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S/S FM 6-3-1 June 68

FM 6-40-3

DEPARTMENT OF THE ARMY FIELD MANUAL

FIELD ARTILLERY
GUN DIRECTION COMPUTER M18
GUNNERY

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HEADQUARTERS, DEPARTMENT OF THE ARMY

SEPTEMBER 1964

TAGO 5479-A—August

FIELD MANUAL
No. 6-40-3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *14 September 1964*

FIELD ARTILLERY

GUN DIRECTION COMPUTER M18 GUNNERY

CHAPTER 1
GENERAL

1. Purpose

This manual is a guide to assist fire direction personnel in incorporating the gun direction computer M18 into the functions of the fire direction center (FDC).

2. Scope

a. The material contained in this manual provides the artillery gunnery officer with the necessary information and procedures to cmploy the M18 computer in solving the field artillery cannon and rocket gunnery problem.

b. Detailed capabilities and operating instructions for the computer are contained in FM 6-3-1 and appropriate technical manuals.

c. 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 the text for which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, ATTN: AKPSIPL, U.S. Army Artillery and Missile School, Fort Sill, Okla. 73504.

3. Solution of the Gunnery Problem

The M18 computer performs most of the computations necessary to deliver fire. Considering the greater inherent accuracy and flexibility of the computer, it should be considered the primary method for obtaining firing data. A manual backup is required, however, in order to sustain the capability to deliver fires at all times.

CHAPTER 2
FIRE DIRECTION CENTER ORGANIZATION

4. General

The introduction of the M18 computer has not changed the purpose and role of the fire direction center, cannon or rocket. However, the capability for the timely determination and the production of more accurate firing data has improved the operation of the fire direction center.

5. Organization and Duties

The duties of certain personnel are modified by the inclusion of the M18 computer in the FDC. A suggested method for organizing the duty positions of selected FDC personnel is described below. Former duty positions are shown in parentheses and are referenced to FM 6–40, FM 6–40–1, and appropriate tables of organization and equipment.

a. *Cannon Fire Direction Center.*

(1) *Computer operator* (*chart operator*). The computer operator operates the M18 computer. The detailed duties of the computer operator are contained in FM 6–3–1. If it becomes necessary to utilize the manual backup, the computer operator assumes the duties prescribed for the chart operator designated as HCO in FM 6–40.

(2) *Chart operator.* The chart operator designated as the vertical control operator (VCO) performs the following duties in addition to those prescribed for the VCO in FM 6–40:

(*a*) Plots and maintains the horizontal control chart (grid sheet) for manual backup.

(*b*) Determines the altitude of targets requested by coordinates and announces the data to the computer operator.

(*c*) Computes site for manual backup.

(*d*) Determines chart data for missions when required.

(*e*) Announces chart data to the nonadjusting battery computers when more than one battery fires for effect in will-adjust missions.

(3) *Computer/recorders* (*fire direction computers*).

(*a*) The computer/recorders when receiving data from computer operator perform their duties as prescribed in FM 6–40, except for the computation of deflection, the determination of fuze settings, the computation of announced site plus 20/R and computation of changes in site during adjustment, the determination of quadrant elevation and the construction of the deflection correction scale. However each computer/recorder must be *prepared* to perform *all* functions in case of computer malfunction.

(*b*) The nonadjusting computer/recorder records, computes, and transmits the initial data to his battery when a will-adjust mission is processed. The fire-for-effect data is determined by the M18 computer.

(4) *Generator operator.* A select member of the FDC operates the generator as an additional duty.

(5) *Duty combinations.* During periods of reduced activity or when operating the FDC with reduced personnel the duties of the chief of fire direction (chief fire direction computer) and the vertical control operator may be conveniently combined. The duties of the computers and the radiotelephone operators also may be combined.

b. *Free Rocket Fire Direction Center.*

(1) *Computer operator* (*fire direction computer*) The computer operator (fire direction computer) operates the M18 computer. If it becomes necessary to use manual FDC procedures, the computer operator assumes the duties outlined in FM 6–40–1.

(2) *Generator operator.* A selected member of the FDC operates the generator as an additional duty.

Note. The titles of fire direction personnel are based on proposed changes to AR 611–201 and appropriate TOE's. Former duty positions are shown in parentheses.

CHAPTER 3
COMPUTER APPLICATION, CANNON ARTILLERY

Section I. GENERAL

6. Purpose

This chapter describes the application of the M18 computer in—

a. Normal fire direction center operations.

b. Special situations.

c. Registrations.

d Observed fire chart procedures.

7. Fire Direction Center Operation

Table I contains a suggested sequence and distribution of duties for normal fire direction operations. The detailed requirements for computation and transmission of firing data for routine will-adjust and fire-for-effect missions are described in *a* and *b* below.

a. Will-Adjust Mission. When a will-adjust mission is received in the FDC, the S3 issues the fire order, and directs the computer operator to process the mission.

(1) The adjusting battery computer/recorder receives data from the computer operator and announces fire commands to the adjusting battery.

