1 on display panel.

position E–5 (CLEAR MEMORY). After the channel has been cleared and the correct data for that channel have been entered, repeat the test.

c. A test, which insures proper computer operation, is to cause the computer to solve a sample problem for which the answer is known. This test should be performed only during lulls in firing or during maintenance periods.

2–16. Marginal Test

a. The marginal test procedure is as follows:

(1) When the POWER READY indicator is on, turn the MARGINAL TEST switch to the 1 position.

(2) Depress the PROG TEST button and the 1 key on the 2–15 keyboard. This action initiates the program test described in paragraph 2–15*a*. If the PARITY or ERROR indicator blinks, the computer has malfunctioned under the marginal conditions induced when the switch is in the 1 position and may malfunction under normal voltages.

(3) If the indicators fail to blink, turn the switch to test position 2 and repeat the test. If the PARITY or ERROR indicator blinks, the computer has malfunctioned under the marginal conditions induced when the switch is in the 2 position.

(4) Continue the steps in (2) and (3) above, through positions 3, 4, and 5. If the indicators fail to blink in any of the five positions, the computer is functioning properly. When the test indicates a malfunction, the computer should be checked by maintenance personnel as soon as possible.

b. Each of the five test positions causes the POWER READY indicator light to blink; however, this does not indicate a malfunction. In normal operation the MARGINAL TEST switch should be in the off position.

c. The PARITY indicator may blink when the MARGINAL TEST switch is rotated from one position to another. If it does, depress the RESET button. The indicator should stop blinking. If not, turn the computer off then turn it on again.

2–17. Display Test

a. The procedure for testing the Nixie display tubes is as follows:

(1) Depress the PROG TEST button; the KEYBOARD indicator will light.

(2) Depress the 3 key on the keyboard. The computer will automatically test the Nixie tubes by successively lighting each filament starting with 0 and ending with the decimal point. In addition the + and − filaments in the sign window will light in turn.

b. The operator should observe the display panel and note any filament that fails to light properly. Defective tubes should be replaced at once.

Section V. COMPUTER INPUTS

2–18. General

a. The input selection matrix and the keyboard are the principal means used to insert data into the computer. A mechanical paper tape reader is used to insert meteorological information, when it is received on a paper tape. The matrix, the keyboard, and the control buttons enable the operator to initiate a problem solution by using instructions to the computer in terms applicable to standard artillery terminology or in simple codes of one or two-digit numbers.

b. The most accurate information available must be entered in the computer. If all the elements are not known, then the information that is known should be entered, and the unknown data should be either left at standard or entered on an experience factor basis.

c. The input elements that affect the ballistic trajectory solution are discussed in (1) through (10) below.

(1) *Battery information.* The battery coordinates, easting and northing, and the altitude are required inputs. They are obtained by

the same methods used for manual FDC procedures.

(2) *Target information.* The target easting, target northing, and target altitude are required inputs. They are obtained by the same methods used for manual FDC procedures.

(3) *Azimuth laid and deflection.* The azimuth on which the battery is laid and the deflection at which the aiming posts are placed (referred deflection) must be entered. They are obtained from the battery executive officer's report.

(4) *Latitude.* The latitude of the battery may be obtained from the marginal data on a map of the area in which the unit is operating. This latitude should be the latitude of the center of the battalion area. It applies to all batteries.

(5) *Grid declination.* The grid declination is obtained from the marginal data on a map of the area and applies to all batteries. It is the angular difference between true north and grid north.

(6) *Powder temperature.* The powder temperature is obtained from the firing battery and is measured with a powder thermometer since only one powder temperature for a battery may be entered at a time, the temperature should be obtained by actually measuring the temperature of the lot of propellant to be fired.

(7) *Projectile weight.* The projectile weight input is the absolute weight of the projectile in pounds. This weight may be stenciled on the shell or be coded in squares which may be converted to pounds (app C). The projectile weight for each different type of shell is obtained from the battery executive officer's report; i.e., shell HE, shell WP. Whenever a different lot of projectiles is to be fired, new data should be entered.

(8) *Meteorological data.* Meteorological data are furnished periodically by a met station as raw met. A message is prepared specifically for computer use. The methods used in preparing the met message are described in FM 6–15. The met message may be entered manually or by punched paper tape. When it is entered by paper tape, using the mechanical reader, the tape must be prepared correctly (app B).

(9) *Registration corrections.* When computing and applying registration corrections with the M18 computer, a current met message as well as all other ballistic parameters should be entered before using matrix function H–8 (COMP REG). If this is done, the change in weather will be correctly applied when a new met message is entered. If either the standard met data or the old invalid met data are in the computer when registration corrections are computed, the registration corrections will include the errors in met or any other incorrect parameters that have been entered. In this case, matrix position H–7 (ZERO CORR) should be used to delete these corrections before the current valid met data and other known conditions are entered; otherwise, inaccurate firing data will result.

(10) *Muzzle velocity.* The muzzle velocity may be obtained by using the M36 chronograph or by determining the muzzle velocity from fall of shot calibration data or from precision registration data. The procedures are as follows:

(*a*) With the M36 chronograph, the muzzle velocity may be measured during any type of fire mission. The muzzle velocity measured by the chronograph is a measure of the shooting strength of the weapon, ammunition, and charge combination. It is recommended that for each charge and lot combination, a minimum of six rounds be fired, exclusive of the two conditioning rounds fired, exclusive of group of six. The muzzle velocity is entered for each charge, if it is known; otherwise, the computer automatically uses a standard value. This method is the preferred method for determining muzzle velocity.

(*b*) When current met data and the other elements that affect the trajectory are known and input, the muzzle velocity may be determined from registration as follows: First, compute the registration corrections by using matrix positions G–6 (DF INPUT), G–7 (TIME INPUT), G–8 (QE INPUT), and H–8 (COMP REG). Then, convert the displayed range K into a total correction by multiplying it by the range to the registration point. From the tabular firing tables, determine the unit effect for muzzle velocity and divide the total range correction by this figure to determine the change in muzzle velocity. Apply this change in muzzle velocity to the muzzle velocity used in the registration and enter the new muzzle velocity in the computer. Finally, reenter the adjusted data and recompute the registration corrections. The range K should now be zero. If it is other than zero, repear the procedure until it is zero. By using the difference in comparative velocity errors (VE) between batteries (calibration data), the muzzle velocities of the nonregistering batteries may be determined. This method may be used only when the muzzle veloctiy is the single unknown factor. Valid meterological data, accurate powder temperature, the projectile weight, the location of the registering piece, the location of the target, the latitude, and the grid declination must be entered. The accuracy of the muzzle velocity obtained is in direct ratio to the accuracy of these inputs.

(*c*) The fall of shot calibration data may be used to determine the muzzle velocity. This is actually a velocity error (VE) coonverted to muzzle velocity. It absorbs the errors at the time of firing and is valid only for the projectile lot and propellant lot used in the calibration. The VE's computed are converted to MV by algebraically adding the VE to the standard muzzle velocity. The VE's derived from a registration with a concurrent met may be similarly used; however, this is the least preferable method.

2-19. Meteorological Message Input Procedures

a. Entry of the most recent meteorological data is vital to the computation of accurate firing data for surprise fires. The special computer met message (METCM) used by the M18 is weather data as it actually exists at the various layers of atmosphere through which the trajectory passes. It is different from the met message used in manual computations where the weather conditions existing in one layer or zone have been weighted against the lower layers and then grouped together. The M18 *cannot* use the NATM met message.

b. In the cannon program, the met input is stored in channel 136 of the working storage. A maximum number of 26 lines of met data may be entered. The standard met data are placed in this channel when the program is first loaded and are again placed in the channel when the met is set to standard by using matrix function H-6 (MET STD). If less then 26 lines of met data are entered, the remaining lines of met data will be standard. To preclude using invalid met data that may be retained in memory above the last line of the current met data being entered, the met should be set to standard prior to entering a met message with less than 26 lines.

c. This manual entry of met data is accomplished as follows:

(1) Depress matrix buttons E and 6 (MET INPUT). Then depress the SM key to prepare the computer for keyboard input.

(2) On the keyboard, depress the 0 key and then the ENTER key; the number 88 will be displayed.

(3) On the keyboard, type the identification line of the met message starting with the date-time group (12 digits). Then depress the ENTER key; the number 00 will be displayed.

(4) On the keyboard, type the 00 line of the met message, starting with 00 (16 digits). Then depress the ENTER key; the number 00 will be displayed.

(5) Continue to enter each successive line of met in the same manner until the last line has been entered. Terminate the input mode by typing 9 and depressing the ENTER key.

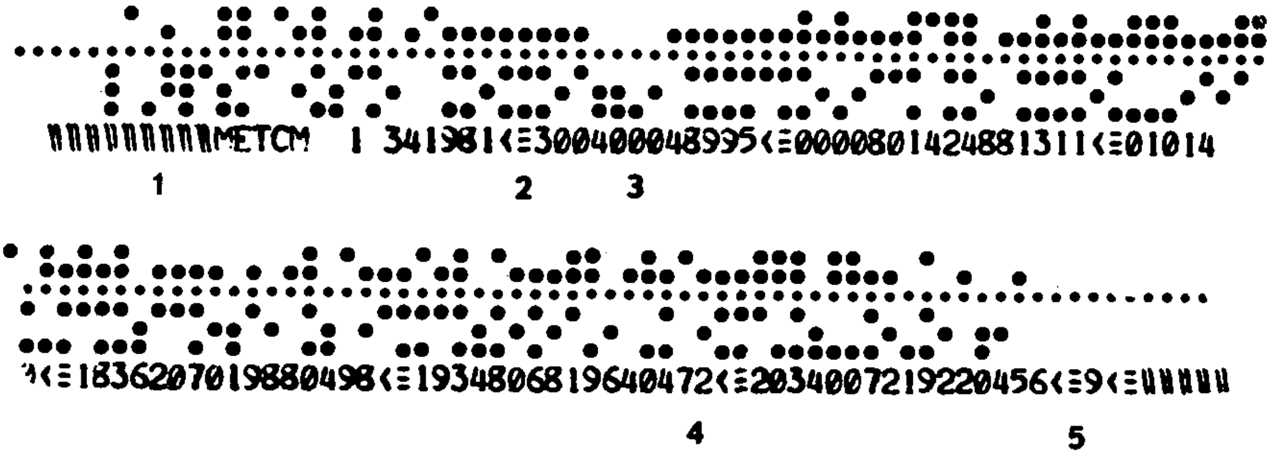
(6) If a mistake is made in any line entry and it is not discovered before the input mode was terminated, a correction may be made as follows:

(*a*) Depress the SM key and enter a 2 on the keyboard.

(*b*) On the keyboard type the line number to be reentered (line number will be displayed).

(*c*) On the keyboard, type in the correct (16 digits) line.

d. The use of the met message punched on paper tape is the fastest method of entering



1. **Tape Advance Symbol at Front of Tape.**
2. **Line Feed Carriage Return Symbol.**
3. **Identification line.**
4. **Last line of meteorological message.**
5. **Line Feed Carriage Return, Stop Code (9) symbols.**

Figure 2-4. Meteorological message tape.

met data. The meteorological message tapes (fig. 2-4) are usually cut by radio teletypewriter equipment, such as the teletypewriter reperforator-transmitter TT-76/GCC, which is a component of radio sets AN/GRC-46, AN/GRC-122, and AN/GRC-142. If the tape is cut by a radio teletypewriter, there will be a printout of the met data along the margin on the wide side of the tape. The procedure for entering the met message tape in the mechanical tape reader is as follows:

(1) A line of small sprocket holes run the length of the tape and slightly off center. Opposite each sprocket hole, there may be as many as three punched holes on the wide side of the tape and as many as two punched holes on the narrow side of the tape. Determine the front of the tape by placing the wide side toward the computer with the printing up. Open the armature clamp on the mechanical tape reader and place the tape under the clamp with the wide side—three holes—toward the computer. Insure that the message portion of the tape is to the left of the read head (fig. 2-5).

(2) Engage the tape sprocket holes with the reader sprocket and close the armature clamp (fig. 2-6). Turn the sprocket knob a few times to insure that the tape is properly engaged. If the tape does not move freely, open the clamp and insure that the sprocket holes are engaged on the sprocket teeth. Reclose the clamp and turn the sprocket knob again to insure proper threading.

(3) Depress the matrix buttons E and 6 (MET INPUT). Then depress the SM key to prepare the computer for keyboard input.

(4) On the keyboard, type the digit 3 and depress the ENTER key. The reader will automatically start reading the tape. Insure that the tape does not tangle while reading. The reader will stop automatically at the end of the tape, and the input mode will terminate.

2-20. Functions Demanding a Signed Input

a. Several numerical inputs require that a plus or minus sign precede the numerical entry. The keys used to input these signs are labeled RIGHT, UP, ADD, + and LEFT, DOWN, DROP.

b. The following matrix functions require that a sign precede the entry:

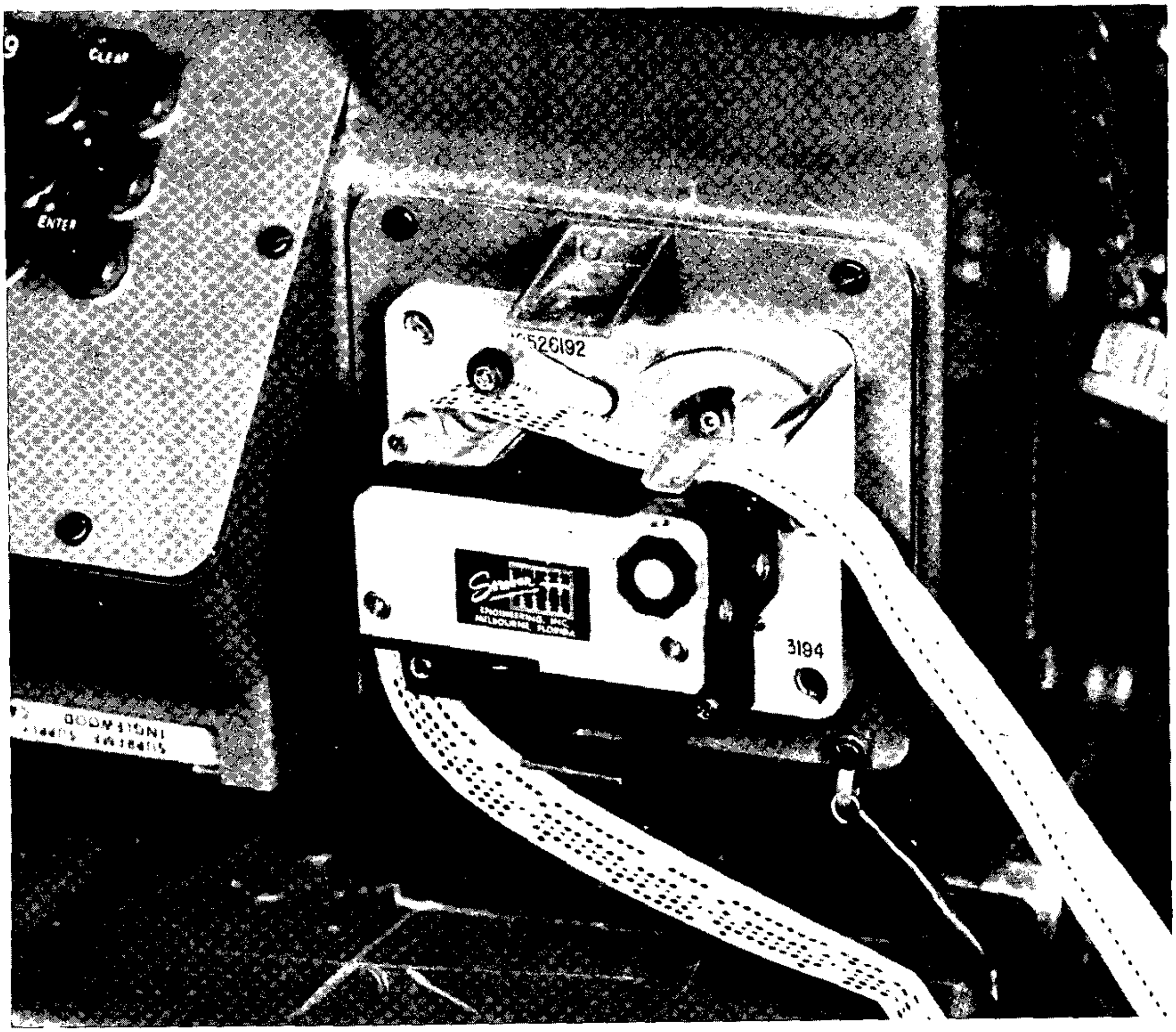


Figure 2-5. Meteorological message tape in reader.

(1) A-6 (RIGHT/LEFT).
(2) A-7 (ADD/DROP).
(3) A-8 (UP/DOWN).
(4) C-7 (OBS VERT ANGLE).
(5) F-6 (DF CORR).
(6) F-7 (TIME CORR).
(7) F-8 (RANGE K).
(9) G-4 (LAT).
(10) G-5 (GRID DECL).

2-21. Enabling Procedure

a. The cabling procedure is designed to act as a safeguard against inadvertently entering an error. It is required in the use of certain matrix functions and is used for functions that override the normal program parameters; e.g., function H-6 (MET STD). The computer ordinarily computes the trajectory with current data; therefore, if the met standard is to be used, matrix buttons H and 6 are depressed. Then the SM key is depressed, and the KEYBOARD indicator lights. On the keyboard, an enabling entry of 0 tells the computer to use standard met, or the input mode can be terminated by an entry of 9 which tells the computer to disregard.

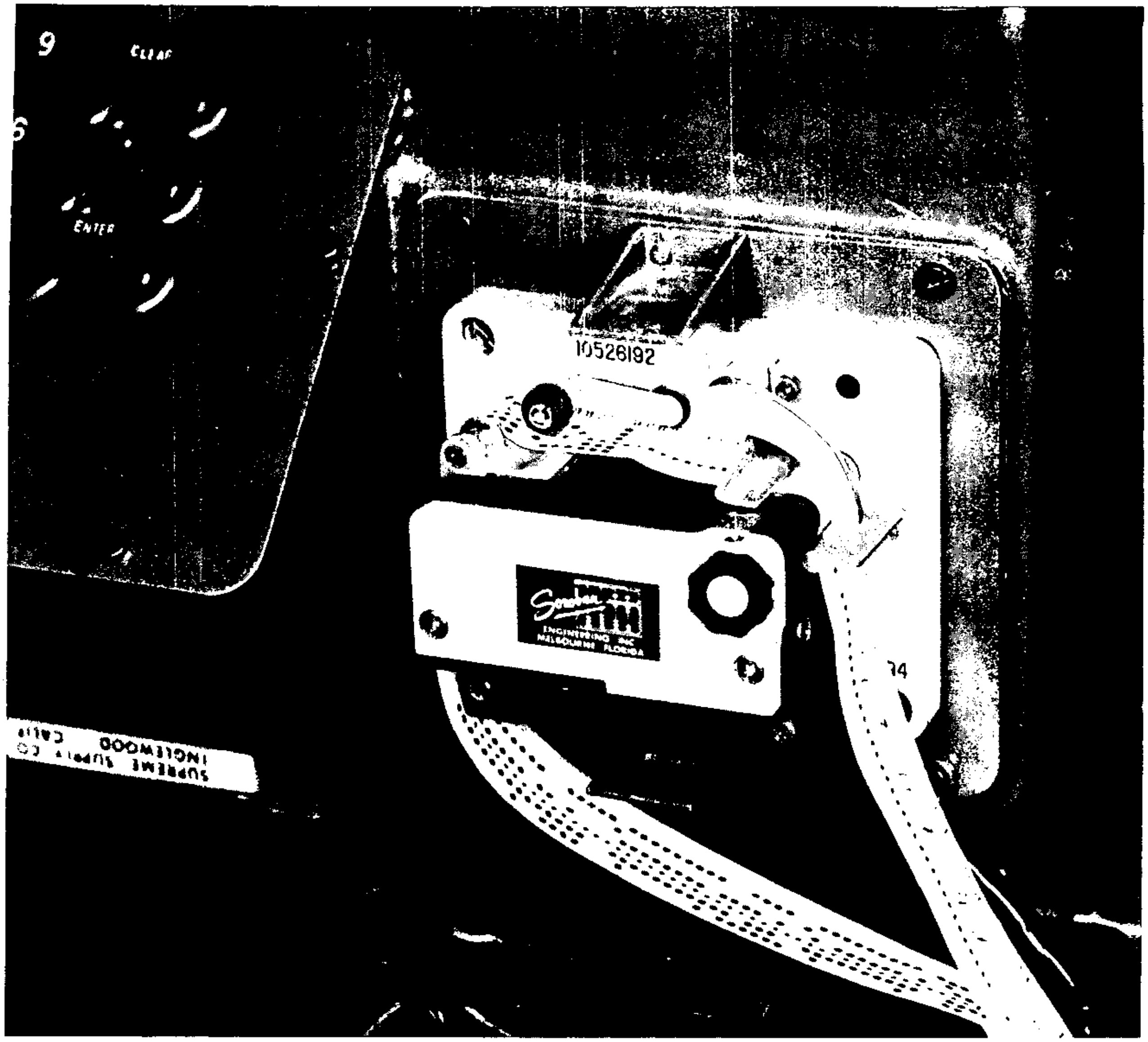


Figure 2-6. Tape in reader, armature clamp closed.

b. The matrix functions that require an enabling procedure are as follows:

(1) B-2 (HI ANGLE).
(2) B-3 (AUX CHG).
(3) B-4 (GT LINE ADJ).
(4) B-8 (WHITE CHG 3, 4, 5).
(5) D-6 (TEMP MSN RECALL).
(6) D-7 (TEMP MSN STORE).
(7) E-1 (EOM).
(8) H-6 (MET STD).
(9) H-7 (ZERO CORR).

2-22. Functions Reset to Minus Zero

The computer resets certain functions to zeros, preceded by a minus sign. During the computational sequences, this safety factor precludes errors being made by failure of the operator to enter the complete data for a problem solution. For example, function E-1 (EOM) resets the target data to minus zero; then, if the operator enters the target easting for a subsequent mission and forgets to enter the northing, the computer will not use the minus zero northing and the NO SOLUTION indicator will blink and the 6 error flag will be displayed.

2–23. Detailed Matrix Functions

a. Table 2–1 contains detailed instructions on the use of each of the input selection matrix functions for the entry or recall of data. The information in table 2–1 is described below:

(1) The "Input function" column identifies the function by its abbreviated name as it appears on the input selection matrix for the cannon program.

(2) The "Matrix location" column identifies each function by the row (A through H) and the column (1 through 8) in which it is found. The input functions are listed in table 2–1 in alphabetical and numerical order from A–1 to H–8.

(3) The "Btry" Column indicates whether a function is battery associated data. If the word "Specific" appears in this column, the input data must be entered with a specific battery button depressed to associate it with that battery. If the word "Any" appears in this column, it does not matter which battery button is depressed. In all cases, a battery button must be depressed to start the computaions; otherwise, the NO SOLUTION indicator will blink.

(4) The "Entry Procedure" column gives detailed instructions for entering data for a specific function or the steps in problem solution presented by a particular function. The term "enter" means that after the datum has been typed on the keyboard and displayed, the ENTER key is depressed. Some functions, such as D–5 (SURVEY) require the entry of more than one function, and a sequence of entry must be followed. Unless specifically noted, information is normally entered in a convenient sequence.

(5) The "Recall procedure" column gives detailed instructions for recalling information stored in memory. All input functions that are not recallable are indicated by the abbreviation "NA" or by an explanation of the procedure required instead of using the RECALL key.

(6) The "Remarks" column contains comments about the function and cautions on its use.

b. A graphic illustration of the location in memory of input data is shown in figure 2–7. If function E–5 (CLEAR MEMORY) has been used and the data are to be reentered, the operator should refer to figure 2–7 to determine specifically which data to re-enter.

WORKING STORAGE CHANNELS

70	72	74	110	130	76	112	114	116	132	134	136
BATTERY AND MISSION INFORMATION					ENTER LATITUDE (F-1)	ENTER TARGET LIST (I-88)(E-4)			ENTER NO FIRE AREA LIST (I-20) (F-4)	ENTER OBSERVER LIST (I-9)(D-3)	ENTER MET MESSAGE
BTRY C	BTRY A	BTRY B	BTRY D	BTRY E	ENTER TARGET				INTERSECTION SURVEY ENTER DATA AS DESIGNATED IN SURVEY (D-5), TYPE 2		
1. SET UP BATTERY FOR CALIBERS DESIRED (F-5) 2. ENTER BATTERY INFORMATION (H-1-5) 3. ENTER BATTERY NON-STANDARD CONDITIONS (G-1-4) 4. ENTER TARGET BY METHOD FORMERLY USED AND OT AZ (A-5) 5. ENTER MISSION OVERRIDES (B-1-8) 6. RECOMPUTE FIRING DATA					ENTER REG CORR DATA (G-6-8,) (B-1,5,6)						
ENTER GRID DECL ANGLE (F-2)	ENTER MASS FIRES (D-8)	ORIENTATION SURVEY ENTER DATA AS DESIGNATED IN SURVEY, TYPE 3									
	TRAVERSE SURVEY ENTER DATA AS DESIGNATED IN SURVEY (D-5), TYPE 1										

NOTE: CHANNEL NUMBERS IN OCTAL BASE.

Figure 2–7. Map of memory working storage.

Table 2–1. Detailed Matrix Functions

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
TGT DATA RECALL.	A–1	Specific	NA	1. Depress matrix buttons A–1. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter number assigned to target (1 to 88). (Coordinates and altitude of target are displayed.)	1. Used to recall target coordinates previously stored by TGT DATA STORE (E–4). 2. Target is associated with battery selected. 3. An entry of zero will recall the current battery target coordinates and altitude updated for observer shifts.
TGT EAST.	A–2	Specific	1. Depress matrix buttons A–2. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter target easting to nearest meter.	1. Depress matrix buttons A–2. (Matrix position lights.) 2. Depress RECALL key. (Target easting is displayed.)	1. Used to enter easting coordinates of target. 2. Five-digit coordinates must he used. If not, the NO SOLUTION indicator light will flicker and the display will remain. 3. Resct to minus zero by EOM.
TGT NORTH.	A–3	Specific	1. Depress matrix buttons A–3. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter target northing to nearest meter.	1. Depress matrix buttons A–2. (Matrix window lights.) 2. Depress RECALL key. (Target northing is displayed.)	1. Used to enter northing coordinates of target. 2. Five-digit coordinates must be used. If not, the NO SOLUTION indicator light will flicker and the display will remain. 3. Reset to minus zero by EOM.
TGT ALT.	A–4	Specific	1. Depress matrix buttons A–4. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter altitude to nearest meter.	1. Depress matrix buttons A–4. (Matrix window lights.) 2. Depress RECALL key. (Altitude is displayed.)	1. Used to enter altitude of target above sea level. 2. Reset to minus zero by EOM. 3. If no TGT ALT is input, computer will use BTRY ALT (H–3) for the target in computations. 4. TGT ALT must be + 1 meter or greater. For altitudes of zero or less, the computer will use BTRY ALT (H–3) for computations. In the event this occurs, comparative false altitudes of battery and target may be used.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OT DIR.	A-5	Specific	1. Depress matrix buttons A-5. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter observer-target azimuth to nearest mil (0 to 6400 mils).	1. Depress matrix buttons A-5. (Matrix window lights.) 2. Depress RECALL key. (Observer-target azimuth is displayed.)	1. Used to enter azimuth from observer to target. 2. Reset to minus zero by EOM. 3. Entry of leading zeros is not necessary. 4. This entry is not used if GT LINE ADJ (B-4) or POLAR PLOT MSN (C-8) is used.
RIGHT/ LEFT.	A-6	Specific	1. Depress matrix buttons A-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Depress LEFT or RIGHT key on keyboard. (Left causes a − sign to be displayed; right causes a + sign to be displayed.) 4. Enter correction to nearest meter.	1. Depress matrix buttons A-6. (Matrix window lights.) 2. Depress RECALL key. Correction is displayed. (A left correction has a − sign; a right correction has a + sign.)	1. Target coordinate values are modified as a result of the shift. 2. Automatically reset to zero during computation.
ADD/ DROP.	A-7	Specific	1. Depress matrix buttons A-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Depress ADD or DROP on keyboard. (ADD causes a + sign to be displayed; DROP causes a − sign to be displayed.) 4. Enter correction to nearest meter.	1. Depress matrix buttons A-7. (Matrix window lights.) 2. Depress RECALL key. (Correction is displayed. An add correction has a + sign; a drop correction has a − sign.)	1. Target coordinate values are modified as a result of the shift. 2. Automatically reset to zero during computation.
UP/ DOWN.	A-8	Specific	1. Depress matrix buttons A-8. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Depress UP or DOWN on keyboard. (UP causes a + sign to be displayed; DOWN causes a − sign to be displayed.) 4. Enter correction to nearest meter.	1. Depress matrix buttons A-8. (Matrix window lights.) 2. Depress RECALL key. (Correction is displayed. An up correction has a + sign; a down correction has a − sign.)	1. Target altitude is modified as a result of the shift. 2. Automatically reset to zero during computation.
CHG-------	B-1	Specific	1. See remarks before using function.	1. Depress matrix buttons B-1. (Matrix window lights.)	1. This is an override function. The computer will normally select its own charge unless this override is directed.

			2. Depress matrix buttons B–1. (Matrix window lights.) 3. Depress SM key. (KEYBOARD indicator light will light.)	2. Depress RECALL key. (Charge is displayed.)	2. Selection of charge may be changed at any time during mision by following the entry procedure.
					3. This function must be used to enter a specific charge, before using function H–8 (COMP REG).
			4. Enter charge desired (1 to 7).		4. Computer will again select its own charge after— a. EOM (E–1) has been selected. b. Entering a charge of zero. 5. See appendix C to determine permissible charges.
HI ANGLE	B–2	Specific	1. Depress matrix buttons B–2. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.)	1. Depress matrix buttons B–2. (Matrix window lights.) 2. Depress RECALL key. (If HI ANGLE has been selected for this mission, a 0 is displayed. If HI ANGLE has not been selected for this mission, a 9 is displayed.	1. Unless this input function is selected, the computer will give the solution for low-angle fire. 2. After selection of this function for a mission, firing data will be computed or high-angle fire until this function is dismissed. To dismiss this function and return to low-angle fire, the following procedure is used: a. Perform steps 1 and 2, entry procedure. b. Depress 9 on keyboard. (KEYBOARD indicator light extinguishes.)
			3. Depress the 0 key to cause the computer to solve the mission for high-angle fire. (KEYBOARD indicator light extinguishes.)		3. This function is dismissed by selection of EOM.
AUX CHG.	B–3	Specific	1. Insure that computer is in high-angle mode (See HI ANGLE, B–2) and that the battery selected is a 105-mm howitzer battery. 2. Depress matrix buttons B–3. (Matrix window lights.)	1. Depress matrix buttons B–3. (Matrix window lights.) 2. Depress RECALL key. (If AUX CHG has been selected for this mission, a 0 is displayed; if AUX CHG has not been selected for this mission, a 9 is displayed. To recall the specific auxiliary charge used, perform the recall	1. This override is used to have the computer compute the mission for the subzone charges (green bag) for the 105-mm howitzer. 2. The need for this override will be designated by an out-of-range display for charge 1, with the computer in high-angle fire. This override should not be used unless out of range is displayed.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
	B-3 (Cont)			procedure outlined for CHG (B-1).	
AUX CHG			3. Depress SM key. (KEYBOARD indicator light will light).		3. This override applies only to the 105-mm howitzer batteries and can be used only in high-angle fire.
			4. Enter 0 to cause computer to solve mission for auxiliary charges. (KEYBOARD indicator light extinguishes.)		4. The subzone charges reduce the minimum range in high-angle fire. 5. This function is dismissed by EOM. 6. If this function has been selected and the SM key has been depressed, this function may be dismissed by depressing the 9 key on the keyboard.
GT LINE ADJ.	B-4	Specific	1. Depress matrix buttons B-4. (Matrix window lights.)	1. Depress matrix buttons B-4. (Matrix window lights.)	1. This function is used to effect corrections with respect to the gun-target line instead of the observer-target line.
			2. Depress SM key. (KEYBOARD indicator light will light.)	2. Depress RECALL key. (If GT LINE ADJUST (B-4) has been selected for the mission, a 0 is displayed; if GT LINE ADJUST has not been selected for this mission, a 9 is displayed.)	2. This function is dismissed by EOM.
			3. Enter 0 to cause computer to use the gun-target azimuth in adjustment. (KEYBOARD indicator light extinguishes.)		3. Azimuth of gun-target line can be recalled on the following recall procedures outlined for OT DIR (A-5). 4. If this function has been selected and the SM key has been depressed, this function may be dismissed by depressing the 9 key on the keyboard.
PROJ TYPE.	B-5	Specific	1. Depress matrix buttons B-5. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter flag for desired projectile type.	1. Depress matrix buttons B-5. (Matrix window lights.) 2. Depress RECALL key, shell model flag is displayed.	1. The computer normally selects shell HE. 2. This is an override function and is dismissed by EOM (E-1) or by selection of flag 1. 3. This override can be changed at any time during the mission.

					4. See appendix C for shell-fuze combinations.
FUZE TYPE.	B-6	Specific	1. Depress matrix buttons B-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.)	1. Depress matrix buttons B-6. (Matrix window lights.) 2. Depress RECALL key. (Flag is displayed.)	1. For fuze time or fuze VT, program will solve for a 20-meter height of burst. 2. The computer normally selects fuze quick (1) and displays time of flight. If fuze time (2) or fuze VT (3) is used, the fuze setting will be displayed instead of time of flight.
			3. Enter flag for desired fuze type. (See appendix C for fuze flags.)		3. This is an override function and is dismissed by EOM (E-1) or selection of flag 1. 4. The program will subtract 2 seconds from the fuze setting for a zero height of burst (fuze time) to determine the fuze setting for the base-ejection smoke round. 5. When using fuze VT, M513 or M514, 0.51 pound must be added to the projectile weight to compensate for the added weight of the fuze over the standard VT fuze. See appendix C for other fuze weight compensations. 6. This override can be changed at any time during the mission. 7. See appendix C for allowable shell-fuze combinations.
HOB	B-7	Specific	1. Depress matrix buttons B-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter actual height of burst above the target.	1. Depress matrix buttons B-7. (Matrix window lights.) 2. Depress RECALL key. (Height of burst selected is displayed.)	1. This function is used with shell types 4 and 5 for the 8-inch howitzer.
WHITE CHG 3, 4, 5.	B-8	Specific	1. Depress matrix buttons B-8. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.)	1. Depress matrix buttons B-8. (Matrix window lights.) 2. Depress RECALL key. (If this function has been selected for	1. Computer normally selects green bag for charges 1 to 5 and white bag for charges 6 and 7 on 155-mm and 8-inch howitzers. This override will select white bag for charges 3, 4, and 5. 2. This override is dismissed by EOM.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
WHITE CHG. 3, 4, 5	B-8 (Cont)			the mission, a 0 is displayed; if this function has not been selected for the mission, a 9 is displayed.)	
			3. Enter 0 to cause computer to solve problem for white bag ammunition for charges 3, 4, and 5. (KEYBOARD indicator light extinguishes.)		3. If this function has been selected and the SM key has been depressed, it may be dismissed by entering a 9 through the keyboard.
OBS EAST.	C-1	Any	1. Depress matrix buttons C-1. (Matrix window lights.)	1. Depress matrix buttons C-1. (Matrix window lights.)	1. This function is used to input the observer easting for use in the survey routine or in polar plot missions.
			2. Depress SM key. (KEYBOARD indicator light will light.)	2. Depress RECALL key. (Observer easting is displayed.)	2. When entering coordinates, five digits must be used. If not, the NO SOLUTION indicator light will flicker and the display will remain.
			3. Enter observer easting to nearest meter.		3. See SURVEY (D-5), remark 4.
OBS NORTH.	C-2	Any	1. Depress matrix buttons C-2. (Matrix window lights.)	1. Depress matrix buttons C-2. (Matrix window lights.)	1. Used to input the observer northing for use in the survey routine or a polar plot mission.
			2. Depress SM key. (KEYBOARD indicator light will light.)	2. Depress RECALL key. (Observer northing is displayed.)	2. When entering coordinates, five digits must be used. If not, the NO SOLUTION light will flicker and the display will remain.
			3. Enter observer northing to nearest meter.		3. See SURVEY (D-5), remark 4.
OBS ALT.	C-3	Any	1. Depress matrix buttons C-3. (Matrix window lights.)	1. Depress matrix buttons C-3. (Matrix window lights.)	1. Used to input the observer altitude for use in the survey routine or for a polar plot mission.
			2. Depress SM key. (KEYBOARD light lights.) 3. Enter observer altitude to nearest meter.	2. Depress RECALL key. (Altitude is displayed.)	2. See SURVEY (D-5), remark 4.

OBS DIR.	C-4	Any	1. Depress matrix buttons C-4. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light. Number of observer for whom data is being entered appears in right QUADRANT window.) 3. Enter observer direction to the nearest mil (0 to 6,400 mils).	1. Depress matrix buttons C-4. (Matrix window lights.) 2. Depress RECALL key. (Observer direction is displayed. See remark 3.)	1. This function is used to enter the azimuth in the survey routine or the observer direction in a polar plot mission. 2. Automatically set to minus zero during computation. 3. If two observer locations are used and an observer direction is entered for each, depressing the RECALL key the first time causes the last observer direction entered to appear. Depressing the RECALL key the second time causes the first observer direction entered to appear. In both cases, the number of the observer is also displayed. 4. See SURVEY (D-4), remark 4.
OBS HORIZ DIST.	C-5	Any	1. Depress matrix buttons C-5. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light. Number of observer for whom data are being entered appears in right QUADRANT window.) 3. Enter observer horizontal distance (to nearest meter).	1. Depress matrix buttons C-5. (Matrix window lights.) 2. Depress RECALL key. (Distance is displayed. See remark 3.)	1. Entry of this function destroys information entered for OBS SLANT DIST. 2. Automatically set to minus zero during computation. 3. Entry of data in C-6 (OBS SLANT DIST) sets this function to minus zero. 4. If two observer locations are used and an observer horizontal distance is entered for each, depressing the RECALL key the first time causes the last observer horizontal distance entered to appear. Depressing the RECALL key the second time causes the first observer horizontal distance entered to appear. In both cases, the number of the observer is also displayed. 5. See SURVEY (D-4), remark 4.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OBS SLANT DIST.	C-6	Any	1. Depress matrix buttons C-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light. Number of observer for whom data are being entered appears in right QUADRANT window.) 3. Enter observer slant range to nearest meter.	1. Depress matrix buttons C-6. (Matrix window lights.) 2. Depress RECALL key. (Distance is displayed, see remark 3.)	1. Entry of this function destroys information entered for OBS HORIZ DIST (C-5). 2. Automatically set to minus zero during computation. 3. Entry of data in C-5 (OBS HORIZ DIST) sets this function to minus zero. 4. If two observer locations are used and the observer slant distance is entered for each, depressing the RECALL key the first time causes the observer slant distance entered last to appear. Depressing the RECALL key the second time causes the first observer slant distance entered to appear. In both cases, the number of the observer is also displayed. 5. See SURVEY, remark 4.
OBS VERT ANGLE.	C-7	Any	1. Depress matrix buttons C-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light. Number of observer for whom data are being entered appears in right QUADRANT window.) 3. Enter observer vertical angle to the nearest mil (0 to ±1600 mils).	1. Depress matrix buttons C-7. (Matrix window lights.) 2. Depress RECALL key. (Sign and angle are displayed. See remark 3.)	1. Sign (+ or −) must precede entry. 2. Automatically set to minus zero during computation. 3. If two observer locations are used and an observer vertical angle is entered for each, depressing the RECALL key the first time will cause the vertical angle for the first observer to appear. Depressing the RECALL key the second time will cause the second observer to appear. In both cases, the number of the observer will also be displayed. 4. See SURVEY (D-5), remark 4.