(2) The VCO announces the target altitude to the computer operator and the chart data to the nonadjusting battery computer/recorders. The VCO computes site for the nonadjusting batteries. The VCO continues to monitor the mission to provide manual backup.

(3) The computer/recorders for the nonadjusting batteries manually compute the initial data for the mission and send this information to their respective batteries with the command DO NOT LOAD. This procedure reduces the reaction time of the nonadjusting batteries when entering fire-for-effect.

(4) When the observer enters fire-for-effect, the computer operator determines and announces fire-for-effect data for the adjusting battery. The computer operator then associates the target with the nonadjusting batteries, enters the necessary overrides for the nonadjusting batteries and computers fire-for-effect data for each nonadjusting battery. The computer operator must precede all announced firing data with the associated battery.

b. Fire-for-Effect Mission. When a fire-for-effect mission is received in the FDC, the S3 directs that the mission be processed as in *a* (1) and (4) above.

(1) The computer operator computes and announces fire-for-effect data for each battery to fire.

(2) In order to expedite firing, the computer operator first computes data for slower firing (larger caliber) weapons. The computer operator must precede all announced firing data with the designation of the battery to fire.

c. Reduced Strength Operation. Table II contains a suggested distribution of duties and a sequence of events for processing fire missions when operating at reduced strength or during periods of reduced activity.

Table I. Duties of Cannon Fire Direction Center Personnel (During Firing)

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator (VCO)	Computer/recorders	Radiotelephone operator	Switchboard operator
1	Supervises activities of section personnel.	Supervises activities of section personnel.				Receives fire mission.	Operates switchboard as required.
2			Enters target data.	Plots target on grid sheet and map.	Record fire mission data on computer's record.		
3	Issues fire order.						
4				Determines and announces the target altitude.	Send preliminary fire commands to the batteries.	Sends appropriate part of fire order to the observer.	
5			Enters target altitude announced by the VCO.	Announces chart data for nonadjusting batteries.			
6			Enters fuze type and other overrides.	Computes site and prepares for manual backup as directed.			
7			Computes firing data.				
8			Announces firing data for batteries to fire.				
9					Send remaining fire commands to the batteries.		
10					Receive ON THE WAY from the battery.	Transmits ON THE WAY to the observer.	
11			Enters observer target azimuth (OT–AZ) if not entered previously.			Receives and relays observer corrections.	
12			Enters observers corrections and announces firing data.	Plots observer corrections.	Send subsequent fire commands to the batteries.		

Table II. Duties of Cannon Fire Direction Center Personnel (Reduced Strength)

Sequence	S3	Computer operator	Vertical control operator (VCO)	Computer/recorder	Switchboard operator
1	Supervises activities of section personnel.		Checks and supervises preparation of firing data.	Receives and records fire mission.	Operates switchboard as required.
2		Enters target data.	Plots target grid sheet and map.		
3	Issues fire order.				
4			Determines and announces target altitude.	Sends preliminary fire commands to the batteries.	
5		Enters target altitude announced by the VCO.	Announces chart data for non-adjusting batteries.	Sends appropriate parts of the fire order to the observer.	
6			Computes site and prepares for manual backup.		
7		Computes firing data.			
8		Announces firing data for batteries to fire.			
9				Sends remaining fire commands to the batteries.	
10				Transmits ON THE WAY to the observer.	
11		Enters observer-target azimuth (OT AZ) if not entered previously.		Receives and relays observer corrections.	
12		Enters observers corrections and announces firing data.	Plot's observers corrections.	Sends, subsequent fire commands to the batteries.	

Section II. COMPUTER PROCEDURES FOR SPECIAL SITUATIONS

8. Multiple Fire Missions

The computer may be used to conduct five separate battery missions concurrently. Targets may be transferred to another battery by using the MASS FIRE function, and a battery mission may be temporarily suspended in order to attack a more lucrative target and subsequently reengaged by using the TEMP MSN STORE and TEMP MSN RECALL functions. These capabilities provide the S3 with considerable flexibility for processing multiple fire missions. If required, the S3 can process additional fire missions manually with other fire direction personnel.

9. Polar Coordinate Missions

a. When an observer locates a target by polar coordinates, he should report the vertical angle not the vertical interval and he should designate the reported range as horizontal range or slant range. The vertical interval is then computed by the M18 computer.

b. The vertical interval may be used by entering a vertical angle of +0 with the OBS VERT ANGLE function. The vertical interval is entered directly into the computer using the UP/DOWN function. The computer does not display the correct target altitude; however, it is used internally by the computer during the computation.

10. Replotting Targets

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 RECTANGULAR function). Table III illustrates the steps performed by the computer operator and the VCO to determine target replot data. The computer operator and the VCO continue the process outlined in table III until the altitude displayed by the computer and the altitude determined by the VCO agree within 1 meter.

11. Computations for Shell Illuminating

The computer is programmed to compute firing data for shell illuminating. The computations automatically provide a 750-meter height of burst but do not include computations for range and/or deflection spreads. Spreads should be computed manually, or by the computer as follows:

a. A deflection spread is computed by entering a shift of 400 meters, left and right, from the center of the burst pattern.

b. A range spread is computed by entering range shifts of plus and minus 400 meters from the center of the burst pattern.