POLAR PLOT MSN.	C-8	Specific	1. Recall observer location by following procedure outlined for OBS LOC RECALL (D-4), or enter observer location by following the procedures outlined for OBS EAST (C-1), OBS NORTH (C-2), and OBS ALT (C-3). 2. Depress matrix buttons C-8. (Matrix window lights.) 3. Depress SM key. (COMPUTE indicator light will light. Target coordinates and altitude are displayed when the battery button is depressed. The target easting, northing, and altitude are stored in matrix positions A-2, A-3, and A-4, respectively. The OBS DIR is stored as OT DIR.)	NA	1. Azimuth, distance, and vertical angle are automatically reset to minus zero during computation. 2. The vertical angle measured by the observer must be entered in order for the computer to display the correct target coordinates and altitude. If no angle is reported, enter +0. 3. If the observer reports the vertical displacement as a shift in meters, enter the vertical angle as +0 and enter the vertical shift using the UP/DOWN function (A-8). The computer displays the target coordinates and the observer altitude; however, the computer uses the target coordinates and target altitude in solving the ballistic trajectory.
OBS LOC STORE.	D-3	Any	1. Enter the easting, northing, and altitude of the observer's position by following the procedures outlined for OBS EAST (C-1), OBS NORTH (C-2), and OBS ALT (C-3). 2. Depress matrix buttons D-3. (Matrix window lights.) 3. Depress SM key. (KEYBOARD indicator light will light.) 4. Enter assigned number of observer (1 to 9). (Observer coordinates and altitude are displayed in appropriately marked windows. Assigned observer number is displayed in CHARGE window.)	1. To recall location of observer, use OBS LOC RECALL (D-4) procedure. 2. If this function is recalled by depressing matrix buttons D-3 and the RECALL key, only the number assigned to the observer in step 4, entry procedure, will be displayed.	1. Until changed by the operator, the computer will associate the observer's location with the number assigned in step 4, entry procedure. 2. See SURVEY (D-5), remark 4.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OBS LOC RECALL.	D-4	Any	--	1. Depress matrix buttons D-4. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the number assigned to the observer. 4. COMPUTE indicator light will light. Coordinates and altitude of observer's location are displayed in appropriately marked windows and observer's number is displayed in CHARGE window.) NA	1. Observer's location must have been stored by using the procedure outlined in OBS LOC STORE (D-3). 2. Recalling the observer's location allows it to be used in SURVEY (D-5) and in POLAR PLOT MSN (C-8). 3. See SURVEY (D-5), remark 4.
SURVEY---	D-5	Any	1. The procedure for solving a traverse is to— a. Enter or recall the starting coordinates and altitude of the traverse. (1) To enter the starting coordinates and altitude of the traverse, follow the procedures outlined for OBS EAST (C-1), OBS NORTH (C-2), and OBS ALT (C-3). (2) To recall the starting coordinates and altitude of the traverse, follow the procedure outlined for OBS LOC RECALL (D-4). b. Enter the direction, the horizontal or slant distance, and the vertical angle to the forward station of the traverse by following the procedures outlined for OBS DIR (C-4),	NA	1. This function is used to cause the computer to solve a traverse survey (type 1), to compute an intersection from the 01-02 base (type 2), and to compute the orientation data for the 01-02 base to a given point (type 3).

		OBS HORIZ DIST (C-5) or OBS SLANT DIST (C-6), and OBS VERT ANGLE (C-7). The direction, the distance, and the vertical angle must be entered for each leg. c. Depress matrix buttons D-5. (Matrix window lights.) d. Depress SM key. (KEYBOARD indicator light will light.) e. Enter 1. (KEYBOARD light extinguishes. COMPUTE indicator light will light. Coordinates and altitude of forward station are displayed in appropriate windows with 0 displayed in CHARGE window.) f. To compute the next leg of the traverse, return to step b above.		
		2. The procedure for solving an intersection is to— a. Recall the coordinates and altitude of the first observer by following the procedure outlined for OBS LOC RECALL (D-4). b. Enter the azimuth from the first observer to the unknown station by following the procedure outlined for OBS DIR (C-4). If this observer measured the vertical angle, enter the vertical angle by following the procedure outlined for OBS VERT ANGLE (C-7). The vertical angle may be entered for only one observer. c. Recall the location and altitude of the second observer as outlined in a above. d. Enter the azimuth and vertical angle (if applicable) from the second observer to		2. Azimuth, distance, and vertical angle are automaticaly reset to minus zero during computation.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
SURVEY	D-5 (Cont)	Any	the unknown station as outlined in b above. e. Depress matrix buttons D-5. (Matrix window lights.) f. Depress SM key. (KEYBOARD indicator light will light.) g. Depress 2. (KEYBOARD indicator light extinguishes, COMPUTE indicator light will light, coordinates and altitude of the unknown point are displayed.) h. Compute the coordinates of a new unknown station by repeating steps a through g above.		
			3. The procedure for computing the orienting data for two observers to a target is to— a. Enter or recall the target coordinates and altitude. (1) To enter the target coordinates and altitude, follow the procedure outlined for TGT EAST (A-2), TGT NORTH (A-3), and TGT ALT (A-4). (2) To recall the target coordinates and altitude, follow the procedure outlined for TGT DATA RECALL (A-1). b. Recall the coordinates and altitude of the first observer by following the procedure outlined for OBS LOC RECALL (D-4). c. Recall the coordinates and altitude of second observer by following the procedure out-		3. In an intersection survey (type 2), if the vertical angle from both observers to the target has been entered, the computer will use the vertical angle entered for the last observer recalled to compute the altitude of the target.

			lined for OBS LOC RECALL (D–4). d. Depress matrix buttons D–5. (Matrix window lights.) e. Depress SM key. (KEYBOARD indicator light will light.) f. Depress the 3 key and the ENTER key. (KEYBOARD indicator light stays on; the direction, distance, and vertical angle from one observer to the target are displayed in the appropriate windows; and the number of the observer is displayed in the CHARGE window.) g. Depress the ENTER key again. (KEYBOARD indicator light extinguishers; for the other observer are the orienting data displayed as described in f above.)		4. For greater accuracy in the survey routine, the coordinates and altitude of the observer's location and the observer's direction, horizontal or slant distance, and vertical angle may be entered to the nearest 0.01 mil or meter. Recall of the observer location will not show the decimal portion entered; however, it will be stored and the entire easting or northing may be recalled by recalling the observer location and then recalling the easting, northing, and altitude, separately.
TEMP MSN RECALL.	D–6	Specific	NA	1. Insure that battery button for which mission was stored is depressed. 2. Depress matrix buttons D–6. (Matrix window lights.)	1. Only the target coordinates will be displayed. The observer-target direction and overrides will be stored and may be checked by recall after termination of TEMP MSN RECALL procedure. 2. Used to recall a mission previously stored by TEMP MSN STORE (D–7).

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
TEMP MSN RECALL	D-6 (Cont)	Specific		3. Depress SM key. (KEYBOARD indicator light will light.) 4. Depress 0. (Target coordinates are displayed.)	3. If this function has been selected and SM (sample matrix) key has been depressed, it may be dismissed by entering 9 on the keyboard. 4. After a target stored in TEMP MSN STORE (D-7) has been recalled by using TEMP MSN RECALL (D-6), it cannot be recalled again; if this is attempted, the NO SOLUTION indicator light will flicker.
TEMP MSN STORE.	D-7	Specific	1. Insure that the appropriate battery button is depressed. 2. Depress matrix buttons D-7. (Matrix window lights.) 3. Depress SM key. (KEYBOARD indicator light will light.) 4. Depress O.	NA	1. Target data corresponding to the battery button depressed are stored temporarily. 2. All overrides and observer-target direction for mission are stored temporarily. 3. If this function has been selected and the SM key has been depressed, it may be dismissed by depressing 9 on the keyboard.
MASS FIRES.	D-8	Specific	1. Insure that battery button with which target is associated is depressed. 2. Depress matrix buttons D-8. (Matrix window lights.) 3. Depress SM key. (KEYBOARD indicator light will light.) 4. Enter batteries to be massed by using flags shown below: *Flag* *Btry* 1 A	1. Depress matrix buttons D-8. (Matrix window lights.) 2. Depress RECALL key. (Flags of batteries selected to be massed are displayed.)	1. If this function is selected in error, the operator may dismiss it by entering the flag corresponding to the battery button depressed. 2. This function transfers the target associated with the battery button depressed to each battery selected in step 4. 3. To cause the computer to compute the firing data for each battery selected in step 4, the appropriate battery button and the COMPUTE button must be depressed.

			2 B 3 C 4 D 5 E 5. Depress each battery button separately and compute.		
EOM	E-1	Specific	1. Depress matrix buttons E-1. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.)	NA	1. Used to end mission and dismiss data associated with that mission. 2. Computer automatically dismisses— a. CHG (B-1) override. b. HI ANGLE (B-2). c. AUX CHG (B-3). d. GT LINE ADJUST (B-4). e. WHITE CHG 3, 4, 5 (B-8).
			3. Depress 0. (KEYBOARD indicator light extinguishes.)		3. Computer automatically sets— a. PROJ TYPE (B-5) to HE. b. FUZE TYPE (B-6) to Q. c. HOB (B-7) to minus zero. d. TGT EAST, TGT NORTH, and TGT ALT (A-2, A-3, and A-4) to minus zero. 4. If this function has been selected and the SM key has been depressed, the function may be dismissed by entering 9 or by depressing the RESET button.
SET UP.	E-2	Specific	1. Depress matrix buttons E-2. (Matrix window lights.)	NA	1. This function is used to designate to the computer the applicable portion of the program for caliber.
			2. Depress battery button desired.		2. *All constants pertaining to the battery selected in step 2, entry procedure, are set to standard.* These constants are muzzle velocity, projectile weight, ballistic coefficient function, and powder temperature.
			3. Designate caliber of battery selected in step 2 by depressing either the 1 or 2 button. (See para 2-13 for explanation of caliber designations by buttons 1 and 2.)		3. All registration corrections for the battery selected are set to zero.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
EOM	E-1 (Cont)	Specific	4. Depress the SET UP button. (COMPUTE indicator light flashes.) 5. After COMPUTE indicator light has flashed and extinguished, return to step 2 to set up other batteries. Repeat the procedure for all batteries desired.		
MAX ORD.	E-3	Specific	NA	1. Depress matrix buttons E-3. (Matrix window lights.) 2. Depress the SM key. The maximum ordinate will be displayed for the last computed trajectory.	1. This function is used to determine the maximum ordinate of the trajectory that will result from firing the displayed gun data. 2. Ordinate is displayed to the nearest meter above sea level. 3. This function is set to minus zero by function E-1 (EOM).
TGT DATA STORE.	E-4	Specific	1. Enter a target by following procedures outlined for TGT EAST (A-2), TGT NORTH (A-3), and TGT ALT (A-4). 2. Depress matrix buttons E-4. (Matrix window lights.) 3. Depress SM key. (KEYBOARD indicator light will light.) 4. Enter number (1-88) to be assigned to target (coordinates and altitude of target are displayed; KEYBOARD indicator light extinguishes.)	Not applicable. Target is recalled by following the procedure outlined for TGT DATA RECALL (A-1).	1. This function is used to place a target on the target list in the computer storage. 2. The NO SOLUTION indicator light will flicker if a number greater than 88 is entered. 3. Since the zero is reserved for recall of the battery associated target, a target cannot be assigned a zero for storage. 4. See remark 2 for matrix function E-8 (REPLOT RECT).
CLEAR MEMORY.	E-5	Any	1. If the PARITY indicator light flickers, test the working storage by following the procedures outlined in paragraph 2-15*b*. (Computer displays the line of memory in which the PARITY error occurred.)	NA	1. This function is used to return the selected line of working storage to the state it was in after the program was entered with the signal data reproducer AN/GSQ-64. The necessity for using this function is shown by a blinking PARITY indicator light.

			2. Enter the proper section of clear memory tape into the mechanical tape reader. This may be determined by comparing the number at beginning of tape section with the line number displayed by the computer in step 1. 3. Depress matrix buttons E–5. (Matrix window lights.)		2. If the program test of working storage is successful (number 136 is displayed) and the parity error persists, the trouble is not in the working storage, and the program should be reloaded with the signal data reproducer AN/GSQ–64. 3. To prevent undue delay in computing firing data, step 7, entry procedure, may be omitted.
			4. Depress SM key. (KEYBOARD indicator light will light.)		4. The clear memory tape consists of sections of tape for each line of memory. At the beginning of each section of tape the number of the line of memory is written. The computer will accept only the correct section of tape according to the keyboard input.
			5. Enter the line number displayed by computer as result of working storage test in step 1. (Computer reads the proper section of tape through mechanical tape reader. This returns the line number entered to the state it was in after the program was entered with the signal data reproducer AN/GSQ–64.) 6. Refer to map working storage (fig. 2–7) to determine the data stored in cleared line. 7. Re-enter data into the cleared line by following the normal entry procedure. 8. Repeat steps 1 through 7 until the test of working storage is successful.		5. See the procedure for entering the tape into the mechanical tape reader.
MET INPUT.	E–6	Any	1. The procedure for keyboard entry is as follows: a. Depress matrix button E–6. (Matrix window lights.) b. Depress SM key. (KEYBOARD indicator light will light.)	1. Depress matrix buttons E–6. (Matrix window lights.) 2. Depress RECALL key. (ID line only is displayed.)	1. To insure that all old or invalid met data have been deleted, function H–6 (MET STD) should be used before a current met message is entered using this function.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
MET INPUT	E-6 (Cont)	Any	c. Enter a 0 on the keyboard. (88 will be displayed.) d. Enter entire ID line: 2 digits (date). 4 digits (valid time). 3 digits (MDP altitude to nearest 10 meters). 3 digits (surface pressure in percent of standard to nearest 0.1 percent). (Do not enter decimal point. If surface pressure exceeds 100 percent, do not enter first digit.) After ENTER key has been depressed, computer will demand line 00 (00 will be displayed). e. Enter entire 00 line: 2 digits (00). 3 digits (wind direction to nearest 10 mils). 3 digits (wind speed to nearest knot). 4 digits (temperature in degrees Kelvin to nearest 0.1 degree). (The decimal point is not entered.) 4 digits (density to nearest gram/cubic meter). After ENTER key has been depressed, the computer will demand line 01. f. The remaining lines are entered in same manner as line 00. When all intended lines are entered (maximum is 26), the input mode is terminated by entering 9 or a period after the last complete line has been entered. If the maximum number of lines is		

		entered, the input mode automatically terminates.		
		2. If a mistake is made in any line entry and the mode has been terminated then a correction may be made as follows: a. Depress the SM key. b. Enter a 2 on the keyboard. c. On the keyboard, type the line number to be re-entered. (Line number will be displayed.) d. On the keyboard, type then enter the correct line (16 digits).		2. If, on keyboard entry, a line is entered without the proper number of digits (16), the computer will call for the same line again.
		3. The procedure for entering a tape met message is as follows: a. Load the tape into the tape reader. (See para 2-19 for procedure used to enter tape.) b. Depress matrix buttons E-6. (Matrix window lights.) c. Depress SM key. (KEYBOARD indicator light will light.) d. Enter a 3 digit. (The reader will automatically feed the tape and end the mode. If the computer does not accept a line of the met message through the tape reader, it will display the line number of the met message, on which it has stopped, and light the KEYBOARD indicator light. Then the remainder of the met message may be entered manually by following the procedure outlined in steps 1e and f (starting with the line displayed). If it is not desired to enter any more of the met message, enter 9.)	3. On the keyboard, type the line number to be recalled. The line will be displayed.	3. When function H-6 (MET STD) has been used, the display recalled by this function will be zeros except that A Battery's altitude will be displayed. 4. A display of zeros for ID line on recall signifies a standard met is in use. See MET STD (H-6). 5. The correct grid declination angle should be entered before using this function.

Table 2–1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
REPLOT POLAR.	E–7	Specific	1. Depress matrix buttons E–7. (Matrix window lights.) 2. Depress SM key. (Azimuth, range, and vertical angle from selected battery to target are displayed.)	NA	1. Must be preceded by REPLOT RECT if registration corrections are being used. 2. NO SOLUTION indicator light will blink if REPLOT POLAR function has not been preceded by REPLOT RECT as a warning to indicate that the result is not not precisely correct if registration corrections are being used. 3. Last ballistic trajectory computed is used for replot. 4. 20/R is automatically removed in case of fuze VT and fuze time trajectories.
REPLOT RECT.	E–8	Specific	1. Depress matrix buttons E–8. 2. Depress SM key. (The computer displays the target coordinates used to establish the trajectory which hit the target. The KEYBOARD indicator light remains on.) 3. Compare the target altitude displayed with the altitude shown at the same location on a map of the area. If there is a difference in the altitudes, enter the map altitude. The CLEAR key may be depressed before entering the altitude.	NA	1. Used to successfully approximate the target altitude after adjusting the original target location. 2. If the final replot location of the target has crossed a UTM 100,000-meter grid line from the original target location so that the five-digit easting or northing has increased to a value greater than 99999; the displayed coordinates cannot be stored directly by using matrix function E–4 (TGT DATA STORE). *When this situation occurs*, manually record the final replot coordinates, end the mode, and re-enter the coordinates in matrix functions A–2, A–3, and A–4; then store these data by using function E–4.

			4. After entering the new altitude, the computer displays new coordinates and altitude. If they do not compare favorably, perform step 3. If the altitudes agree, the target is properly located and may be stored by TGT DATA STORE (E–4) procedure. 5. Enter a period on keyboard to terminate mode.		
NO FIRE AREA EAST.	F–1	Any	1. Depress matrix buttons F–1. (Matrix window lights.) 2. Depress SM key --------------- 3. Enter the area easting to the nearest meter.	1. Depress matrix buttons F–1. (Matrix window lights.) 2. Depress RECALL KEY. (Easting is displayed.)	1. This function is used to enter the no-fire area easting coordinate. 2. Entry of five digits is required. 3. Easting cannot be entered as 00000. In such event, enter 00001.
NO FIRE AREA NORTH.	F–2	Any	1. Depress matrix buttons F–2. (Matrix window lights.) 2. Depress the SM key ----------- 3. Enter the area northing to the nearest meter.	1. Depress matrix buttons F–2. (Matrix window lights.) 2. Depress RECALL key. (Northing is displayed.)	1. This function is used to enter the no fire area northing coordinate. 2. Entry of five digits is required.
NO FIRE AREA RADIUS.	F–3	Any	1. Depress matrix buttons F–3. (Matrix window lights.) 2. Depress SM key --------------- 3. Enter the area safe radius to the nearest meter (1 to 20,000).	1. Depress matrix buttons F–3. (Matrix window lights.) 2. Depress the RECALL key. (Safe radius is displayed.)	1. This function is used to enter the no fire area safe radius. 2. A radius greater than 20,000 meters should not be entered. 3. Safe radius values may be calculated as described in paragraph 2–27. 4. If more than one safe radius is applicable to the same area, see remark 3 for matrix location F–4 (NO FIRE AREA STORE).
NO FIRE AREA STORE.	F–4	Any	1. Depress matrix buttons F–4. (Matrix window lights). 2. Depress the SM key -----------	1. To recall a specific no-fire area, use matrix location F–5 (NO FIRE AREA RECALL). 2. Depress the RECALL key, and and number assigned to the last area stored will be displayed.	1. This function is used to store the easting, northing, and safe radius entered in matrix locations F–1, F–2, and F–3. 2. All or any specific no fire area may be deleted from the list by entering 00000 in matrix positions F–1, F–2, and F–3 and then following the entry procedure for this function.

Table 2-1.—Continued.