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

d. When the computer is used to compute deflection and/or range spreads, errors are more easily avoided by making spreads along the observer-target line rather than the gun-target line. However, spreads may be made along the gun-target line by selecting the GT LN ADJ function prior to making the spread computation as outlined above. The observer-target azimuth must be reentered in the computer, using the OT AZ function, before the next observer correction is entered.

Table III. Fire Direction Procedures for Data for Replot

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator (VCO)	Computer/recorder
1	Supervises activities of section personnel.	Checks and supervises preparation of replot data.			
2			Causes computer to replot target.		
3			Announces target coordinates displayed by the computer.		
4				Plots target on map and announces target altitude.	
5			Enters target altitude announced by the VCO.		
6			The computer operator and the VCO perform the steps in sequence 2, 3, 4, and 5 until the target altitude displayed by the computer and the target altitude determined by the VCO agree within 1 meter.		
7	Directs the computer operator to store the target if desired.				Records data for replot on computers record.
8			Stores target in the computer as directed by the S3.	Plots target on the firing chart as directed by the S3.	

12. General

a. When input data is less accurate than data required for predicted fire, a registration is necessary to determine the corrections, to be applied to firing data.

b. When registering with the computer, all known meteorological weapons and ammunition data should be entered before starting the registration. The registration corrections displayed by the computer are the residual corrections between the adjusted data and data computed using the entered input data. As such, the size of the registration corrections displayed by the computer may be used as an indication of the accuracy of the input data entered into the computer.

13. Registration Procedures

a. The procedures to conduct a precision registration, center-of-impact registration and high-burst registration are outlined in the entry procedures of the COMP REG function, table I, FM 6–3–1.

b. The duties of the FDC personnel and the sequence of events for a precision and time registration are contained in table IV, this manual. In general, the computer is used for the adjustment phase and the fire-for-effect phase is conducted as outlined in chapter 18, FM 6–40. The computer may be used to assist in the determination of the angle *T*, fork, factor *S*, and site. The computer operator procedures are described in remark 6 of the COMP REG function, table I, FM 6–3–1.

c. The duties of the FDC personnel and the sequence of events for a high-burst and center-of-impact registration are contained in table V, this manual. In general, the computer is used to compute orienting data for the target base, firing data for the registering piece, and the location of the high burst or center of impact after the registration has been fired.

14. GFT Settings

a. General. The registration corrections displayed by the computer are residual corrections and are used internally by the computer; consequently, these data, should not be used to construct a GFT setting. In order to construct a GFT setting and determine a deflection correction for use with graphical equipment, it is necessary to determine the adjusted data, and chart range and deflection to the registration point.

b. Precision Registration.

(1) *Registering battery.* Normal procedures are used to determine adjusted data. The chart range is determined from the chart and the adjusted deflection, elevation, and fuze setting are determined from the registration. The computer or a GST may be used to determine the amount of site to be subtracted from the adjusted quadrant elevation to obtain the adjusted elevation.

(2) *Nonregistering batteries.* The adjusted data to the registration point for the nonregistering batteries are obtained by transferring the corrections from the registering battery. The M18 computer procedures to transfer the data are outlined in FM 6–3–1. All nonstandard conditions known for the nonregistering batteries should be entered in the computer. After the registration corrections have been transferred and known nonstandard conditions have been entered, firing data for the surveyed coordinates and altitudes of the registration point are computed. If a time registration was fired, the operator selects fuze time and enters a correction of DOWN 20 to compensate for the 20/R automatically applied by the computer. The data displayed by the computer are adjusted deflection, time, and quadrant elevation. The VCO measures the chart range from the chart and determines the site with a GST. He then applies the site to the adjusted quadrant elevation to determine the adjusted elevation.

(3) *Construction of GFT setting.* The GFT setting is constructed for both the registering and nonregistering batteries using the chart range and adjusted data determined for each battery as outlined in FM 6–40. The following problem outlines the procedure to be used.

(*a*) Battery A of a 105-mm howitzer battalion has completed a precision registration and time registration using the M18 computer. The S3 has directed that a GFT setting and a deflection index be constructed for each battery.

Table IV. Fire Direction Center Duties, Precision and Time Registration

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator (VCO)	Computer/recorder	Radiotelephone operator	Switchboard 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 Record of Precision Fire. 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 and map.			
4			Computes and announces firing data.	Computes sites and prepares for manual backup.	Transmits remaining firing commands to battery.		
5					Receives "on the way" from the battery.	Transmits "on the way "to the observer.	
6			Enters observer target azimuth (OT–AZ) into the computer if not previously entered.	Plots observer corrections.	Records observer corrections. *Note.* Use line sensings for determining adjusted deflection.	Receives corrections from the observer.	
7			Enters observer correction and announces firing data.				

Table IV.—Continued.

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator (VCO)	Computer/recorders	Radiotelephone operator	Switchboard operator
8			Perform sequence steps 3 through 7 until the adjustment phase is completed.				
9			Enters surveyed coordinates and altitude of the registration point.		Determines firing data for the fire for effect phase and transmits fire commands to the battery.		
10					Receives ON THE WAY from the battery.	Transmits ON THE WAY to the observer.	
11					Records observer sensings and announces firing data.	Receives and announces observer sensings.	
12	Perform sequence steps 9 through 11 until adjusted deflection and quadrant elevation are determined.						
13			Enters adjusted deflection and quadrant elevation.	Computes and announces site.	Announces adjusted data.		
14	Directs that time registration be fired.			Corrects graphical equipment for registration corrections.	Computes adjusted elevation.	Notifies observer to observe time registration.	
15					Determines fuze setting with GFT to begin registration.		
16					Transmits fire commands to the battery.		

					Receives ON THE WAY from the battery.	Transmit ON THE WAY to the observer.
17					Records observer sensing and determines subsequent firing data.	Receives observer sensing.
18			Perform sequence steps 16 and 17 until the adjusted time is determined.			
19			Enters adjusted time and causes the computer to compute registration corrections.		Announces adjusted time. Constructs GFT setting.	
20	Announces the batteries charges for which to store registration corrections.		Stores corrections for batteries and charges into the computer as directed.			

Table V. Fire Direction Center Duties, High Burst or Center of Impact, Registration

Sequence	S3	Chief of fire direction	Computer operator	Vertical control operator (VCO)	Computer/recorder	Radiotelephone operator	Switchboard 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 for the high burst (HB) or center of impact (CI). Causes computer to compute orienting data to 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 the battery.		
5			Causes computer to compute firing data. Announces firing data.		Transmits remaining fire commands to the battery.	Transmits 01 and 02 orienting data to the observers.	
6					Receives ON THE WAY from the battery.	Transmits ON THE WAY to 01 and 02.	
7			Enters 01 and 02 data.	Plots registration point determined from the 01 and 02 data.	Records 01 and 02 data. Averages 01 and 02 data and announces the results.	Receives and announces data from 01 and 02.	

8			Causes the computer to compute the coordinates and altitude of the HB or GI.	Checks announced coordinates and altitude of the HB or CI displayed by the computer.			
9			Enters the deflection, time, and quadrant elevation fired. Causes computer to compute registration corrections.		Constructs GFT settings and chart corrections.		
10	Announces batteries and charges for which to store registration corrections.		Stores corrections for batteries and charges as directed.				

The following data had been entered into the computer when the registration was conducted.

	Battery A	Battery B	Battery C
Azimuth of fire	700 mils	700 mils	700 mils
Deflection	2800 mils	2800 mils	2800 mils
Latitude	34°N	34°N	34°N
Grid declination angle	+6 mils	+6 mils	+6 mils
Powder Temperature	+81°	+81°	+81°
Projectile weight, Shell HE	34.8 lb	34.8 lb	34.8 lb
Muzzle velocity shell HE, charge 7	456.9m/sec	455.7m/sec	454.4m/sec

Note. No meteorological message had been received at the time of registration: met was set to standard.

(*b*) The adjusted data determined from the Battery A registration are:

Charge: 7
Deflection: 2811
Time: 33.9
Quadrant elevation: 464

(*c*) The adjusted data are entered into the computer, and the following corrections are computed and stored for all batteries and charges using the COMP REG function:

Deflection correction: Left 1.7
Time correction: +0.2
Range correction: +8m/1000m

(*d*) The VCO plots the coordinates of the registration point on the firing chart and, using the GST, computes the site as +2 mils. The following data for Battery A are determined:

Adjusted elevation: 462 mils
Chart range: 9,000 meters

(*e*) The GFT setting for Battery A is: GFT A: Charge 7, lot X, range 9,000, elevation 462, time 33.9. The deflection index is constructed at deflection 2811.

(*f*) Firing data are then computed with the M18 computer to the registration point for Batteries B and C, overriding for charge 7, shell HE, and fuze time. A correction of DOWN 20 is entered to compensate for the 20/R automatically applied by the computer. The following adjusted data for Battery B are displaced:

Charge: 7
Deflection: 2810
Time: 31.9
Quadrant elevation: 433

(*g*) The chart range for Battery B is 8620 meters. Using the GST, a site of +2 mils is computed. The adjusted elevation is 431 mils (433−2).

(*h*) The GFT setting for Battery B is: GFT B: Charge 7, lot X, range 8620, elevation 431, time 31.9. The deflection index is constructed at deflection 2810.

(*i*) The following adjusted data for Battery C are displayed:

Chart: 7
Deflection: 2871
Time: 32.0
Quadrant elevation: 436

(*j*) The chart range for Battery C is 8620 meters. Using the GST, a site of +3 mils is computed. The adjusted elevation is 433 mils (436.3).

(*k*) The GFT setting for Battery C is: GFT G: Charge 7, lot X, range 8620, elevation 433, time 32.0. The deflection index is constructed at 2871.

c. High-Burst and Center-of-Impact Registration.