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
NO FIRE AREA STORE.	F-4 (CONT)	Any	3. Enter the number assigned to the no fire area (1 to 21). The co-ordinates and safe radius are displayed.	3. To determine the no fire area causing the NO SOLUTION indicator to blink, depress the RECALL key. (The assigned number of the area will be displayed.)	3. When the areas entered are to be checked for two different type shells with different safe radii, the areas described by the smaller radius for one type shell must be stored *first* on the list; then, all areas for the second type shell with a larger safe radius are stored last.
NO FIRE AREA RECALL.	F-5	Any	1. Depress matrix buttons F-5. (Matrix window lights.) 2. Depress the SM key. 3. Enter the assigned number of the no fire area (1 to 21) to be recalled. (Easting, northing, and safe radius are displayed.)	Comment 3 for matrix location F-4 recall procedure applies.	This function is used to recall the easting, northing, and safe radius of any one of 21 stored no fire areas.
DF CORR.	F-6	Specific	1. Depress matrix buttons F-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the charge by using the charge flag as outlined in CHG (B-1). (KEYBOARD indicator light remains on.) 4. Enter deflection correction by entering the sign (left or right) and the correction to the nearest mil.	1. Depress matrix buttons F-6. (Matrix window lights.) 2. Depress RECALL key. (KEYBOARD indicator light will light.) 3. Enter the charge by using one of the charge flags outlined in CHG (B-1). (Deflection correction is displayed.)	1. This function is used to enter the deflection correction for a specific charge for the battery designated. 2. Depressing the ENTER key after computing the registration corrections in the COMP REG (H-8) procedure will automatically enter the deflection correction for the battery selected.
TIME CORR.	F-7	Specific	1. Depress matrix buttons F-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.)	1. Depress matrix buttons F-7. (Matrix window lights.) 2. Depress RECALL key. (KEYBOARD indicator light will light.)	1. This function is used to enter the fuze correction for a specific charge for the battery designated. 2. Depressing the ENTER key after the computation of registration corrections in the COMP REG (H-8) procedure will automatically enter the fuze correction for the battery selected.

			3. Enter the charge by using one of the charge flags outlined in CHG (B–1). (KEYBOARD indicator light remains on.) 4. Enter the time correction by entering the sign (+ or −) and the correction to the nearest 0.1 second.	3. Enter the charge by using the charge entered in CHG (B–1). (Fuze correction is displayed.)	
RANGE K.	F–8	Specific	1. Depress matrix buttons F–8. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the charge by using one of the charge flags outlined in CHG (B–1). (KEYBOARD indicator light remains on.) 4. Enter the range correction by entering the sign (+ or −) and the correction to the nearest meter/1,000.	1. Depress matrix buttons F–8. (Matrix window lights.) 2. Depress RECALL key. (KEYBOARD indicator light will light.) 3. Enter the charge by using the charge entered in CHG (B–1). (Range correction is displayed.)	1. This function is used to enter the range K for a specific charge for the battery designated. 2. Depressing the ENTER key after the computation of registration corrections in the COMP REG (H–8) procedure will automatically enter the range correction for the battery selected.
MV	G–1	Specific	1. Depress matrix buttons G–1. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter a flag of two or three digits. The first digit is the projectile type flag (see app C for appropriate flag) and the second digit is the charge flag. (KEYBOARD indicator light remains on.) 4. Enter muzzle velocity to nearest 0.1 m/sec.	1. Depress matrix buttons G–1. (Matrix window lights.) 2. Depress RECALL key. (KEYBOARD indicator light will light.) 3. Enter flag as outlined in step 3, entry procedure. (MV is displayed.)	1. Example of flag entry: *Description* — *Flag* Shell HE, chg 2 — 12 2. See appendix C for standard muzzle velocities. 3. If a nonstandard muzzle velocity is entered for shell HE, WP smoke, or gas for the 105-mm, or 155-mm howitzer, the computer automatically applies the muzzle velocity entered to the other projectiles of this group.
POWD TEMP.	G–2	Specific	1. Depress matrix buttons G–2. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the sign and numerical value of the powder temperature to the nearest degree Fahrenheit.	1. Depress matrix buttons G–2. (Matrix window lights.) 2. Depress RECALL key. (Powder temperature is displayed.)	Standard temperature is +70° F.

Table 2-1.—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
PROJ WEIGHT.	G-3	Specific	1. Depress matrix buttons G-3. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the digit (flag) for projectile type desired. (See app C for flags.) (KEYBOARD indicator light remains on.) 4. Enter projectile weight to the nearest 0.1 pound.	1. Depress matrix buttons G-3. (Matrix window lights.) 2. Depress RECALL key. (KEYBOARD indicator light will light.) 3. Enter the digit (flag) for projectile to be recalled. (The stored weight for the projectile desired will be displayed.)	1. Minor differences will occur between inputs and recall of inputs. This is caused by the computer using the projectile weight to the nearest one-sixteenth pound. 2. See appendix C for standard projectile weights.
LAT	G-4	Any	1. Depress matrix buttons G-4. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the sign and numerical value of the battery latitude to the nearest degree (0 to ±90).	1. Depress matrix buttons G-4. (Matrix window lights.) 2. Depress RECALL key. (Latitude is displayed.)	1. Enter a + sign if battery is located in Northern Hemisphere or a − sign if battery is located in Southern Hemisphere. 2. The latitude entered for one battery is applied to all batteries.
GRID DECL.	G-5	Any	1. Depress matrix buttons G-5. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter the sign and numerical value of the grid declination angle to the nearest mil (0 to ±63 mils).	1. Depress matrix buttons G-5. (Matrix window lights.) 2. Depress RECALL key. (Grid declination angle is displayed.) 3. Depress RECALL key. (Grid declination angle is displayed.)	1. This function is used to convert the wind azimuth from true north to grid north. If grid north is to the right of true north, the sign is plus; if grid north is to the left of true north, the sign is minus. 2. If no entry is made, the computer will assume that the grid declination angle is 0. 3. This function must be entered before using MET INPUT (E-6).
DF INPUT.	G-6	Specific	1. Depress matrix buttons G-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter deflection to nearest mil.	1. Depress matrix buttons G-6. (Matrix window lights.) 2. Depress RECALL key. (Deflection input is displayed.)	This function is used to enter the adjusted deflection after a registration. It is used by the computer to determine the deflection correction.

TIME INPUT.	G-7	Specific	1. Depress matrix buttons G-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter fuze setting to nearest 0.1.	1. Depress matrix buttons G-7. (Matrix window lights.) 2. Depress RECALL key. (Time input is displayed.)	This function is used to enter the adjusted time after a registration. It will be used by the computer to determine the fuze correction.
QE INPUT.	G-8	Specific	1. Depress matrix buttons G-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter QE to nearest mil.	1. Depress matrix buttons G-7. (Matrix window lights.) 2. Depress RECALL key. (QE input is displayed.)	This function is used to enter the adjusted QE after a registration. It is used by the computer to determine the range correction (range K).
BTRY EAST.	H-1	Specific	1. Depress matrix buttons H-1. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter battery easting to the nearest meter.	1. Depress matrix buttons H-2. (Matrix window lights.) 2. Depress RECALL key. (Battery easting is displayed.)	On entering the coordinates, five digits must be used. If not, the NO SOLUTION indicator light will flicker and the display will remain.
BTRY NORTH.	H-2	Specific	1. Depress matrix buttons H-2. (Matrix window lights.)	1. Depress matrix buttons H-2. (Matrix window lights.)	On entering the coordinates, five digits must be used. If not, the NO SOLUTION indicator light will flicker and the display will remain.
			2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter battery northing to the nearest meter.	2. Depress RECALL key. (Battery northing is displayed.)	On entering the coordinates, five digits must be used. If not, the NO SOLUTION indicator light will flicker and the display will remain.
BTRY ALT.	H-3	Specific	1. Depress matrix buttons H-3. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter altitude to the nearest meter.	1. Depress matrix buttons H-3. (Matrix window lights.) 2. Depress RECALL key. (Battery altitude is displayed.)	1. Used to enter the altitude of the battery above sea level. 2. Negative inputs are not accepted.
BTRY AZ LAID.	H-4	Specific	1. Depress matrix buttons H-4. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter azimuth of fire to nearest mil.	1. Depress matrix buttons H-4. (Matrix window lights.) 2. Depress RECALL key. (Battery azimuth is displayed.)	
BTRY DF.	H-5	Specific	1. Depress matrix buttons H-5. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Enter referred deflection of battery to nearest mil.	1. Depress matrix buttons H-5. (Matrix window lights.) 2. Depress RECALL key. (Battery referred deflection is displayed.)	

Table 2-1.—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
MET STD.	H-6	Any	1. Depress matrix buttons H-6. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Depress 0. (KEYBOARD indicator light extinguishes; COMPUTE indicator light flashes.)	NA	This function deletes the most recent met input and replaces it with standard values.
ZERO CORR.	H-7	Specific	1. Depress matrix buttons H-7. (Matrix window lights.) 2. Depress SM key. (KEYBOARD indicator light will light.) 3. Depress 0 on keyboard. (KEYBOARD indicator light extinguishes; COMPUTE indicator light flashes.)	NA	1. This function deletes all registration corrections for the battery whose battery button is depressed. 2. Entering 9 instead of 0 as described in step 3, entry procedure, dismisses this function without setting the registration corrections to zero. 3. The setup procedure outlined under SET UP (E-2) also sets all registration corrections to zero for the battery selected. 4. Selection of COMP REG (H-8) automatically sets all previous registration corrections to zero, for the battery selected.
COMP REG.	H-8	Specific	1. The procedure for computing the corrections for both a precision registration and a time registration is as follows: a. *Conduct of registration.* The computer is used to compute the firing data for the adjustment phase only. The steps are as follows: (1) Select the battery to which the corrections will apply by depressing the battery button. (2) Recall or enter the coordinates and altitude of the registration point by following the procedures in TGT DATA RECALL (A-1), or TGT EAST (A-2), TGT NORTH	NA	1. This function is used to determine the registration corrections after a precision, time, high-burst, or mean-point-of-impact registration. 2. Selection of this function automatically zeros all previous registration corrections for the battery selected. 3. The registration corrections displayed by the computers are the residual corrections between the data required to hit the registration point (adjusted data) and the data the computer would have used to hit that point, using all parameters for weather and material parameters entered. Since the computer at the time the SM key was depressed.

(A-3), and TGT ALT (A-4).
(3) A specific charge must be selected for the registration, using the procedure outlined for CHG (B-1).
(4) Compute the firing data in the normal manner for the *adjustment* phase.
(5) Upon entering fire for *effect*, the firing data are completed by using the procedures in FM 6-40 and on DA Form 6-12, (Record of Precision Fire). (See remark 6.)

b. *Computation of registration corrections*. The computer is used to compute the registration corrections. The steps for computing the registration corrections and applying them to subsequent computations are as follows:
(1) Re-enter the coordinates and altitude of the registration point.
(2) Enter the adjusted deflection, adjusted time (time registration only), and adjusted QE as outlined in DF INPUT (G-6), TIME INPUT (G-7), and QE INPUT (G-8).
(3) Override the fuze time by using the procedure outlined for FUZE TYPE (B-6), if a time registration was also fired.
(4) Override HI ANGLE (B-2) if a high-angle registration was fired.
(5) Override the charge by

These corrections are not the same as those used for manual corrections, since there is no way graphically to separate the corrections and they exclude factors, such as *drift*, that are automatically included by the computer. The corrections displayed by the computer are described below.
a. The deflection correction is displayed to the nearest mil in the DEFLECTION window. The direction (sign) of the correction appears in the sign window. A + indicates a right correction; a − indicates a left correction.
b. The fuze correction is displayed to the nearest 0.1 second in the fuze setting window. The sign of the correction is displayed on the first Nixie tube in the window. A blank indicates a plus correction; a 9 indicates a minus.
c. Range correction is displayed as range K (meters/1,000) in the QUADRANT window. The sign of the correction is displayed in the same manner as the sign of the fuze correction.

4. All known materiel and meteorological parameters, such as muzzle velocity, should be entered into the computer before computing the registration corrections. The corrections displayed by the computer are the functions of any parameters left at standard, inaccuracies of measurement, the age of the met data and the materiel parameters entered. Since the computer adds the corrections displayed to the effect of the met data and materiel parameters in

Table 2-1.—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
COMP REG.	H-8 (Cont)	Specific	following the procedure for CHG (B-1). (6) Depress matrix buttons H-8. (COMP REG). (Matrix window lights.) (7) Depress SM key. (COMPUTE indicator lights, KEYBOARD indicator light will also light, and the computer displays the registration corrections and remains in the keyboard input mode.) (See remark 3.) (8) Store the registration corrections for the charge used by typing the charge number on the keyboard and depressing the ENTER key. (KEYBOARD indicator light remains on.) (9) If it is desired to store the corrections for the nonregistering batteries, depress the appropriate battery button and repeat step (8). Repeat for each battery desired. (10) After the corrections have been stored for batteries desired, terminate the mode by depressing the PERIOD key. (KEYBOARD indicator light extinguishes.) 2. The procedure for computing the corrections for a mean-point-of-impact registration is as follows: a. *Conduct of registration.* The		its computations, the success of the transfer of registration corrections to other batteries varies with the accuracy and completeness of this input prior to computations of registration corrections. Registration corrections are battery, charge, and trajectory type associated. They are not projectile associated; therefore, they will be applied for all types of shells. Registration corrections determined for the 8-inch AE shell by firing HES shell should be dismissed by using function H-7 (ZERO CORR) before firing other types of shell, and, conversely, registration corrections determined for HE should be dismissed before calculating data for the HES or AE rounds. 5. The computer may be used to assist in determining the following data for a precision registration: a. *Angle T.* Upon entry of the registration point coordinates and altitude, use the REPLOT POLAR (E-7) function to determine the azimuth and range from the battery to the registration point. Manually compare the battery-registration point azimuth with the observer-registration point azimuth to determine the angle T. b. *Factor S.* Use the range displayed by the computer and the angle T determined in a above to enter the S/2 table on DA Form 6-12 and determine the value of S/2.

computer is used to compute the firing data, orient the target base, and compute the location of the mean-point-of-impact. The steps are as *follows:*

(1) Select the battery to which *the corrections* will apply by depressing the battery *button.*

(2) Recall or enter the coordinates and altitude of the registration point by following the procedure in TGT DATA RECALL (A-1) or TGT EAST (A-2), TGT NORTH (A-3), and TGT ALT (A-4).

(3) Compute the orienting data by performing step 3, entry procedure, SURVEY (D-5). Observers are oriented as outlined in FM 6-40.

(4) Insure that fuze quick or shell HE has *not* been overridden and cause the computer to compute the firing data in normal manner.

(5) Conduct the registration by following the procedure in FM 6-40.

b. *Computation of registration corrections.* The computer is used to compute the registration corrections. (See remark 3.) The procedure for computing the registration corrections and applying them to subsequent computations is as follows:

(1) Determine manually the average azimuths and the vertical angle from observer base.

c. *Site. Enter the* registration point coordinates and altitude into the computer.

(1) Cause the computer to compute the firing data in the normal manner.

(2) Change the target altitude to the altitude of the battery.

(3) Cause the computer to compute the firing data.

(4) Subtract the QE determined in (3) above from the QE determined in (1) above. The difference is site.

(5) Re-enter the correct target altitude for subsequent corrections.

d. *Fork. Upon entering fire* for effect, use the REPLOT POLAR (E-7) function again. Use the range displayed to enter a tabular or graphical firing table and determine the fork as outlined in FM 6-40.

6. If the base piece is displaced from the battery center, the coordinates and altitude of the base piece must be entered in place of the coordinates and altitude of the battery center before computing the registration. After the registration corrections have been displayed and entered, the coordinates and altitude of the battery center should be re-entered for future firing. In this way the computer will automatically correct for the base piece displacement. These corrections may then be transferred to other batteries without regard to the base piece displacement.

Table 2-1.—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
COMP REG.	H-8 (Cont)	Specific	(2) Use of computer to compute the location of the mean point of impact by performing step 2, entry procedure, SURVEY (D-5). The computation of the mean-point-of-impact in this manner will cause it to be stored as the current target for the battery whose button is depressed. If the mean point of impact has been determined by another method, enter its location by following the procedures for TGT EAST (A-2) TGT NORTH (A-3), and TGT ALT (A-4). (3) The remainder of the procedure is the same as that for precision registration. Perform steps 1b(2) through (10). 3. The procedure for computing the corrections for a high-burst registration is as follows: a. *Conduct of registration.* The computer is used to compute the firing data, orient the target base, and compute the location of the high burst. The steps are as follows: (1) Select the battery to which the corrections are to apply by depressing the battery button. (2) Recall or enter the coordinates and altitude of the registration point (adding the height of burst over the registra-		

			tion point to the altitude of the registration point) by following the procedures for TGT DATA RECALL (A–1) or TGT EAST (A–2), TGT NORTH (A–3), and TGT ALT (A–4). (3) Compute the orienting data by performing step 3, entry procedure, SURVEY (D–5). Observers are oriented as outlined in FM 6–40. (4) Select fuze time as outlined in FUZE TYPE (B–6). (5) Insure that shell HE *has not been overridden.* (6) Enter a correction of DOWN 20, using the procedure for UP/DOWN (A–8). This correction compensates for the automatic addition of 20/R by the computer for fuze time. (7) Cause the *computer to* compute the firing data *in the normal* manner. (8) Conduct the registration as outlined in FM 6–40. b. *Computation of registration corrections.* The registration corrections and the procedure for computing the registration corrections are identical to those presented for the *mean-point-of-impact* registration except that the high-burst point is used instead of the mean point of impact, and since fuze time was fired, the remarks pertaining to the fuze correction in steps 1b(2) and (3), apply.		

Section VI. COMPUTER OUTPUT AND COMPUTATIONAL SEQUENCE

2-24. Display Panel

a. The display panel (fig. 2-3) is the primary output device for the cannon programs. It consists of 18 Nixie tube indicators, which display the numerical sign, and designation information either as the output for problem solution or as the data being entered through the keyboard. Error indication flags are also displayed if there is *no solution* to a problem.

b. The display panel is divided into six windows which display the following data:

(1) The first window, BATTERY, displays the letter A, B, C, D, or E, for the battery button depressed.

(2) The second window, SIGN, displays the algebraic sign (+ or −) for the numerical output or input. When latitude is entered, a plus sign indicates north latitude and a minus sign indicates south latitude.

(3) The third window, CHARGE, displays the powder charge selected or the optimum charge determined by the computer. Certain input data (first digit in met entry) are displayed in this window prior to depressing the ENTER key.

(4) The fourth window has five Nixies labeled DEFLECTION AZIMUTH and EASTING. The display data depends on the matrix position selected and whether the information is an input or output. When coordinates are being entered in sequence (easting, northing, altitude), the easting is displayed in this window and the northing and altitude are displayed in the next two windows to the right. However, when the northing or the altitude is recalled separately, it is displayed in this window. The deflection is displayed as a result of trajectory computation and solution. Other data recalled or being entered, such as MV or LAT, are displayed in this window.

(5) The fifth window has five Nixies and is labeled FUZE SETTING, TIME OF FLIGHT, DISTANCE, and NORTHING. The display data depends on the matrix position selected and whether the data are input data or output data.

(6) The last window has five Nixies and is labeled QUADRANT, VERTICAL ANGLE, and ALTITUDE. The display data depends on the matrix position selected and whether the data are input data or output data. In certain instances, a flag typed in on the keyboard is initially displayed in the fourth window. Then, when the ENTER key is depressed, the flag is displayed in this window during the keyboard entry of additional data.

2-25. No Solution Display Indications

When an input item is entered by an erroneous procedure or the data being entered are incorrect (i.e., too large a value), the NO SOLUTION indicator blinks and a number is displayed to identify the error. Table 2-2 describes the errors identified by numbers and explains the corrective action. The flag cards for each specific program indicate the meanings of error displays in abbreviated form.

2-26. How FADAC Computes the Ballistic Trajectory

a. The M18 computer is programmed to solve the ballistic trajectory, by integrating the equations of motion for a projectile in flight. This technique is the same as the computing technique used on making a firing table, except that in the computer solution, the trajectory is computed by using the weather, weapon, and ammunition data as they actually exist instead of the hypothetical standard conditions. The computer uses the nonstandard conditions entered by the operator, and, if a specific condition is unknown and not entered, the computer will use the standard value.

b. Figures 2-8, 2-9, and 2-10 illustrate graphically the steps used in the cannon program to solve the ballistic equations of motion.

(1) From the battery and target coordinates entered, the range and azimuth to the target are computed mathematically.

(2) The computer then selects the optimum charge or uses the ordered charge and determines a trail quadrant elevation.

(3) Using the trail quadrant elevation,

Table 2–2. No Solution Displays, Description of Error, and Corrective Action

Display	*Description of error*	*Corrective action*
X ____0	Out of range for X charge	Using function B–1 (CHG), enter the next higher charge.
______1	Battery button was changed during computations.	Check to insure that the COMPUTE indicator, has extinguished before changing the battery button.
______2	Fuze type or projectile type in error, improper shell/fuze combination, no height of burst entered, or projectile weight too great.	Recall the inputs to determine which error is indicated and reenter the data.
______3	Observer corrections entered without A–5 (OT DIR) entry.	Enter OT direction, and reenter corrections.
______4	Improper auxiliary or white bag charge	Enter correct data. See appendix C.
______5	No observer azimuth, horizontal distance, slant range, or vertical angle entered in survey problem. Or, both horizontal and slant distance entered. Procedure error.	Recall the inputs to determine which data were not entered. Enter data.
______6	No target entered	Enter target data.
X ____8	Target before the peak of the trajectory. Out of range for X charge.	Using function B–1 (CHG), enter the next lower charge, or use high-angle fire.
______7	No charge entered before using function H–8 (COMP REG).	Enter charge used in registration.
______9	Error in entry of decimal values	Re-enter data with less than 2 digits after decimal point.
______10	Attempt to store negative altitude	Store only positive altitude values.
Gun data and NSL indication	Target or intended impact point is in a no fire area or the maximum on-carriage elevation will be exceeded.	Use recall procedure for F–4 (NO FIRE AREA STORE), to determine the number of the specific area.

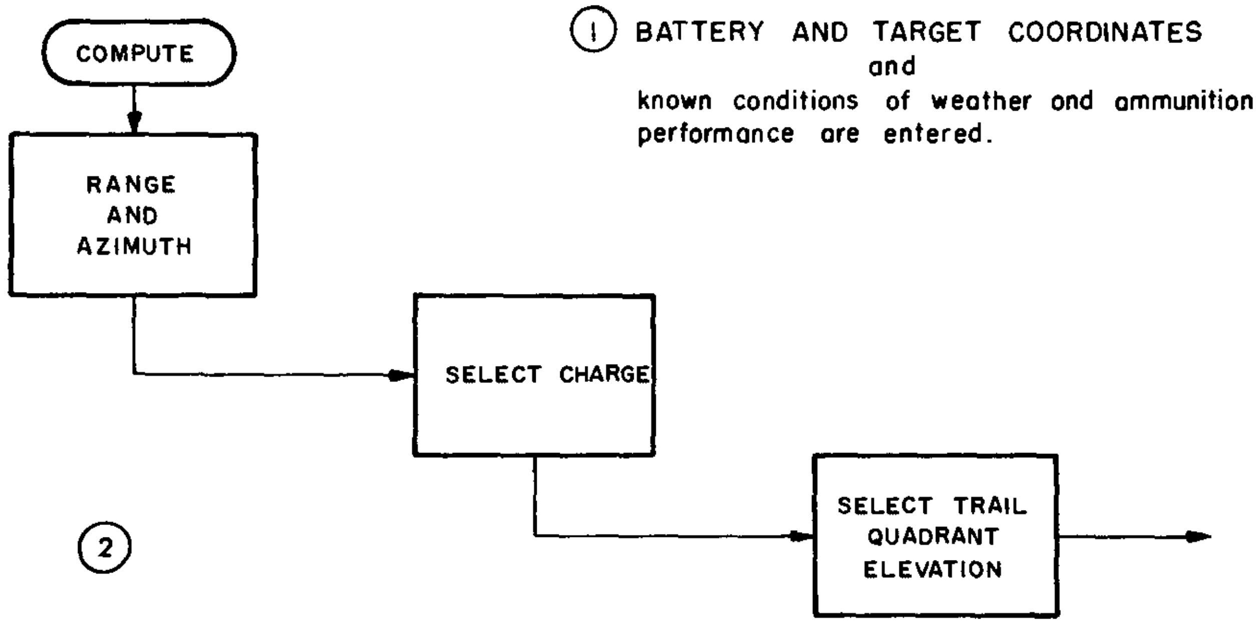


Figure 2–8. Steps 1 and 2 computation.

the computer simulates the trajectory by integrating the equations of motion for a projectile in flight with gravity, weather, aerodynamic drag, and the other forces acting on the projectile. The battery location, the muzzle velocity, and a trial quadrant elevation are used as the initial conditions for the first integration.

(4) After the projectile has traveled the first fraction of a second and its location in range (X) and height (Y) are known, the computer solves the next integration. Acceleration is integrated to find velocity, and velocity is further integrated to determine a new location, acceleration, and velocity for continuing the integration. At each step, the location of the projectile is compared with the target altitude.

(5) When the computed altitude of the projectile is below the altitude of the target, the integration stops and a miss distance is computed from the initial range. If the miss distance is less than 10 meters, final corrections are applied for the miss distance. Then the lateral displacement resulting from drift, rotation of the earth, registration deflection correction, and crosswind are applied to the initial gun-target azimuth, and data are displayed. If the miss distance is greater than 10 meters, a correction for the miss distance is applied to the initial trial quadrant elevation, and the trajectory computations are repeated.

c. The computer uses high-explosive shell (HE), fuze quick (Q), unless the operator enters a number designating a specific shell or fuze. The computer automatically uses the best propellant charge, unless a specific charge designated by the operator.

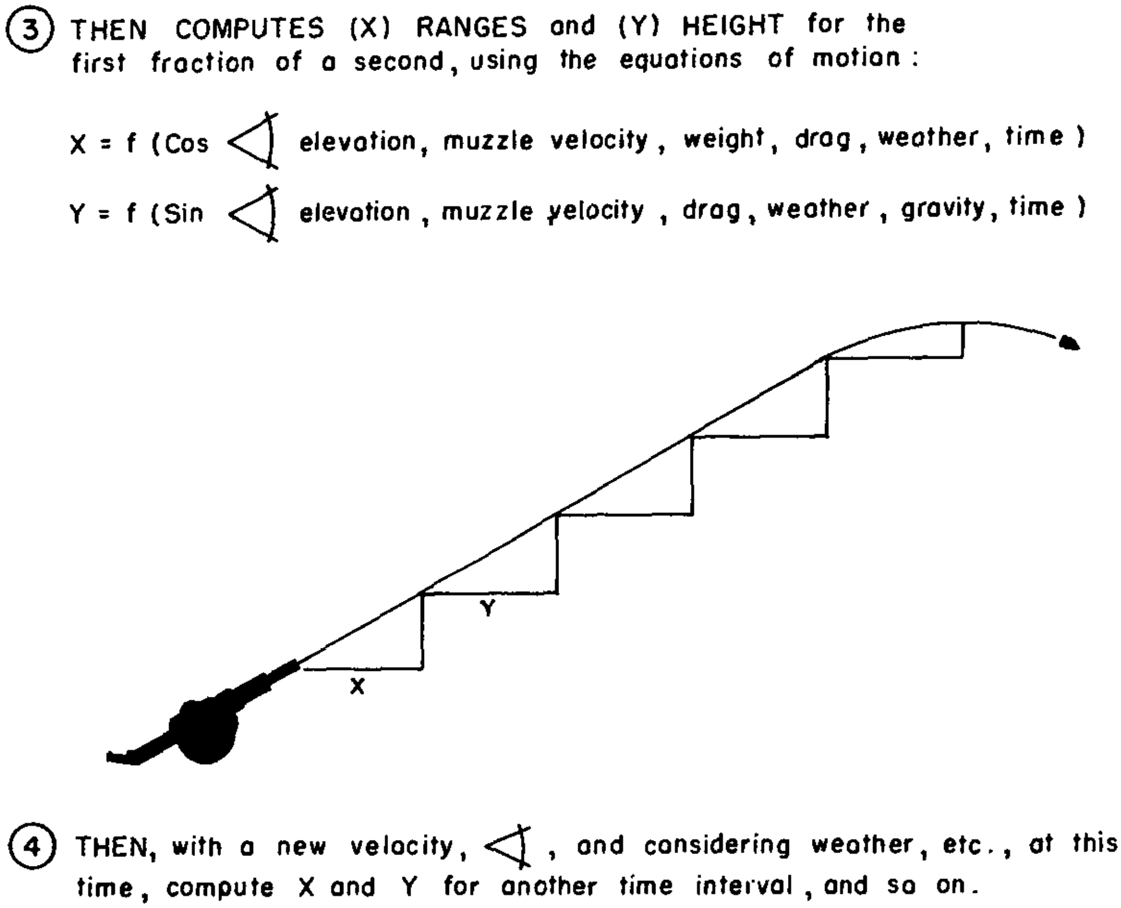


Figure 2-9. Steps 3 and 4 of computation.

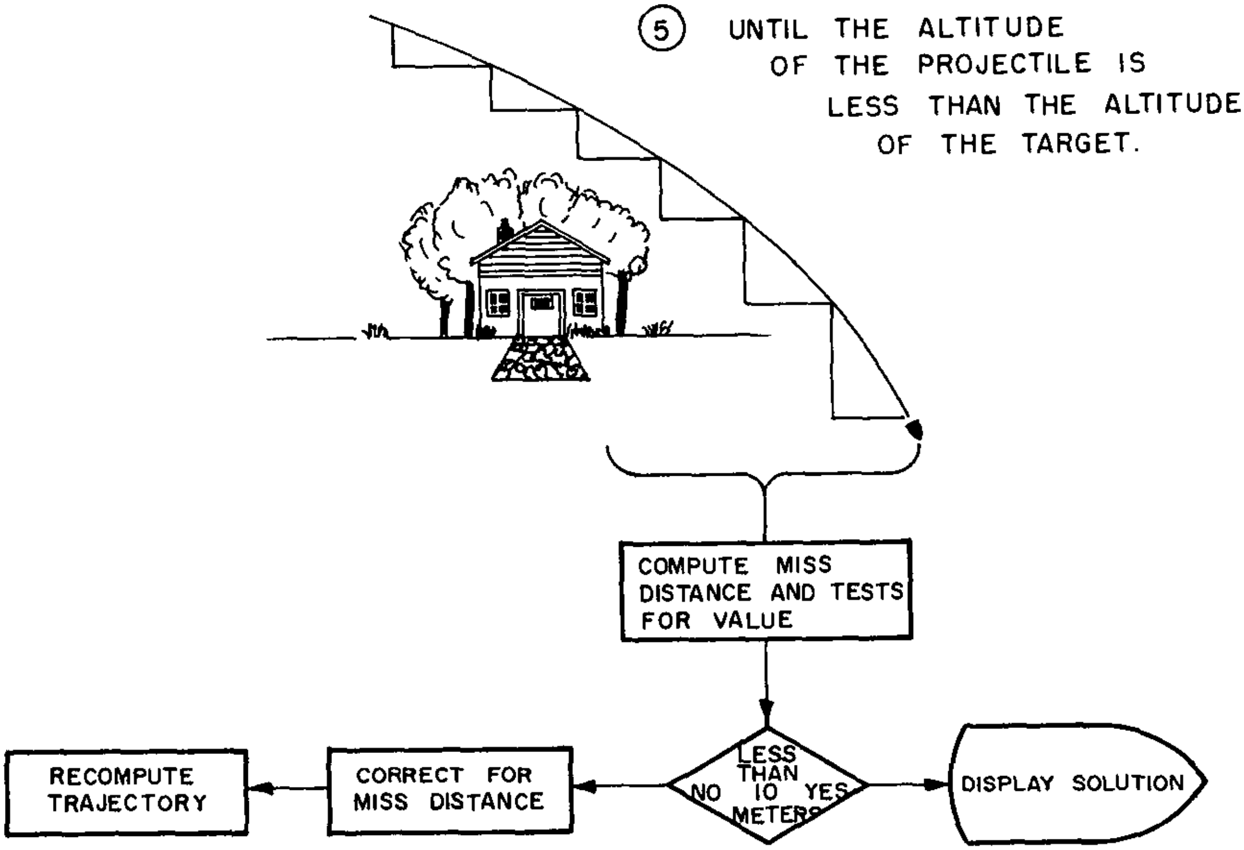


Figure 2-10. Step 5 of computation.

2-27. No Fire Area Subroutine

a. The cannon programs provide a safety subroutine that permits areas or points to be precluded from friendly artillery fires. Each area is input as a circle. Input data consist of the coordinates of the center of the circle and a safe radius. Twenty-one such areas may be stored in memory. When the M18 computes firing data, it first determines the direction and range to the target or intended burst point. If the intended burst point falls inside any one of the no fire areas stored in memory, the NO SOLUTION indicator light will blink; however, the compute light will remain on and the gun data will be displayed. The blinking light warns the operator that the displayed firing data will result in rounds falling in one of the no fire areas stored in memory. The computer checks each area sequentially, beginning with area number 1. The operator may identify which area is causing the NO SOLUTION indicator light to blink by depressing matrix buttons F-4 (NO FIRE AREA STORE) and then depressing the RECALL key. The number of the area will be displayed. During an observer adjusts fire mission, when the observer adjusts rounds into a precluded area, the NO SOLUTION indicator light will blink the same as if the initial target location was in the area.

b. The safe radius of an area may be determined by using a map or photomap and a scale to measure the size of the area and then adding a buffer distance to compensate for the width or depth of the battery, the distance from the point of impact to which shell fragments are effective, and dispersion. To attain a high assurance (98 percent) that rounds will not fall in the area, a buffer distance of 3 probable errors for range, plus one-half the width of the battery front, plus 100 meters (for HE shell fragmentation) is added to the measured radius to attain a total safe radius. All charges are considered, and the largest PE_r indicated in the tabular firing table for the range to the center of the preclusion area is used.

c. The safety warning is valid only when *all* gunnery parameters entered in the M18 are accurate. For example, if the met data being used is in error, or if poor registration corrections are in the computer, or if the altitude of the target is incorrect, errors will occur in the gun data; and as a result, the rounds might impact in a no fire area. This safety feature is only as good as the data used in the computer. If the accuracy of the corrections is doubtful, the S3 should consider using a larger buffer distance in calculating the safe radius.

d. When the no fire area data stored in memory are no longer valid for specific firing positions, the data must be deleted. An area inadvertently left in memory when a new firing position is occupied may indicate a false unsafe condition. The operator should delete the no fire area list or delete specific areas by using the following procedure to enter zeros in the pertinent locations as follows:

(1) Depress matrix buttons F–1 (NO FIRE AREA EAST).

(2) Depress the SM key.

(3) On the keyboard, type 00000.

(4) Depress the ENTER key.

(5) Depress matrix buttons F–2 (NO FIRE AREA NORTH).

(6) Depress the SM key.

(7) On the keyboard, type 00000.

(8) Depress the ENTER key.

(9) Depress matrix buttons F–3 (NO FIRE AREA RADIUS).

(10) Depress the SM key.

(11) On the keyboard, type 00000.

(12) Depress the ENTER key.

(13) Depress matrix buttons F–4 (NO FIRE AREA STORE).

(14) Depress the SM key.

(15) On the keyboard, type 1.

(16) Depress the ENTER key.

(17) Depress the SM key.

(18) On the keyboard type 2.

(19) Depress the ENTER key. Then repeat the steps in (17), (18), and (19) above and enter 3, 4, 5, . . . 21 or only the applicable numbers.

CHAPTER 3
COMPUTER, APPLICATION, CANNON ARTILLERY

Section I. GENERAL

3–1. Purpose

This chapter describes the application of the M18 computer in—

a. Normal fire direction center operations.

b. Special situations.

c. Registrations.

3–2. Fire Direction Center Operations

A suggested sequence of events and distribution of duties for battalion fire direction center personnel are shown in table 3–1. The detailed requirements for the computation and transmission of firing data for routine adjust-fire and fire-for-effect missions are described in *a* and *b* below.

a. Adjust-Fire Mission. When an adjust-fire mission is received, the vertical control operator (VCO) plots the target on a battle map or a firing chart. The S3 checks the target location and issues the fire order.

(1) The computer operator enters the target data and the appropriate mission overrides requested by the forward observer or announced in the fire order. He computes the firing data for the batteries to fire, computes the polar replot to check the VCO's orienting data with the data input, enters the observer corrections, announces the new firing data when required, and stores the target when directed.

(2) The adjusting battery computer/recorder receives the orienting data from the VCO and the firing data from the computer operator and announces the fire commands to the adjusting battery.

(3) The VCO announces the target altitude to the computer operator and the orienting data to the computer/recorders. The VCO computes the site for all batteries. He assists in computing the data for replot and plots the targets on his firing chart, when directed.

(4) The computer/recorders for the non-adjusting batteries receive the orienting data from the VCO and the initial firing data from the computer operator. They transmit the mission to their respective batteries with the command DO NOT LOAD.

b. Fire-for-Effect Mission. The fire-for-effect mission is processed similarly to the adjust-fire mission.

(1) When a mixed caliber battalion is being massed, the computer operator first computes the data for the slower firing (larger caliber) weapons to expedite speed in firing for effect.

(2) Identical to the fire-for-effect phase of the adjust-fire mission, the computer operator must precede all announced firing data with the designation of the battery to fire.

c. Battery Operation. A suggested sequence of events and distribution of duties for battery fire direction personnel operating a battery FDC are shown in table 3–2.

Table 3-1. Duties of Battalion Fire Direction Center Personnel (During Firing)

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator	Switchboard operator
1	Supervises activities of section personnel.	Supervises activities of section personnel.			Records fire mission data on computer's record.	Receives and records fire mission.	Operates switchboard.
2			Enters target data.	Plots target on grid sheet or map.			As required.
3	Issues fire order.						
4			Enters target altitude announced by the VCO.	Determines and announces target altitude and orienting data for batteries to fire.	Sends orienting data and preliminary commands to batteries.	Sends message to observer.	
5			Enters required mission overrides.				
6			Computes and announces firing data. Checks VCO orienting data.	Computes site and prepares for manual backup, as directed.	Sends remaining fire commands to batteries.		
7					Receives SHOT from the batteries.	Transmits SHOT to the observer.	
8			Enters OT direction, if required. Enters observer corrections and announces firing data.		Sends subsequent commands to the batteries.		
9	Orders replot of target, as required.		Assists VCO in target replot.	Assists computer operator in target replot.	Records data for replot on computer's record.		
10			Stores target, as required.	Updates firing chart, as required.			

Notes:

1. When two artillery units employ the M18 and check data prior to firing, the Fire Direction officer controlling the mission may announce the altitude selected for the target prior to the target number in the Fire Order.

2. The S3/FDO of the unit or headquarters controlling the mission, when using the M18, carefully analyzes all aspects of the mission before making a decision to accept or override the selection by the computer of the charge to be fired. Further, if a decision is made to override the selection by the computer of the charge to be fired, the charge selected should be announced in the Fire Order and passed to all other units employing the M18 for the Mission.

Table 3-2. Duties of Battery Fire Direction Center Personnel

Sequence	Fire direction officer	Computer operator	Vertical control operator	Computer/ recorder	Radiotelephone operator
1	Supervises activities of section personnel.			Records fire mission data on computer's record.	Receives and records fire mission.
2		Enters target data	Plots target on grid sheet or map.		
3	Issues fire order.				
4		Enters target altitude announced by VCO.	Determines and announces target altitude and orienting data.	Sends orienting data and preliminary commands to the battery.	Sends message to observer.
5		Enters required mission overrides.	Computes site and prepares for manual backup, as directed.		
6		Computes and announces firing data. Checks VCO orienting data.		Sends remaining fire commands to the battery.	
7				Receives SHOT from the battery.	Transmits SHOT to the observer.
8		Enters OT direction, if required. Enters observer corrections and announces firing data.		Sends subsequent commands to the battettry.	
9	Orders replot of target as required.	Assists VCO in target replot.	Assists computer operator in target replot.	Records data for replot on computer's record.	
10		Stores target, as required	Updates firing chart, as required.		

Section II. COMPUTER PROCEDURES FOR SPECIAL SITUATIONS

3-3. Multiple Fire Missions

The FADAC may be used to conduct five separate fire missions, concurrently. Targets may be transferred to another battery by using the MASS FIRES (D-8) function. A mission may be temporarily suspended in order to attack a more lucrative target and subsequently reengaged by using the TEMP MSN STORE (D-7) and TEMP MSN RECALL (D-6) functions. These capabilities provide the S3 with considerable flexibility in processing muttiple fire missions. If necessary, the S3 can process additional fire missions manually using the other fire direction personnel.