(1) *Registering battery.*

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

(*b*) The deflection, fuze setting (high burst only), and quadrant elevation fired are the adjusted deflection, time, and quadrant elevation. The VCO, using a GST, determines the site and subtracts it from the adjusted quadrant elevation to obtain the adjusted quadrant elevation.

Note. As an alternate solution, the M18 computer may be used to determine the adjusted elevation by entering the coordinates of the high burst or center of impact and the battery altitude as the target. The computer will then display the adjusted elevation.

(2) *Nonregistering batteries.* The same procedures outlined for computing adjusted data for nonregistering batteries with a precision registration are used. The computer operator enters the location of the high burst (center of impact) as the registration point. If a high burst was fired, fuze time must be selected and a correction DOWN 20 must be entered before computing adjusted data.

(3) *Construction of GFT setting.* The procedures outlined in *b*(3) above for constructing the GFT setting and applying the

deflection for a precision registration are used for determining the high-burst (center-of-impact) data. The example given in *b* above for the precision and time registration is applicable to the high-burst and center-of-impact registrations. The following additional factors are also applicable:

(*a*) The actual fired data is the adjusted data for the registering battery.

(*b*) The computer coordinates and altitude of the high burst (center of impact) are used as the registration point. When firing a high-burst registration, the computer operator applies a correction of DOWN 20 to the altitude of the high-burst before computing the adjusted data for the nonregistering batteries.

15. Base Piece Displacement

a. 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. The computer automatically corrects for base piece displacement of the registering battery. However, in constructing the GFT setting and determining the adjusted deflection for the manual method, corrections to the adjusted deflection and chart range of the registering battery are made as outlined in FM 6–40.

b. The coordinates and altitude of the battery center for the registering battery must be reentered prior to computing data for subsequent fire missions.

c. The following base piece displacements were reported by the battery executive officers:

Battery A: 30 meters to the rear, 40 meters to the right.

Battery B: 20 meters to the rear, 30 meters to the right.

Battery C: 10 meters to the front, 5 meters to the right.

d. Before computing registration corrections for Battery A, the computer operator substitutes the coordinates of the Battery A base piece for the coordinates of the Battery A battery center. Hence, the computed registration corrections which are transferred to the nonregistering batteries are based on corrected data. However, the registering battery must account for base piece displacement as follows:

Registration point range: 9,000 meters

Base piece displacement: 40 meters right; 30 meters to the rear.

Deflection correction: $\frac{40}{9.0}$ = right 4 mils

Deflection at which to construct deflection index: 2807 mils (2811+right 4)

Chart range: 9,030 meters (9,000 + 30)

e. The GFT setting for Battery A is—

GFT A: Charge 7, lot X, range 9030, elevation 462, time 33.9

f. Prior to firing subsequent missions, the coordinates and altitude of the Battery A battery center are reentered into the computer.

g. GFT settings for the nonregistering batteries may be made without regard for base piece displacement. The GFT settings for Batteries B and C remain unchanged from those shown in paragraph 14.

16. General

a. The gun direction computer may be used in situations where no maps are available and where an observed fire chart would normally be used. The methods used for manual fire direction procedures apply to the computer application except that information is entered into the computer rather than on a chart.

b. Determination of valid altitudes is of primary importance regardless of whether data is determined from an observed firing chart or by use of a computer. The ability of the computer to use all known parameters provides a more accurate solution to the gunnery problem and results in better altitude determination. Although this is not the optimum mode for using the computer, the greater inherent accuracy of the computer and its ability to apply the effects of known nonstandard conditions increases the validity of the gunnery solution.

c. The importance of electronic target acquisition devices such as radar is emphasized. These devices allow refinement of battery altitudes and application of registration corrections and provides an accurate target acquisition means for immediate fire for effect.

17. Time Registration, All Batteries Registering Without Survey

a. The situation is similar to the time plot observed firing chart discussed in chapter 26, FM 6–40.

b. When the time registration is completed, the range corresponding to the adjusted time and the drift and azimuth correction for rotation of the earth at that range are determined using a tabular firing table. Since the computer automatically includes these corrections in all its computations, they must be added to the adjusted azimuth of fire prior to back plotting. These corrections are made in a direction opposite to the sign of the correction in the firing table. Since the rotation correction is based on the latitude of the battery, it is important that the battery latitude be entered into the computer prior to backplotting.

c. With the computer in the traverse survey mode, back plot the battery at the back azimuth of the adjusted azimuth of fire (plus drift and rotation corrections) using a range corresponding to the adjusted time and a vertical angle of +0 mils. The assumed registration point coordinates and altitude are the starting point of the traverse.

d. Enter the battery coordinates and altitude (*c* above) and the other battery data, to include known nonstandard conditions as they existed when the registration was fired, and recompute the firing data to the registration point. The difference between the quadrant elevation displayed by the computer and the adjusted quadrant elevation is considered site.

e. Compute the vertical interval between the battery and the registration point manually or with a GST. Enter the corrected battery altitude into the computer and recompute data to the registration point. Enter a correction of DOWN 20 to the target altitude for a zero height-of-burst. Compare the new data with the adjusted data. If the two sets of data agree to within 1 mil in deflection, 0.1 second in time, and 1 mil in quadrant elevation, the battery location is accepted as correct. If the two sets of data do not agree within the tolerance stated above,, recompute the location and/or altitude until the above criteria is met. The procedure is as follows:

(1) If the displayed deflection disagrees with the adjusted deflection, correct the azimuth used to backplot the battery in the appropriate direction.

(2) If the fuze setting disagrees with the adjusted time, note the difference and adjust the range used in backplotting the battery by the amount necessary to compensate for the disagreement.

(3) Compute the new battery location and altitude as outlined in *d* and *e* above. Compare the new data with the adjusted data. If the deflection or the fuze setting do not agree within tolerance, repeat steps (1) and (2).

(4) If the quadrant elevation is the only element which does not agree with the adjusted data, assume the error to be in the battery altitude. The altitude is adjusted until the data is within tolerance.

f. For example, a 155-mm howitzer battery has registered on a registration point, using charge 5. Adjusted data for the registration point is deflection 2305, time 25.3 seconds, quadrant elevation 392. The registration point is assumed to be at coordinates 20000 30000, altitude 400. The battery was laid on azimuth 3000 and the aiming posts placed at deflection 2400. At the time of registration, the powder temperature was +81°, the projectile weight was 5 squares, and the battery latitude 34° N.

Maps, meteorological data, and muzzle velocity data were not available. Data are prepared and entered into the computer as follows:

(1) Range corresponding to adjusted time (25.3 seconds): 7,000 meters (FT 155–Q–3).

(2) Deflection shift to registration point: Right 95 (2400−2305). Adjusted azimuth: 3095 (3000+R95).

(3) Drift at range 7,000: 8.9 mils (FT 155–Q–3).

(4) Rotation correction for azimuth: Left 1.1 mils (FT 155–Q–3).

(5) Adjusted azimuth corrected for drift and rotation: 3105 (3095+R8.9+R1.1).

(6) Back azimuth: 6305 (3105+3200)

(7) The battery location is computed with the computer in the traverse survey mode. Coordinates 20000 30000 and altitude 400 are entered as the observe location. The observer azimuth (6305 mils) the observer horizontal distance (7000 meters), and the vertical angle (+0 mils) are entered and the following data are displayed: Coordinates 19348 36970, altitude 404.

(8) Firing data displayed by the computer, using the computed battery coordinates and altitude and nonstandard conditions, are: Charge 5, deflection 2305, time 25.3, and quadrant elevation 376.

(9) The battery altitude is computed as follows:

Site: +16 mils (392−376).

Vertical interval: 95 meters (GST, 155-mm howitzer).

Battery altitude: 309 meters (404−95).

(10) Recompute firing data with the battery altitude derived in (9) above. The computer displays: Charge 5, deflection 2305, time 25.5, quadrant elevation 392.

(11) The computed deflection agrees with the adjusted deflection and the azimuth on which the battery is back plotted is accepted as correct.

(12) The .2 second difference in fuze setting as compared with the adjusted time is not acceptable.

(13) Since the computed fuze setting is .2 second greater than the adjusted time, subtract .2 second from the adjusted time to determine the next trial range.

New fuze setting: 25.1 seconds (25.3−.2).

Range corresponding to new time (25.1 seconds): 6960 meters.

(14) Recompute the battery location with the computer in the traverse survey mode. (The same data used in *f*(7) above is entered, except that the observer horizontal distance is 6960 meters.) The computer displays coordinates 19352 36930 and altitude 404.

(15) Firing data displayed by the computer using computed battery coordinates and altitude and nonstandard conditions are: Charge 5, deflection 2305, time 25.1, quadrant elevation 373.

(16) The battery altitude is recomputed as follows:

Site: +19 mils (392−373)

Vertical interval: 110 meters (GST, 155-mm howitzer)

Battery altitude: 294m 3534w (404−110)

(17) Recompute firing data with the battery altitude derived above. The computer displays: Charge 5, deflection 2305, time 25.3, quadrant elevation 392. Since the data is within the prescribed tolerances, the coordinates and altitude are accepted as the battery location. The same procedures are followed for the remaining batteries of the battalion.

18. Impact Registration, All Batteries Registering Without Survey

a. The procedures in paragraph 17 are followed for an impact registration without survey, except that the range corresponding to the adjusted quadrant elevation is used to back plot the registering battery. Fuze quick is used to determine computer data to the registration point.

b. Using the example presented in paragraph 17*f*, assume that an impact registration only was fired with charge 5 and that the adjusted data is: Deflection 2305, quadrant elevation 392. Data are prepared and entered into the computer as follows:

(1) Range corresponding to adjusted quadrant elevation (392 mils): 7200 meters (FT 155–Q–3).

(2) Adjusted azimuth: 3095 mils (no change from previous situation).