3-4. Polar Coordinate Missions

a. When an observer locates a target by polar coordinates, he should report the vertical angle instead of the vertical interval, if possible. Also, he should indicate whether the range is horizontal range or slant range, unless it is obvious. If the range is measured by mechanical means, such as laser or radar, it is considered to be a slant range. The range measured from a map or estimated is considered to be a horizontal range. A forward observer equiped with laser may be reporting either horizontal range or slant range depending on his method of measuring the range. The vertical interval is computed by the FADAC.

b. The vertical interval may be used when the observer does not have a means of accurately measuring a vertical angle. However, this procedure is the least preferred method. The procedure for entering a vertical interval is to first enter a vertical angle of +0 for the OBS VERT ANGLE (C-7) function. Then the vertical interval is entered into the FADAC with the UP/DOWN (A-8) function. When the target location is computed using the POLAR PLOT MSN (C-8) function, the target altitude will appear to be in error. This altitude is actually more accurate than if it were calculated manually by simple trigonometry, because the FADAC applies the curvature of the earth and determines a more accurate altitude.

c. Radar locations may be stored in the FADAC as observer locations. This permits fast, accurate fire-for-effect target location calculations using the POLAR PLOT MSN (C-8) function.

3-5. Replotting Targets

a. The computer has the capability of replotting targets. It will display either the azimuth, distance, and vertical angle from the battery to the target (REPLOT POLAR function) or the coordinates and altitude of the point where the computed trajectory passes through the target altitude (REPLOT RECT function). The range displayed for the REPLOT POLAR function will be the firing table range for the elevation required to reach the target. Therefore, it will not be accurate if registration corrections (range K other than zero) are being used. Table 3-3 gives the steps performed by the computer operator and the vertical control operator to determine the target replot data.

b. The accuracy of the target replot coordinates is dependent on the accuracy of the ballistic data entered into the computer. The accuracy of survey, met, weapon, and ammunition data affects the replot accuracy. If some of these parameters are not accurate at the time a mission is fired, the replot coordinates will be of limited value. The same is true of the manual solution. Likewise, when data are updated in the FADAC (i.e., surveyed battery location), the stored target locations determined by adjustment of fire may no longer be valid. After updating the survey, met, muzzle velocity, or other ballistic data in the FADAC, shifting from stored targets, or even attempting to compute fire-for-effect data for them, may produce poor results. When updated parameters are applicable to a mission fired and recorded, the stored target location should be updated. If a current met was used to initially fire on the target, subsequent mets will update the firing data without requiring a change in the stored target location.

c. If targets are fired and stored before the position area survey is complete, the REPLOT POLAR (E-7) function should be used only after first determining and recording the fire-

Table 3-3. Data for Replot Procedures

Sequence	S3	Chief of fire direction	Computer Operator	Vertical control operator	Computer/recorder
1	Supervises activities of section personnel.	Checks and supervises preparation of replot data.			
2			Causes FADAC to display initial replot location.		
3			Announces target coordinates to VCO.		
4				Plots target on map and announces altitude to computer operator.	
5			Enters target altitude announced by VCO.		
6			The computer operator and the VCO perform the duties in sequences 2, 3, 4, and 5 until the target altitude displayed by the FADAC and the target altitude determined by the VCO agree within 1 meter. The last altitude announced is entered into FADAC.		
7	Directs the computer operator to store the target, if desired.				Records data for replot on computer's record.
8			Stores target in FADAC, as directed by the S3.	Plots target on the firing chart, as directed by the S3.	

for-effect data. When the survey has been completed, update the battery location and enter the surveyed location as an observer. Input the recorded azimuth, range, and vertical angle to the target in matrix positions C-4, C-5, and C-7, then use the POLAR PLOT MSN (C-8) function to compute a new target location. Compute the new firing data and compare these data with the actual fire-for-effect data. By using the GT LINE ADJ (B-4) function and applying small observer corrections with matrix positions A-6 and A-8, adjust the target location until the fire-for-effect data are computed by FADAC. The new target location can be recalled using the REPLOT RECT function, as outlined in table 3-3.

d. If corrections are made for weather or materiel, the target data should be recomputed with the updated parameters. Since these data will not agree with the actual "did hit" data, enter the "did hit" data through the input matrix positions G-6 and G-8. Then use the COMP REG (H-8) function to compute and display the data that would normally be the registration corrections. Record the corrections. Use the REPLOT POLAR (E-7) function to determine the range to the target and convert the recorded deflection correction to a meter correction based on the target range. Next, convert the recorded range K to a total range correction based on the target range. Use the GT LINE ADJ (B-4) function and apply the computed deflection and range corrections as observer corrections through matrix positions A-6 and A-7, and compute the new firing data. Continue to make minor adjustments until the "did hit" data are displayed by the computer. The new target location can then be determined by using the REPLOT RECT (E-8) function. Continue to successively replot targets at outlined in table 3-3, if necessary.

3-6. Computations for Illuminating Shell

With the current cannon program, the M18 will automatically compute firing data for shell, illuminating, and provide the correct height of burst for the M314 and M118 shells. The computations for the range and deflection spreads should be computed manually or by the FADAC as follows:

a. The deflection spread is computed by entering shifts of 400 meters left and 400 meters right from the center of the burst pattern. In the manual solution, this shift is from the gun-target line for simplicity. With the FADAC, the deflection spread computation is made on the observer-target line, since the observer direction must be entered for subsequent corrections.

b. The range spread is computed by entering range shifts of plus 400 meters and minus 400 meters from the center of the burst pattern. The range spread computation is made on the observer-target line.

c. The computer operator must shift back to the centers of the burst pattern before entering the next observer correction.

d. The computation of data to fire the new M485, 155-mm illuminating shell, requires special operator procedures. The shell is ballistically matched to the standard 155-mm high-explosive round; therefore, projectile flag 1 and fuze flag 7 may be used. An observer correction of UP 600 is entered with the UP/DOWN (A-8) function to obtain the optimum height of burst. The fuze setting displayed is for the M565 fuze. The lateral spread and the range spread with the M485 should be 500 meters from the center of the burst pattern.

3-7. Battery Operations

When a battery is operating independently and has a requirement to fire in all directions from its position, a special procedure will simplify the computation of firing data. The following setup procedure is suggested:

a. Associate each platoon with a battery button:

Use the A button for the right platoon
Use the B button for the center platoon
Use the C button for the left platoon

b. If the position is organized so that one location is sufficient for battery fires, associate the D battery button with the battery center coordinates.

c. Associate the base piece with the E battery button for use when registrations are necessary.

d. The FADAC can compute simultaneous missions for the three platoons and mass their fires with either the MASS FIRES (D–8) function or the D battery button.

Section III. REGISTRATIONS

3–8. General

a. When the input data are less accurate than the data required for predicted fire, a registration is necessary.

b. When registering with the FADAC, all known meteorological, weapon, survey, and ammunition data should be entered in the computer before starting the registration. The registration corrections displayed by the computer are the residual corrections between the adjusted data and the data computed with the input parameters entered. Therefore, the size of the registration corrections may be used as an indication of the accuracy of the input data (para 2–18*c*(9)).

c. When valid meteorological, survey, and ammunition data are entered before registering, the FADAC can determine an improved muzzle velocity for the lot of ammunition fired, (para 2–18*c*(10)(*b*)).

3–9. Registration Procedures

a. The entry procedures for conducting a precision registration, a mean-point-of-impact (MPI) registration, and a high-burst (HB) registration are outlined under the COMP REG (H–8) function in table 2–1.

b. The duties of the FDC personnel and the sequence of events for a precision or time registration are shown in table 3–4.

c. The duties of the FDC personnel and the sequence of events for a high-burst or mean-point-of-impact registration are shown in table 3–5. In either type registration, the FADAC is used to compute orienting data for the target base, firing data for the registering piece, and the location of the high-burst or mean-point-of-impact.

3–10. Get Settings

a. General. Registration corrections computed by the FADAC are residual corrections used by the computer and should not be used to construct a GFT setting. To construct a GFT setting and determine a deflection correction for use with graphical equipment, it is necessary to determine the adjusted data and the chart range and deflection to the registration point from the chart to be used.

b. Precision Registration.

(1) *Registering battery.* Normal manual procedures should be used to determine the adjusted data for the registering battery. The chart range and deflections are determined from the chart, and the adjusted deflection, elevation, and fuze setting are determined from the registration.

(2) *Nonregistering batteries.* The computed adjusted data to the registration point for the nonregistering batteries are obtained by transferring the corrections from the registering battery. The FADAC procedures are outlined in table 2–1 under the entry procedure for the COMP REG (H–8) function. All nonstandard conditions known for the nonregistering batteries should be entered in the FADAC. After the registration corrections have been transferred and the known nonstandard conditions have been entered, the firing data for the surveyed coordinates and altitude of the registration point are computed. If a time registration has been fired, the operator selects the fuze time override and enters a correction of DOWN 20 to compensate for the 20/R automatically applied by the FADAC. The data displayed by the FADAC are the adjusted deflection, time, and quadrant elevation. The VCO measures the chart range from the firing chart and determines the site with the GST if it has not been determined with the FADAC. He then applies the site to the adjusted quadrant elevation to determine the adjusted elevation.

(3) *Construction of GFT setting.* A separate GFT setting is constructed for each battery using the chart range and the adjusted data determined in (1) and (2) above. An

Table 3-4. Duties of Fire Direction Center Personnel in Precision or Time Registration

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator
1	Supervises activities of section personnel.	Checks and supervises preparation of registration data.				
2	Directs that registration be fired. Selects registration point and observer. Issues fire order.				Enters data on computer's record. Sends preliminary fire commands to the battery.	Sends appropriate part of the fire order to the observer.
3			Enters registration point coordinates and altitude.	Plots registration point on grid sheet.		
4			Computes and announces firing data.	Computes site and prepares manual backup.	Transmits remaining commands to battery.	
5			Enters OT direction		Receives SHOT from the battery.	Transmits SHOT to the observer.
6			Enters observer corrections.		Records observer corrections.	Receives corrections from the observer.
7			Perform duties in steps 4 through 6 until completion of impact registration.			
8	Directs that time registration be fired.		Adds an UP 20 for time registration.		Applies fuze correction to time of flight.	Alerts observer for time registration.
9			Recalls registration point.		Manually computes adjusted time.	
10			Enters adjusted data. Applies a DOWN 20 and causes the FADAC to compute the registration corrections.			
11	Announces the batteries and charges for which to store registration corrections.		Stores corrections for batteries and charges in the FADAC as directed.			
12		Computes firing data to targets and checkpoints throughout zone of responsibility.	Assists computer/recorder in computing GFT settings.	Computes GFT settings based on firing data determined by FADAC.		

additional GFT setting should be constructed for each 800-mils of the zone of responsibility. Surveyed targets or arbitrary checkpoints can be used to compute the additional GFT settings. Two or more points at different ranges on the same direction of fire should be computed for more accurate data when slant scale graphical equipment is used.

c. High-Burst and Mean-Point-of-Impact Registrations.

(1) *Registering battery.*

(*a*) The VCO plots the coordinates and altitude of the computed high-burst (mean-point-of-impact) on the chart and measures the chart range and deflection.

(*b*) The deflection, fuze setting (high burst only), and quadrant elevation fired are the adjusted data. The VCO determines the site with a graphical site table and subtracts it form the adjusted quadrant elevation to obtain the adjusted elevation.

Note. As an alternate solution, determine the adjusted elevation by entering the coordinates of the high-burst (mean-point-of-impact). Then enter the battery altitude as the target altitude. Compute the firing data for fuze quick. The FADAC will display the adjusted elevation.

(2) *Nonregistering batteries.* The procedure for computing a high-burst (mean-point-of-impact) registration for the nonregistering batteries is the same as the procedure for computing the adjusted data for a precision registration. The computer operator enters the location of the high-burst (mean-point-of-impact) as the registration point. If a high burst is to be fired, fuze time must be selected and a correction of DOWN 20 must be entered before computing the adjusted data.

(3) *Construction of GFT setting.* The procedure outlined for constructing a GFT setting for a precision registration is used for determining the high-burst (mean-point-of-impact) data.

3–11. Base Piece Displacement

When the base piece is displaced from the battery center, the coordinates and altitude of the base piece rather than the coordinates and altitude of the battery center are entered in the computer for the registration. The FADAC will automatically correct for the base piece displacement in computing the registration corrections to be used. However, in constructing the GFT setting, the battery coordinates and the altitude must be used to compensate for the base piece displacement with graphical equipment.

3–12. Radar Registration

a. A radar may be used to determine the location of a high-burst registration. The FADAC can compute the location by entering the radar as an observer and using either the traverse SURVEY (D–5) function or the POLAR PLOT MSN (C–8) function.

b. The radar can locate the high burst by either coordinates or polar data (range, azimuth, and vertical angle). The S3 can more easily check for usable rounds with polar data. Six usable rounds are required. The mean of the six rounds must be computed manually and entered into the FADAC. After the location of the high burst has been computed, the data fired are inserted for the matrix functions G–6, G–7, and G–8 (DF INPUT, TIME INPUT, and QE INPUT). The corrections and GFT settings are computed as outlined for a precision registration.

Table 3-5. Duties of Fire Direction Center Personnel in High-Burst or Mean-Point-of-Impact Registration

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator	Computer/ recorder	Radiotelephone operator
1	Supervises activities of section personnel.	Checks and supervises preparation of registration data.				
2	Directs that registration be fired. Selects registration point. Issues fire order.					
3			Enters 01, 02, and registration point. Causes FADAC to compute orienting data for 01 and 02.	Plots 01, 02, and registration point.	Alerts battery to fire.	Alerts observers at 01 and 02.
4			Announces 01 and 02 orienting data.	Manually checks 01 and 02 orienting data.	Transmits preliminary fire commands to battery.	Transmits orienting data to 01 and 02.
5			Causes FADAC to compute firing data. Announces firing data.		Transmits remaining fire command to the battery.	
6	Coordinates firing with observers.				Receives SHOT from the battery.	Transmits SHOT to 01 and 02.
7			Recalls 01 and 02 locations in FADAC.		Records 01 and 02 data and computes mean directions and vertical angle.	Receives and announces data from 01 and 02.
8			Enters mean directions and vertical angle. Causes FADAC to compute HB or MPI location. Announces location.	Plots mean directions to HB or MPI. Checks location of MPI or HB with FADAC location.		
9			Enters the adjusted data and causes FADAC to compute registration corrections.			

10	Announces batteries and charges for which to store registration corrections.	Stores corrections for batteries and charges, as directed.				
11			Computes firing data to targets and checkpoints throughout zone of responsibility.	Assists computer/recorder in computing GFT settings.	Computes GFT settings based on firing data determined by FADAC.	

CHAPTER 4
DESTRUCTION OF EQUIPMENT

4–1. General

a. When it becomes necessary to abandon equipment during combat, the M18 computer and its auxiliary equipment must be destroyed to prevent its use by the enemy.

b. The destruction of any equipment subject to capture will be ordered only upon authority delegated by a division or higher commander.

4–2. Principles

Plans must be prepared for destroying the computer and its auxiliary equipment. The principles to be applied in planning are as follows:

a. Destruction methods must be easy to implement.

b. Destruction must be thorough.

c. Priorities must be applied so that the more essential parts are destroyed first.

d. The same essential parts on all like units must be destroyed to prevent the enemy from constructing a unit from salvaged parts.

e. Spare parts and accessories must be destroyed with the same priorities given to the same parts installed on the equipment.

4–3. Methods

a. The methods employed in the destruction of the computer will be specified in the destruction plan. The use of firearms, grenades, or TNT or other types of explosives or the destruction of some parts by burning or striking with an axe, sledgehammer, or similar instrument are typical methods that should be considered in formulating a plan of destruction for the unit standing operating procedures.

b. The essential parts of the M18 computer are the circuit boards, the magnetic disc memory, and the control panel assembly. If time permits, the chassis can be removed from the case and the parts can be destroyed by smashing with a sledge hammer. Each circuit board should be smashed. The computer may also be rendered useless by placing it on a pile of combustible material and pouring gasoline, oil, or a similar liquid over it and igniting it. A hot fire is required. For further details on destruction means, refer to TM 9–1200–221–10.

APPENDIX A
REFERENCES

A–1. FIELD MANUALS

FM 5–25	Explosive and Demolitions.
FM 6–40	Field Artillery Cannon Gunnery.
FM 6–125	Qualification Tests for Specialists, Field Artillery.

A–2. TECHNICAL MANUALS

TM 5–6115–211–10	Operator's Manual: Generator Set, Gasoline Engine: 3KW, AC, 120V, 1 and 3 Phase, 120/240V, Single Phase, 120/208V, 3 Phase, 120/240V, Single Phase, 120/208V,
TM 5–6115–211–20	Organizational Maintenance: Generator Set, Gasoline Engine: 3KW, AC, 120V, 1 and 3 Phase, 120/240V, Single Phase, 120/208V, 3 Phase, 400 Cycle, Skid Mounted.
TM 5–6115–211–20P	Organizational Maintenance Repair Parts and Special Toool Lists. Generator Set, Gasoline Engine: 3 KW, AC, 120V, 1 and 3 Phase, 120/240V, Single Phase, 120/208V, 3 Phase, 400 Cycle, Skid Mounted.
TM 9–1220–221–10	Operator's Manual: Computer, Gun Direction, M18.
TM 9–1220–221–20/1	Organizational Maintenance Manual: Computer, Gun Direction, M18.
TM 9–1220–221–20P	Organizational Maintenance Repair Parts and Special Tool Lists for Computer, Gun Direction, M18.

A–3. MISCELLANEOUS

AR 611–201	Manual of Enlisted Military Occupational Specialties.
ATP 6–100	Field Artillery Cannon Units.
DA Pam 310-series	Indexes of Military Publications.

APPENDIX B

COMPUTER METEOROLOGICAL MESSAGE TAPE PREPARATION

B–1. Met message perforated tapes should be prepared from training the operators to solve sample problems. In actual operations, it is the function of the met section at a higher echelon to prepare and transmit the met message for use at unit level; however, tapes to be used for training may be prepared as outlined below.

B–2. The gun direction computer M18 (FADAC) uses a special computer met message in its computations. This met message allows the computer to use weather data that actually exists. It is different from the met message used in the manual computation of firing data where the effects of one layer of atmosphere are weighted against the effects of lower layers or zones and then grouped together.

B–3. The entry of any data into FADAC is a function of the computer program; therefore, the met message must be in a format which conforms to the input portion of that program and the perforated tape must be in a specific format to be acceptable for input. Any deviation from the procedure for cutting the tape will cause the computer to reject the tape message.

B–4. The tape may be prepared by using the teletypewriter reperforator-transmitter TT–76/66C in the AN/GRC–46, AN/GRC–122, and the AN/GRC–142 radio sets.

B–5. The procedures for cutting a training met message tape are outlined below:

a. Advance the tape 4 to 5 inches by using the tape advance lever on the TT–76 (table B–1).

b. Cut the text of the message; e.g., the identification lines, and then cut the met data lines of the computer met message, using 16 digits for each data line. Use only one *carriage return* and *one line feed instruction* at the end of each line.

c. After cutting the last line of available met data, cut the digit 9 and one carriage return instruction. (The digit 9 is stop instruction to FADAC.)

d. Advance the tape 3 to 4 inches, using the BLANK key or the tape advance lever on the TT–76.

Table B–1. Computer Meteorological Message Tape Preparation Procedures

Message parts	Met Message text	Machine functions	Remarks CR—Carriage return LF—Line feed
		Advance the tape 4 to 5 inches using the BLANK key on the TT–76 teletypewriter.	Blank tape is used to thread the tape into the mechanical tape reader.
Introduction	METCM 1 361320	1 CR, 1 LF	
Date-time	270400036970	1 CR, 1 LF	ID line.
Body	0002000526621122	1 CR, 1 LF	The carriage return code causes computer to store the previous 16 digits.
	0102601026281110	1 CR, 1 LF	
	0203002026021084	1 CR, 1 LF	
	0305102225881062	1 CR, 1 LF	
	* * * *	* * *	
	1018205025100743	1 CR, 1 LF	
	9	1 CR,	The 9 code is a halt.
		Advance the tape 3 to 4 inches, using the BLANK key on the T–76 teletypewriter.	

APPENDIX C
AMMUNITION REFERENCE DATA

C-1. Standard Projectiles and Projectile Weights

Flag	Type	105-mm howitzer		155-mm howitzer		8-inch howitzer		175-mm gun	
		Models	Std wt	Models	Std wt	Models	Std wt	Models	Std wt
1	HE	M1	33.0(a)	M107	95.0(a)	M106	200.0(a)	M437	147.8(a)
2	WP	M60	34.8(a)	M110	97.2(a)	—	—	—	—
3	Smoke	M84	32.9(c)	M116	86.4(c)	—	—	—	—
4	Illum	M314	35.0(c)	M118	100.0(c)	—	—	—	—
	Illum	—	—	M485	90.0(c)	M424(f)	242.0(d)	—	—
5	AE	—	—	M454	120.5(d)	M422	242.0(d)	—	—
6	HE	M444	33.0(a)	M449	95.5(a)	M404	201.0(a)	—	—
7	HE	—	—	M449A1*	95.7(a)	—	—	—	—
8	HE	—	—	M449E1*	97.0(a)	—	—	—	—
9	Gas	M360	35.4(a)	M121	99.4(a)	M426	200.0(a)	—	—
9	Gas	M60	33.0(a)	—	—	—	—	—	—

* Also model M449E2.

a. The variance from standard weight is indicated by small squares printed on the projectile. If the projectile is standard weight, a specific number of squares is used to designate that it is standard, depending on the caliber and type of shell, as follows:

Caliber	Shell type	Standard weight squares
105-mm	HE, M1, M444	2
	Gas, M60	2
	WP	5
	Gas, M360	6
155-mm	HE, M107, M107B2, M449	4
	M449A1, M449E2	4
	HE, M449E1	6
	WP, M110	6
	Gas, M110	4
	Gas, M121A1	8
8-inch	HE, M106, M426, M404	4
175-mm	HE, M437	2

b. Each square represents a weight zone depending on the caliber as follows: A weight difference on one square is 0.6 pound for the 105-mm howitzer, 1.1 pounds for the 155-mm howitzer, 2.5 pounds for the 8-inch howitzer, 1.1 pounds for the 175-mm howitzer.

c. Weight is not indicated on these projectiles. Standard nominal weights are used: Standard weight for illumination M485 and for colored smoke M84 must be entered manually. Standard weights for colored smoke are 30.3 pounds for yellow, 30.7 pounds for red, and 31.2 pounds for green.

d. The actual weight of this projectile, if it varies from standard, is stamped on the projectile.

e. Standard weight must be entered through matrix position G=3 (PROJ WT).

f. HES round.

C–2. Charges and Standard Muzzle Velocities

a. 105-mm Howitzers M101A1 and M52.

Flag	Proj	Type	Normal charges 1	2	3	4	5	6	7	Subzone charges 1	2	3	4
1	HE	M1	195.1	211.8	233.2	262.1	301.8	365.8	464.8	132.6	146.3	160.0	176.8
2	WP	M60											
3	Smoke	M84, M84B1											
6	HE	M444											
9	Gas	M360											
4	Illum	M314	187.5	203.9	221.9	246.9	284.4	343.8	433.7	—	—	—	—

b. 105-mm Howitzer M101.

Flag	Proj	Type	Normal charges 1	2	3	4	5	6	7
1	HE	M1	196.6	213.4	236.2	266.7	309.4	374.9	474.0
2	WP	M60							
3	Smoke	M84, M84B1							
6	HE	M444							
9	Gas	M360							
4	Illum	M314*	187.5	203.9	221.9	246.9	284.4	343.8	433.7

* Data not available, use M101A1 data.

Note. When the muzzle velocity is set to standard by function F–5 (SETUP) with the M101A1 program, the values outlined in *a* above are used as standard. The M101 data must be entered manually.

c. 105-mm Howitzers M108 and M102.

Flag	Proj	Type	Normal charges 1	2	3	4	5	6	7
1	HE	M1	205.0	223.0	247.0	278.0	325.0	393.0	494.0
2	WP	M60							
3	Smoke	M84, M84B1							
6	HE	M444	206.5	223.7	246.7	276.6	322.1	388.6	488.4
9	Gas	M360							
4	Illum	M314	187.0	208.0	232.0	263.0	309.0	374.0	468.0

d. 155-mm Howitzers M114A1 and M44A1.

Flag	Proj	Type	Green bag propellant charges 1	2	3	4	5	White bag propellant charges 3	4	5	6	7
1	HE	M107	207.3	234.7	268.2	310.9	371.9	268.2	310.9	371.9	463.3	563.9
2	WP	M110										
3	Smoke	M116										
9	Gas	M121A1										
4	Illum	M118	198.1	224.0	256.0	295.7	353.6	256.0	295.7	353.6	440.4	541.0
6	HE	M449	206.7	234.1	267.6	310.2	371.0	274.3	316.1	374.0	462.3	562.6
7	HE	M449A1	206.1	233.6	261.1	309.9	371.1	273.3	315.4	373.8	462.7	563.5
8	HE	M449E1	206.7	233.6	266.5	308.5	368.3	272.5	313.9	371.0	458.2	557.0

e. 155-mm Howitzer M109.

Flag	Proj	Type	Green bag propellant charges					White bag propellant charges				
			1	2	3	4	5	3	4	5	6	7
1	HE	M107	213.0	240.0	273.0	313.0	375.0	280.0	319.0	378.0	463.0	561.0
2	WP	M110										
3	Smoke	M116										
9	Gas	M121A1										
4	Illum	M118	200.0	228.0	259.0	298.0	355.0	270.0	309.0	360.0	443.0	536.0
	Illum	M485	See Note (5), Table C-1									
6	HE	M449	214.5	241.1	273.5	312.9	373.9	280.4	318.8	376.9	460.5	556.9
7	HE	M449A1 or E2	211.8	238.9	272.0	312.0	374.2	279.0	318.1	372.2	462.4	560.6
8	HE	M449E1	214.4	238.9	271.3	310.6	371.4	278.2	316.5	274.4	457.9	554.1

Note. The values for standard muzzle velocities for white bag propellant charges 3, 4, and 5, must be entered manually by first using function B-8 with an enabling entry of 0. Then using function G-1, type the muzzle velocity for each of the three charges. To dismiss these data, use function B-8 with an enabling entry of 9, then use function G-1 to re-enter the standard velocities for green bag propellant.

f. 8-Inch Howitzers M115, M110, and M55.

Flag	Proj	Type	Green bag propellant charges					White bag propellant		
			1	2	3	4	5	5	6	7
1	HE	M106	249.9	274.3	304.8	350.5	420.6	420.6	499.9	594.4
4	HES	M424	254.5	359.7	547.1					
5	AE	M422	251.5	356.9	543.9					
6	HE	M404	249.9	274.3	304.8	349.3	418.2		497.1	591.3

g. 175-mm Gun M107.

Flag	Proj	Type	Charges		
			1	2	3
1	HE	M473	510.5	704.1	914.4

Note. When firing charge 3, propelling charge M86 or M86A, with the additive jacket XM1, use a correction of —2 meters per second in muzzle velocity.

C-3. Projectile-Fuze Combinations.

a. The following table indicates the fuze flags to be used for the fuze models and types indicated. These flags apply to the 105-mm, 155-mm, and 8-inch howitzer programs as indicated:

Flag	*Type*	*Remarks*
1	PD	All models of point-detonating fuze.
2	Time	M501 and M520 series.
3	VT	All models.
5	Spec MT	Only for the M543 or XM32E1 used with spotting or AE projectiles.
6	MT	Only for the M548 or M565 when used with projectile flag 6, 7, or 8.
7	Time	M564 and M565.

b. The 175-mm gun program uses only fuze flag 1; however, if a solution for VT fuze is desired, enter a correction of UP 20 through matrix position A-8 (UP/DOWN). The time of flight displayed, rounded down to the nearest whole unit, may be used as the fuze setting.

c. Table C–1 shows the authorized projectile-fuze combinations that are compatible with the cannon programs. In certain cases, a ballistic correction must be applied for a specific projectile-fuze combination when a predicted fire solution is desired. In these cases, the letter "c" is shown in the table. The procedures for applying the corrections are noted below the table.

Table C–1. Authorized Projectile-Fuze Combinations

Weapon	Cartridge or projectile	Fuze type																
		PD					VT						Time					
		M51 all mods	M508	M557	M572	M78 all mods	M513	M514	M513 mods	M514 mods	M501 all mods	M520 all mods	M542	M543	M548	M564	M565	Spec MT
105-mm howitzers	HE, M1	X		X		c	c		X							X		
	WP, gas, M60	X	X	X														
	Smk, M84										X							
	Illum, M314										X						c	
	Gas, M360		X	X														
	M444														X		c	
155-mm howitzers	HE, M107	X		X		c		c		X		X				X		
	WP, gas, M110											X				X		
	Smk, M116										X							
	Illum, M118										X						c	
	Illum, M485 (See Note 5)																c	
	AE, M454																	X
	Gas, M121		X	X						X								
	M449, MODS														X		c	
8-inch howitzers	HE, M106	X		X		c		c		X		X				X		
	HES, M424													X				
	AE, M422												X					
	Gas, M426		X	X														
	M404														X		c	
175-mm gun	HE, M437				X			c			X							

Notes.

(1) Fuze CP, M78, M78A1: Use fuze flag 1 and add 0.7 pound to the projectile weight.

(2) Fuze VT, models M513, M513B1 and M514: Use fuze flag 3 and add 0.5 pound to the projectile weight. Other models of this series require no correction.

(3) Fuze time, M565 and M548 used with projectiles M444, M449, M449A1, M449E1, M449E2 or M404: Use fuze flag 6.

(4) Fuze time, M565 used with illuminating shells M314 or M118: Use fuze flag 7.

(5) Fuze time M565 used with illuminating shell, M485: projectile flag 1 and fuze flag 7 should be used. Apply a correction of UP 600, using matrix position A–8. The time of flight displayed for fuze flag 1 may also be used for fuze setting.

(6) Use of projectile M413 requires manual methods.

APPENDIX D
SAMPLE PROBLEMS

D-1. General

This appendix contains sample problems which may be used for operator training as well as a check on the operation of the computer. The solutions displayed are obtained using the current issue 2 programs for the caliber and series weapons shown.

D-2. Test and Setup

a. Tests. To insure that the computer is operating properly, the operator should perform the following program before using the computer to solve any problem:

(1) *Program tests 1.*

(*a*) Depress the PROG TEST button.

(*b*) On the keyboard, type 1. The computer will automatically test the program in the permanent storage section of memory. During the test, some of the Nixie tubes will rapidly display numbers. When the test is completed, one of the following program identification numbers will be displayed if the test is successful:

1 00000 00010 05105

1 00000 00010 05155

1 00000 00011 05155

1 00000 00011 05055

1 00000 00011 55008

1 00000 00010 08075

(2) *Program test 2.*

(*a*) Depress the PROG TEST button.

(*b*) On the keyboard, type 2. The computer will automatically test the portion of the program in the working storage section of memory. During this test, the right three Nixie tubes sequentially display numbers. If the test is successful, the number 136 will be displayed when the test is complete.

(3) *Program test 3.*

(*a*) Depress the PROG TEST button.

(*b*) On the keyboard, type 3. The computer will automatically test the Nixie display tube filaments by successively lighting each number from 0 to 9, then the + and − sign filaments in the SIGN windows, and then the decimal point. Filaments that fail to light during the test indicate a bad tube.

b. Setup. To associate the batteries with the proper caliber portion of the program, each battery button must be depressed and the setup procedure performed.

(1) *Setup procedure.*

(*a*) Depress matrix buttons E-2 (SETUP).

(*b*) Depress the Battery A button.

(*c*) Depress the numbered button 1 or 2, (to the right of the matrix) whichever is applicable to the portion of the program pertaining to the caliber and series weapon being used.

(*d*) Depress the SETUP button. The COMPUTE indicator will light momentarily.

(*e*) Repeat (*b*), (*c*), and (*d*) above using battery buttons B, C, D, and E in turn.

D-3. Battery Adjust Fire Mission

a. Situation. Battery A has occupied position and is ready to deliver fires.

b. Given. The following data have been reported:

(1) Coordinates of battery center: 43490 34370.

(2) Altitude: 409 meters.

(3) Azimuth of Lay: 60 mils.

(4) Referred deflection:

105-mm M101A1	– 2800
105-mm M102, M108	– 3200
155-mm M114	– 2400
155-mm M109	– 2600
8-inch M110	– 2600
175-mm M107	– 2600

(5) Muzzle velocity data are unknown at this time.

(6) Powder temperature: +27° F.

(7) Projectile weight: Standard.

(8) Latitude: 34° North.

(9) Grid declination angle: +5 mils.

c. Solution. The operator performs the following actions:

(1) Insure that the Battery A button is depressed.

(2) Depress matrix buttons H-1 (BTRY EAST).

(3) Depress SM key.

(4) On the keyboard, type 43490. Check the Nixie display; then depress the ENTER key.

(5) Depress the matrix buttons H-2 (BTRY NORTH).

(6) Depress SM key.

(7) On the keyboard, type 34370. Check the Nixie display; then depress the ENTER key.

(8) Depress matrix buttons H-3 (BTRY ALT).

(9) Depress the SM key.

(10) On the keyboard, type 409. Check the Nixie display; then depress the ENTER key.

(11) Depress matrix buttons H-4 (BTRY AZ LAID).

(12) Depress the SM key.

(13) On the keyboard, type in 60. Check the Nixie display; then depress the ENTER key.

(14) Depress matrix buttons H-5 (BTRY DF).

(15) Depress the SM key.

(16) On the keyboard, type in the referenced deflection for the caliber and type weapon being used (*b*(4) above). Check the Nixie display; then depress the ENTER key.

(17) Depress matrix buttons G-2 (POWD TEMP).

(18) Depress the SM key.

(19) On the keyboard, type in +27. Check the Nixie display; then depress the ENTER key.

(20) Depress matrix buttons G-4 (LAT).

(21) Depress the SM key.

(22) On the keyboard, type in +34. Check the Nixie display; then depress the ENTER key.

(23) Depress matrix buttons G-5 (GRID DECL).

(24) Depress the SM key.

(25) On the keyboard, type in +5. Check the Nixie display; then depress the ENTER key.

Note. Since the projectile weight is standard it is not necessary to enter it. This function is set to standard by the SETUP procedure.

d. Situation Continued. Since no meteorological (met) message has been received, and the muzzle velocity data are unknown, the S3 directs the computer operator to set the met data to standard and use standard muzzle velocity data already entered in the program.

e. Solution Continued. The operator performs the following actions:

(1) Depress matrix buttons H-6 (MET STD).

(2) Depress the SM key.

(3) On the keyboard, type 0.

f. Situation Continued. The following areas have been designated as NO-FIRE AREAS and the S3 directs they be entered in FADAC.

Activity	*Area number*	*Coordinates*	*Safe radius*
Village	1	48160 43000	800 meters
Village	2	42270 50160	1,000 meters
Friendly patrol	3	44880 43390	200 meters

g. Solution. The operator performs the following actions to enter the NO-FIRE AREAS:

(1) Depress matrix buttons F-1 (NO-FIRE AREA EAST).

(2) Depress the SM key.

(3) On the keyboard, type 48160 and depress the ENTER key.

(4) Depress matrix buttons F-2 (NO-FIRE AREA NORTH).

(5) Depress the SM key.

(6) On the keyboard, type 43000 and depress the ENTER key.

(7) Depress matrix buttons F-3 (NO-FIRE AREA RADIUS).

(8) Depress the SM key.

(9) On the keyboard, type 800 and depress the ENTER key.

(10) Depress matrix buttons F-4 (NO-FIRE AREA STORE).

(11) Depress the SM key.

(12) On the keyboard, type 1 and depress the ENTER key.

(13) Repeat (1) through (12) above to enter the other NO-FIRE AREAS.

h. Situation Continued. The fire direction center receives the following call for fire, and the S3 issues the fire order:

Call for fire	*Fire order*	*VCO data*
FIRE MISSION, GRID 44520 43310	ALPHA	Target altitude
DIRECTION: 6200		435 meters
PLATOON OF INFANTRY	2 ROUNDS	
ADJUST FIRE	TARGET AB 1010	

i. Solution Continued. The operator performs the following actions:

(1) Insure that Battery A button is depressed.

(2) Depress matrix buttons A-2 (TGT EAST).

(3) Depress the SM key.

(4) On the keyboard, type 44520, then depress the ENTER key.

(5) Depress matrix buttons A-3 (TGT NORTH).

(6) Depress the SM key.

(7) On the keyboard, type 43310, then depress the ENTER key.

(8) Depress matrix buttons A-4 (TGT ALT).

(9) Depress the SM key.

(10) O nthe keyboard, type 435, then depress the ENTER key.

(11) Depress the COMPUTE button. The following solution will be dispalyed:*

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	2752	32.1	460
105-mm M102, M108	7	3154	30.5	418
155-mm M114	7	2350	24.9	279
155-mm M109	7	2550	25.0	281
8-inch M110	6	2552	26.7	330
175-mm M107	1	2547	25.0	288

* Depress the RECEIVE button to erase the leading zeros.

j. Observer Corrections. The observer correction is RIGHT 180. The operator performs the following actions:

(1) Depress matrix buttons A-5 (OT DIR).

(2) Depress the SM key.

(3) On the keyboard, type 6200 then depress the ENTER key.

(4) Depress matrix buttons A-6 (RIGHT /LEFT).

(5) Depress the SM key.

(6) On the keyboard, type RIGHT 180, then depress the ENTER key.

(7) Depress the TRIG button, the NO SOLUTION indicator light blinks but the compute light remains on indicating a NO-FIRE AREA will be violated if the following displayed gun data are fired:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	2733	32.4	465
105-mm M102, M108	7	3134	30.8	422
155-mm M114	7	2331	25.2	282
155-mm M109	7	2531	25.2	284
8-inch M110	6	2532	26.9	333
175-mm M107	1	2528	25.2	290

(8) Depress matrix buttons F-5 (NO-FIRE AREA RECALL).

(9) Depress the RECALL key. The display 3 indicates that NO-FIRE AREA 3 will be violated.

(10) Depress the RECEIVE button and gun data is recalled.

k. Situation, Continued. The S3 notes that the patrol active in NO-FIRE AREA number 3 is no longer there and it is safe to fire. The mission is continued.

l. Observer Corrections Continued. The observer correction is ADD 200. The operator performs the following actions:

(1) Depress matrix buttons A-7 (ADD/DROP).

(2) Depress the SM key.

(3) On the keyboard, type ADD 200; then depress the ENTER key.

(4) Depress the TRIG button. The following solution will be displayed:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	2741	33.5	483
105-mm M102, M108	7	3142	31.8	438
155-mm M114	7	2339	25.9	291
155-mm M109	7	2539	25.9	293
8-inch M110	6	2540	27.6	344
175-mm M107	1	2535	25.9	300

m. Observer Corrections Continued. The observer correction is DROP 100. The operator performs the following actions:

(1) Insure matrix buttons A-8 (ADD/DROP) are depressed.

(2) Depress the SM key.

(3) On the keyboard, type DROP 100; then depress the ENTER key.

(4) Depress the TRIG button. The following solution will be displayed:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	2737	32.9	474
105-mm M102, M108	7	3138	31.3	430
155-mm M114	7	2335	25.5	286
155-mm M109	7	2535	25.5	288
8-inch M110	6	2536	27.3	338
175-mm M107	1	2532	25.5	295

n. Observer Corrections Continued. The observer correction is ADD 50 FFE. The operator performs the following actions:

(1) Insure matrix buttons A-8 (ADD/DROP) are depressed.

(2) Depress the SM key.

(3) On the keyboard, type ADD 50; then depress the ENTER key.