(3) Drift at range 7200: 9.3 mils (FT 155–Q–3).

(4) Rotation correction for azimuth: Left 1.1 mils (FT 155–Q–3).

(5) Adjusted azimuth corrected for drift and rotation: 3105 (3095+R9.3+R1.1).

(6) Back azimuth: 6305 mils (3105+3200).

(7) The battery location is computed with the computer in the survey mode. The problem is started at the registration point. The observer azimuth (6305 mils), the observer horizontal distance (7200 meters), and the vertical angle (+0 mils) are entered and the following coordinates are displayed: 19329 37169, altitude 404.

(8) Firing data displayed by the computer, using the computed coordinates and altitude and nonstandard conditions, are: Charge 5, deflection 2306, quadrant elevation 392.

(9) Since this data agrees within 1 mil of the data fired, the battery location is accepted as correct. The battery altitude should be corrected when the survey data is available.

19. Time Registration, All Batteries Registering, Site Determined by Firing

a. The accuracy of firing data may be substantially improved by conducting an executive's high burst following a time registration. Since the high burst allows an accurate determination of vertical interval (approaching survey accuracy), corrections from the registration may be computed and applied.

b. After the executive's high burst is fired and the altitude of the battery determined, the M18 computer is used to determine data to the registration point. The differences between computer data to the registration point and the adjusted data may be considered registration corrections. These corrections are computed and stored in the computer as outlined in FM 6-3-1.

c. The registration corrections should be transferred to the nonadjusting batteries for the determination of firing data to the registration point. The difference between the data computed to the registration point and the adjusted data for the nonadjusting batteries is considered site. Each battery altitude is determined in the manner as outlined in paragraph 17. If the muzzle velocities of all batteries are known and are entered into the computer, as well as other known data, the registration corrections will primarily represent corrections for weather effects. Therefore, the difference between the quadrant elevation computed to the registration point and the adjusted quadrant elevation will be the result of differences in vertical intervals. This allows the determination of altitudes of nonadjusting batteries to approach the accuracy of the battery which fired the high burst.

d. For example, assume that the batteries of a 155-mm howitzer battalion fired a time registration on the registration point. Assumed location of the registration point is coordinates: 200000 300000, altitude 400.

(1) Battery data is as follows:

	Battery A	Battery B	Battery C
Azimuth laid	3000 mils	3000 mils	3000 mils
Aiming post deflection	2400 mils	2400 mils	2400 mils
Registration data, charge 5:			
Adjusted deflection	2367 mils	2305 mils	2235 mils
Adjusted time	24.1	25.3	24.8
Adjusted quadrant elevation	373 mils	392 mils	378 mils
Known data:			
Latitude	34°N	34°N	34°N
Powder temperature	+80°F	+81°F	+79°F
Projectile weight	5 square	5 square	5 square
Muzzle velocity, shell HE, charge 5 (from previous firings)	368.0m/sec	364.4m/sec	361.2m/sec

(2) Maps and meteorological data are not available.

(3) An executive's high burst is conducted by Battery B. The S3 sends the following commands to the Battery B executive officer: OBSERVE HIGH BURST, MEASURE ANGLE OF SITE, 3 ROUNDS, CHARGE 5, ADJUSTED DEFLECTION 2305, ADJUSTED TIME 25.3, ADJUSTED QUADRANT ELEVATION 392. The executive officer determines that a 20 mil angle of site is necessary to insure observation, and fires the following data: Charge 5, deflection 2305, time 25.3, quadrant elevation 412.

(4) After observing the high-burst, the executive officer determines that the average angle of site to the high burst is +33 mils. The angle of site from the battery to the registration point is therefore +13 mils (33 − 20 = 13).

(5) With the computer in the traverse survey mode, the following coordinates and altitude are displayed for Battery B: Coordinates 19348 36970 altitude 315. The location of the registration point (coordinates 200000 300000, altitude 400) was used as the starting point for the survey, and the

observer azimuth 6305 mils (as computed in para. 17*f*(6)) was entered. The observer's horizontal distance was 7000 meters (range corresponding to adjusted time of 25.3 seconds) and the observer's vertical angle was − 13.0 mils (the traverse is from the registration point to the battery).

(6) After entering the Battery B coordinates and altitude and other known battery data into the computer, the firing data to the registration point (charge 5, fuze time, and a DOWN 20 correction) was computed and the computer displayed the following data: Charge 5, deflection 2306, time 25.8, quadrant elevation 402.