(4) Depress the TRIG button. The following fire for effect solution will be displayed:

Weapon type	Charge	Deflection	Time	Quadrant elevation
105-mm M101A1	7	2739	33.2	478
105-mm M102, M108	7	3140	31.6	434
155-mm M114	7	2337	25.7	289
155-mm M109	7	2537	25.7	291
8-inch M110	6	2538	27.5	341
175-mm M107	1	2534	25.7	297

o. Recording Target. The operator takes the following actions to record the target as target number 1.

(1) Depress matrix buttons E-4 (TGT DATA STORE).

(2) Depress the SM key.

(3) On the keyboard, type 1; then depress the ENTER key. Coordinates 44667 43492 and the altitude 435 are displayed.

p. End of Mission. The operator takes the following actions to end the mission:

(1) Depress matrix buttons E-1 (EOM).

(2) Depress the SM key.

(3) On the keyboard, type 0.

q. Deleting No-Fire Areas. The operator takes the following actions to delete the inactive NO-FIRE AREA.

(1) Depress matrix buttons F-1 (NO-FIRE AREA EAST).

(2) Depress the SM key.

(3) On the keyboard, type 00000 and depress the ENTER key.

(4) Depress matrix buttons F-2 (NO-FIRE AREA NORTH).

(5) Depress the SM key.

(6) On the keyboard, type 00000 and depress the ENTER key.

(7)Depress matrix buttons F-3 (NO-FIRE AREA RADIUS).

(8) Depress the SM key.

(9) On the keyboard, type 00000 and depress the ENTER key.

(10) Depress matrix buttons F-4 (NO-FIRE AREA STORE).

(11) Depress the SM key.

(12) On the keyboard, type 3 and depress the ENTER key. This action deletes NO-FIRE AREA number three.

(13) Repeat (11) and (12) above to delete other NO-fire areas that are no longer valid.

Note. The adjusted location of target 1 includes the errors due to using standard met and muzzle velocity data, however, the "did hit" gun data should be noted: Using this "did hit" data, the target location can be updated as soon as the weather and muzzle velocity values are entered. If a change in the weather conditions occur before the target location is updated, it may be necessary to fire check rounds on the target to verify the accuracy of the "did hit" data. See paragraph 3-5.

D-4. Registration

a. Situation. Battery A has occupied positions, however, the fire direction center has not received a meteorological message and muzzle velocity data are unknown. The S3 decides to register using a specific charge. Coordinates and altitude of the registration point are: Registration point 1—41196 43137 457.

b. Situation Continued. The data shown in paragraph D-3 are known.

c. Solution. The operator performs the actions of paragraph D-3*c* to enter the battery data. The operator enters the coordinates of the registration point by following the steps outlined in paragraph D-3*g*. The registration point is stored as target number 1 and the charge override is entered by the following actions:

(1) Depress matrix buttons E-4 (TGT DATA STORE).

(2) Depress the SM key.

(3) On the keyboard, type 1 and depress the ENTER key. Coordinates: 41196 43137 and altitude 457 are displayed.

(4) Depress matrix buttons B-1 (CHG).

(5) Depress the SM key.

Caliber	** Charge*
105-mm	7
155-mm	6
8-Inch	5
175-mm	1

(6) On the keyboard, type in the selected charge* and depress the ENTER key.

(7) Depress the COMPUTE button and the following initial data will be displayed:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm, M101A1	7	3130	32.5	469
105-mm M102, M108	7	3531	30.9	427
155-mm M114	6	2731	29.6	402
155-mm M109	6	2931	29.8	409
8-Inch M110	5	2928	30.7	447
175-mm M107	1	2925	25.2	294

Note. Time displayed is time of flight.

d. Situation Continued. During the adjustment phase, the operator uses the M18 computer to calculate firing data. When the observer enters the fire-for-effect phase, the FDC determines the following adjusted data using manual methods:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	3136		481
105-mmM102, M108	7	3535		434
155-mm M114	6	2740		419
155-mm M109	6	2938		422
8-Inch M110	5	2935		460
175-mm M107	1	2931		310

e. Solution Continued. Since the coordinates of the target input through locations A2, A3, and A4 were changed during the adjustment phase, the operator recalls the surveyed coordinates and altitude of the registration point by depressing matrix buttons A–1 (TGT DATA RECALL) and repeating *c*(2) and (3) above. He then performs the following actions:

(1) Depress matrix buttons B–1 (CHG).

(2) Depress the SM key.

(3) On the keyboard, type in the specific charge and depress the ENTER key.

(4) Depress matrix buttons G–6 (DF INPUT).

(5) Depress the SM key.

(6) On the keyboard, type in one of the adjusted deflections for the weapon concerned (*d* above) and depress the ENTER key.

(7) Depress matrix buttons G–8 (QE INPUT).

(8) Depress the SM key.

(9) On the keyboard, type in the adjusted QE for the weapon concerned (*d* above) and depress the ENTER key.

(10) Depress matrix buttons H–8 (COMP REG).

(11) Depress the SM key, the following is computed and displayed and the keyboard light remains on:

Weapon type	*Deflection correction*	*Range K*
105-mm M101A1	L5.4	+14
105-mm M102, M108	L3.4	+10
155-mm M114	L8.4	+26
155-mm M109	L7.1	+20
8-inch M110	L6.3	+19
175-mm M107	L5.8	+36

(12) On the keyboard, type in the specific charge and depress the ENTER key. Keyboard light remains on.

(13) Depress the (.) decimal point key; the keyboard light extinguishes ending the mode.

(14) End the mission by repeating actions of paragraph D–3*p*.

D–5. Battalion Missions

a. Situation Continued. The battalion has occupied positions; and the battalion survey has been completed.

b. *Given.* The following data are available:

	Battery A	*Battery B*	*Battery C*
Coordinates	43417 34300	43906 34682	43462 34603
Altitude	406	395	398
Direction of fire	60	60	60
Latitude	34° N	34° N	34° N
Grid declination	+5 mils	+5 mils	+5 mils
Deflection	(Use deflections shown in para D–3b(4).)		

c. *Solution.* The operator follows the procedure outlined in paragraph D–2b and associates each battery with the appropriate caliber and then enters the battalion data as follows:

(1) Depress the A battery button.

(2) Depress matrix buttons H–1 (BTRY EAST).

(3) Depress the SM key.

(4) On the keyboard, type 43417, then depress the ENTER key.

(5) Depress matrix buttons H–2 (BTRY NORTH).

(6) Depress the SM key.

(7) On the keyboard, type 34300, then depress the ENTER key.

(8) Depress matrix buttons H–3 (BTRY ALT).

(9) Depress the SM key.

(10) On the keyboard, type 406, then depress the ENTER key.

(11) Depress matrix buttons H–4 (BTRY AZ LAID).

(12) Depress the SM key.

(13) On the keyboard, type 60.

(14) Depress the ENTER key.

(15) Depress matrix buttons H–5 (BTRY DF).

(16) Depress the SM key.

(17) On the keyboard, type the referred deflection for the caliber and type weapon being used (para D–3b(4)).

(18) Depress matrix buttons G–4 (LAT).

(19) Depress the SM key.

(20) On the keyboard, type +34.

(21) Depress the ENTER key.

(22) Depress matrix buttons G–5 (GRID DECL)

(23) Depress the SM key.

(24) On the keyboard, type +5.

(25) Depress the ENTER key.

Note. The latitude and the grid declination angle need not be entered for the other batteries since they are nonbattery associated functions. Their entry for one battery suffices for all batteries.

d. *Solution Continued.* The operator enters B battery and C battery data by repeating the actions in (1) through (17) using the appropriate data for the battery concerned. To insure the computer is cleared of any overrides, the operator performs the following actions:

(1) Depress the A battery button.

(2) Depress matrix buttons E–1 (EOM).

(3) Depress the SM key.

(4) On the keyboard, type 0.

(5) After depressing each of the other battery buttons in turn, repeat (2), (3), and (4) above.

e. *Situation Continued.* The following additional information is reported:

(1) Muzzle velocity—Shell HE, Lat T (105), TZ (155, 8, 175)

		A	*B*	*C*
105-mm	Chg 6	359.6	357.4	356.2
	Chg 7	457.8	456.1	454.9
155-mm	Chg 5	370.0	368.2	367.1
	Chg 6	460.2	459.1	457.6
8-Inch	Chg 5	417.6	414.6	412.0
	Chg 6	495.0	490.9	488.0
175-mm	Chg 1	498.1	505.0	496.2

(2) Powder temperature +28 +29 +26

(3) Projectile Weights.

105-mm	Shell HE	33.6	33.6	34.2
	Shell WP	35.4	35.4	35.4
155-mm	Shell HE	93.9	96.1	97.2
8-Inch	Shell HE	200.0	202.5	205.0
175-mm	Shell HE	148.9	150.0	150.0

(4) Meteorological message.

Introduction

Identification	Octant	Location	Date-Time	Station Height (10's M)	MDP Pressure (% of STD)
METCM	1	341981	261620	036	974

Body

Line Number	Wind Direction (10's mils)	Wind Speed (Knots)	Temperature (1/10° K)	Density (GM's/M³)
00	010	011	2693	1277
01	048	019	2679	1266
02	032	014	2673	1243
03	056	037	2617	1195
04	014	015	2672	1093
05	540	014	2718	1016
06	512	022	2707	0953
07	516	033	2672	0903
08	504	060	2672	0846
09	492	070	2657	0802
10	491	065	2616	0763
11	490	060	2580	0725
12	485	050	2542	0665
13	475	055	2483	0596
14	480	052	2410	0533
15	490	055	2327	0478
16	500	060	2248	0427
17	550	058	2192	0375
18	601	036	2141	0328
19	614	035	2106	0284
20	587	032	2119	0237

f. Solution. The operator enters these data by performing the following actions:

(1) Depress the A battery button.

(2) Depress matrix buttons G-1 (MV).

(3) Depress the SM key.

(4) On the keyboard, type in 16; depress the ENTER key. The keyboard light remains lighted.

(5) On the keyboard, type 359.6 and depress the ENTER key.

(6) Depress the SM key.

(7) On the keyboard, type 17 and depress the ENTER key, keyboard light remains lighted.

(8) On the keyboard, type 457.8 and depress the ENTER key.

(9) Depress matrix buttons G-2 (POWD TEMP).

(10) Depress the SM key.

(11) On the keyboard, type +28 and depress the ENTER key.

(12) Depress matrix buttons G-3 (PROJ WEIGHT).

(13) Depress the SM key.

(14) On the keyboard, type 1 and depress the ENTER key, keyboard light remains lighted.

(15) On the keyboard, type 33.6 and depress the ENTER key.

(16) Depress the SM key.

(17) On the keyboard, type 2 and depress the ENTER key, the keyboard light remains lighted.

(18) On the keyboard, type 35.4 and depress the ENTER key.

Note. (2) through (17) above data applies to the 105-mm howitzer. Use the appropriate values for other calibers.

(19) Repeat actions (2) through (17) above with the B and C battery buttons depressed in turn and using the data associated with that battery.

(20) Depress matrix buttons E–6 (MET INPUT).

(21) Depress the SM key.

(22) On the keyboard, type 0; then depress the ENTER key. The number 88 will be displayed on the right two Nixie tubes.

(23) On the keyboard, type the identification line of the met message, starting with the date-time group; 261620 036 974.

(24) Depress the ENTER key. The number 00 will be displayed to indicate that the computer is ready for the 00 line of the message.

(25) On the keyboard, type the 00 line of the met message; 00 010 011 2693 1277.

(26) Depress the ENTER key. The number 01 will be displayed.

(27) On the keyboard, type the 01 line of the met message: 01 048 019 2679 1266.

(28) Depress the ENTER key. Tte number 02 will be displayed.

(29) Each succeeding lines is entered by continuing this procedure until the last line has been entered. The input mode is terminated by typing 9 on the keyboard and depressing the ENTER key.

Note. The data entered in the computer at this time meets the requirements for accurate unobserved surprise fire, using the shell and the propellant charges for which the muzzle velocity has been entered. The computer has the capability of massing the fires of three batteries on a target.

g. Solution Continued. To insure that previously stored registration corrections are *not used,* the operator performs the following actions:

(1) Depress the A battery button.

(2) Depress matrix buttons H–7 (ZERO CORR).

(3) Depress the SM key.

(4) On the keyboard, type 0.

(5) Repeat (2) through (4) above for each of the other batteries by depressing the B and C buttons in turn.

h. Situation Continued. The following radar (observer) location is reported. This data should be entered to permit rapid target locations using polar plot methods:

Coordinates 49150.2 40250.4 510

i. Solution. The operator performs the following actions to enter this location:

(1) Depress matrix buttons C–1 (OBSR EAST).

(2) Depress the SM key.

(3) On the keyboard, type 49150.2, then depress the ENTER key.

(4) Depress matrix buttons C–2 (OBSR NORTH).

(5) Depress the SM key.

(6) On te keyboard, type 40250.4, then depress the ENTER key.

(7) Depress matrix buttons C–3 (OBSR ALT).

(8) Depress the SM key.

(9) On the keyboard, type 510, then depress the ENTER key.

(10) Depress matrix buttons D–3 (OBSR LOC STORE).

(11) Depress the SM key.

(12) On the keyboard, type 1, then depress the ENTER key. The coordinates are displayed. The radar location is now stored as observer number 1.

j. Situation continued. The following fire mission is received from the radar section:

Call for fire	*S3 fire order*
Direction 500	Battalion
Distance 2000	Lot T (TZ)
Vertical angle −20	Charge: 7 (105),
Assembly area, fire for effect	6 (155), 5(8"), 1 (175)
	Target AB 1050

k. Solution. The operator performs the following actions to process the mission:

(1) Depress the A battery button.

(2) Depress matrix buttons D–4 (OBS LOC RECALL).

(3) Depress the SM key.

(4) On the keyboard, type 1, then depress the ENTER key. The coordinates and altitude of the radar are displayed.

(5) Depress matrix buttons C–4 (OBS DIR).

(6) Depress the SM key.

(7) On the keyboard, type 500, then depress the ENTER key.

(8) Depress matrix buttons C-6 (OBS SLANT DIST).

(9) Depress the SM key.

(10) On the keyboard, type 2000, then depress the ENTER key.

(11) Depress matrix buttons C-7 (OBS VERT ANGLE).

(12) Depress the SM key.

(13) On the keyboard, type −20, then depress the ENTER key.

(14) Depress matrix buttons C-8 (POLAR PLOT MISSION).

(15) Depress the SM key. The computer computes and displays the coordinates and altitude of the target and associates these data with the target input positions A-2, A-3, and A-4, respectively. Coordinates 50093 42014 and altitude 471 are displayed.

(16) Depress matrix buttons B-1 (CHG).

(17) Depress the SM key.

(18) On the keyboard, type 7(105), 6-(155), 5(8"), 1(175), and depress the ENTER key.

(19) Depress the COMPUTE button. The following solution will be displayed for A battery:

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quardrant elevation*
105-mm M101A1	A	7	2159	43.4	675
105-mm M102, M108	A	7	2563	43.2	674
155-mm M114	A	6	1753	37.5	537
155-mm M109	A	6	1953	37.3	536
8-inch M110	A	5	1949	38.9	595
175-mm M107	A	1	1942	31.3	387

(20) Depress matrix buttons D-8 (MASS FIRES).

(21) Depress the SM key.

(22) On the keyboard, type 23 and depress the ENTER key.

(23) Depress the B battery button.

(24) Depress matrix buttons B-1 (CHG).

(25) Depress the SM key.

(26) On the keyboard, type 7(105), 6-(155), 5(8"), or 1(175) and depress the ENTER key.

(27) Depress the COMPUTE button. The following solution will be displayed for B battery:

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quardrant elevation*
105-mm M101A1	B	7	2166	38.7	593
105-mm M102, M108	B	7	2569	38.5	593
155-mm M114	B	6	1763	34.4	491
155-mm M109	B	6	1963	34.3	490
8-inch M110	B	5	1960	35.8	548
175-mm M107	B	1	1954	28.7	347

(28) Depress the C battery button and repeat (25), (26), and (27) above. The following solution will be displayed.

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quardrant elevation*
105-mm M101A1	C	7	2140	41.4	644
105-mm M102, M108	C	7	2544	41.2	642
155-mm M114	C	6	1735	36.4	525
155-mm M109	C	6	1935	36.2	524
8-inch M110	C	5	1932	38.2	594
175-mm M107	C	1	1925	30.4	377

l. Solution Continued. The operator ends the mission by repeating the actions in *d* above.

D–6. Solution of a Traverse Survey

a. Situation. The battalion survey party has completed the field work for Battery A position.

b. Given. The survey officer brought the following field notes into the fire direction center:

SCP	44963.61 31694.50
Altitude	418.8
Azimuth SCP–TS 1	5598.1 mils
Distance SCP–TS 1	918.06 meters
Vertical angle SCP–TS 1	–2.6 mils
Azimuth TS 1–TS 2	692.5 mils
Distance TS 1–TS 2	1121.87 meters
Vertical angle TS 1–TS 2	–4.4 mils
Azimuth TS 2–TS 3	5858.7 mils
Distance TS 2–TS 3	995.08 meters
Vertical angle TS 2–TS 3	–3.3 mils
Azimuth TS 3–BC	5008.3 mils
Distance TS 3–BC	1120.62 meters
Vertical angle TS 3–BC	–2.5 mils

c. Requirement. The operator is directed by the S3 to compute the coordinates of the battery center and to record the coordinates of the various stations of the traverse survey.

d. Solution. The operator enters the coordinates and altitude of the survey control point (SCP) as follows:

(1) Depress matrix buttons C–1 (OBS EAST).

(2) Depress the SM key.

(3) On lhe keyboard, type 44963.61, then depress the ENTER key.

(4) Depress matrix buttons C–2 (OBS NORTH).

(5) Depress the SM key.

(6) On the keyboard, type 31694.50, then depress the ENTER key.

(7) Depress matrix buttons C–3 (OBS ALT).

(8) Depress the SM key.

(9) On the keyboard, type 418.80, then depress the ENTER key.

(10) Depress matrix buttons C–4 (OBS DIR).

(11) Depress the SM key.

(12) On the keyboard, type 5598.10, then depress the ENTER key.

(13) Depress matrix buttons C–5 (OBS HORZ DIST).

(14) Depress the SM key.

(15) On the keyboard, type 918.06, then depress the ENTER key.

(16) Depress matrix buttons C–7 (OBS VERT ANGLE).

(17) Depress the SM key.

(18) On the keyboard, type –2.60, then depress the ENTER key.

(19) Depress matrix buttons D–5 (SURVEY).

(20) Depress the SM key.

(21) On the keyboard, type 1, then depress the ENTER key. The coordinates and altitude of traverse station 1 will be displayed: 44313 32342, 417.

e. Solution Continued. The operator performs the following actions:

(1) Depress matrix buttons C–4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 692.50, then depress the ENTER key.

(4) Depress matrix buttons C–5 (OBS HORZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 1121.87, then depress the ENTER key.

(7) Depress matrix buttons C–7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type –4.40, then depress the ETER key.

(10) Depress matrix buttons D–5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1, then depress the ENTER key. The coordinates and altitude of traverse station 2 will be displayed: 45019 33215, 412.

f. Solution Continued: The operator performs the following actions:

(1) Depress matrix buttons C–4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 5858.70, then depress the ENTER key.

(4) Depress matrix buttons C-5 (OBS HORIZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 995.08, then depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type −3.30, then depress the ENTER key.

(10) Depress matrix buttons D-5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1, then depress the ENTER key. The coordinates and altitude of traverse station 3 will be displayed: 44514 34073, 409.

g. Solution Continued. The operator performs the following actions:

(1) Depress matrix buttons C-4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 5008.30, then depress the ENTER key.

(4) Depress matrix buttons C-5 (OBS HORIZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 1120.62, then depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type −2.50, then depress the ENTER key.

(10) Depress matrix buttons D-5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1, then depress the ENTER key. The coordinates and altitude of the battery center will be displayed: 43417 34300, 406.

h. Discussion. The coordinates and altitude displayed during the process of computing the survey are rounded values and are displayed to the nearest meter. If, for some reason, accuracy is desired to the nearest hundredth of a meter, recall the observer easting, observer northing, and observer altitude, in turn, prior to computing a new traverse station.

By Order of the Secretary of the Army:

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Chief of Staff.

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