(7) The adjusted data are entered into the computer, and registration corrections (differences between the adjusted data and the data displayed by the computer) are determined. (Site was determined by firing.) The computer displays the following registration corrections:

Deflection correction: Right 0.8m
Time correction: − .5
Range correction: − 18m/1000m

(8) The registration corrections are now transferred to the other batteries. The coordinates and trial altitude for Batteries A and C are determined by backplotting along the azimuth of fire at a range corresponding to the adjusted time. The data for this procedure and the results of the computations are as follows:

	Battery A	*Battery C*
Range corresponding to adjusted time (FT 155–Q–3)	6750 meters	6900 meters
Deflection shift to registration point	R33 mils (2400−2367)	R165 mils (2400−2235)
Adjusted azimuth	3033 mils (3000+R33)	3165 mils (3000+R165)
Drift at adjusted time range (FT 155–Q–3)	8.4 mils	8.7 mils
Correction to azimuth for earth rotation (FT 155–Q–3)	L1.1 mils	L1.1 mils
Adjusted azimuth corrected for drift	3042 mils (3033+8.4+1.1)	3175 mils (3165+8.7+1.1)
Back azimuth	6242 mils (3042+3200)	6375 mils (3175+3200)
Coordinates displayed by computer	18957 36669	19831 36898
Altitude displayed by computer	404 meters	404 meters

(9) The battery data above, the azimuth of lay, the aiming post deflection, and nonstandard conditions are entered for Batteries A and C. Firing data is computed for each battery to the registration point, using shell HE, charge 5, fuze time, and a DOWN 20 correction. The following data are displayed by the computer:

	Battery A	*Battery C*
Deflection	2367	2234
Time	23.8	24.8
Quadrant elevation	353	374

(10) The computations to compute battery altitude are:

	Battery A	*Battery C*
Site	+20 mils (373−353)	+4 mils (378−374)
Vertical interval	119 meters	23 meters
Battery altitude	285 meters (404−119)	381 meters (404−23)

(11) With the new altitude entered, recompute data for Batteries A and C to the registration point. The data displayed by the computer are:

	Battery A	*Battery C*
Deflection	2367	2234
Time	24.0	24.8
Quadrant elevation	374	378

(12) Since the computed quadrant elevations agree within 1 mil of the adjusted quadrant elevations, the altitudes are accepted as correct. Registration corrections from Battery B are included in the computations since they were transferred in (8) above. The transferral of the data provides greater accuracy in the altitude computation.

20. Time Registration, One Battery Registering, Limited Position Area Survey

a. A limited position area survey allows an accurate determination of direction and the establishment of an orienting line for each battery. Only one battery registration is required since the other batteries are located with respect to that battery.

b. The registering battery is backplotted in the manner described in paragraph 17. Refinements to the battery altitude, such as determination of site by firing, allow the separation of registration corrections from vertical interval and improve the accuracy of subsequent data. This improvement is transferred to the nonregistering batteries. This is especially true if the muzzle velocities for the batteries are known and entered into the computer.

c. Accurate directional data determined from the survey should be entered into the computer. This entry eliminates errors introduced by inaccuracies of the magnetic needle of the aiming circle.

d. To facilitate computation of survey data with the M18 computer, field notes should be prepared, using the registering battery as the starting point.

e. For example, assume that in paragraph 19*d* only Battery B conducted a time registration. The results are shown in paragraph 19*d*(1). Assume also that all battery data are as shown in paragraph 19*d*(1) except that Batteries A and C did not register.

(1) After Battery B registered, the battery executive officer measures the orienting angle as 1836 mils. The adjusted azimuth of fire is 3095 mils (1731+6400−5036). The azimuth of the Battery B orienting line is 1731.42 mils. The other data and procedures for the computation of Battery B coordinates and altitude are as outlined in paragraph 17. The following location is entered for Battery B: Coordinates 19352 36930, altitude 294.

(2) After the position is occupied, the battalion survey officer conducts a limited position area survey to establish an orienting line for each battery and the locations and altitudes of Batteries A and C with respect to Battery B. Survey data are as follows:

Leg	Azimuth	Distance	Vertical angle
B–TS 1	3548.10	310.06	+5.3
TS 1–A	4747.03	308.10	+1.0
A–TS 2	1386.31	479.88	−1.3
TS 2–C	1190.61	460.34	+3.3

(3) The azimuths of the orienting lines are as follows:

Battery A: 1605.38
Battery B: 1731.42
Battery C: 1886.81

(4) With the computer in the traverse survey mode, the locations of Batteries A and C are computed as follows:

	Coordinates	Altitude
Battery A	18940 36622	296
Battery C	19833 36902	297

These data are entered into the computer.

(5) The executive officers of Batteries A and C measure the orienting angle and compute the true direction of fire as follows:

	Battery A	Battery C
Azimuth or orienting line	1605	1887
	+6400	+6400
	8005	8287
Orienting angle	5007	5285
Azimuth laid	2998	3002

(6) The azimuth of lay and the battery deflection (2400) are entered into the computer for each battery, and all nonstandard conditions are entered for future firing.

21. Time Registration, All Batteries Registering, Data Improved by Radar

a. The application of radar-produced data provides for the determination of registration corrections by the M18 computer. All batteries are located and their altitudes are determined as outlined in paragraph 17. The difference in the computed quadrant elevation to the registration point, using all known nonstandard conditions and the adjusted quadrant elevation to the registration point, is site and is used to compute the battery altitude.

b. Following the determination of the battery locations and altitude, one battery conducts a high-burst registration, using the radar to determine the high-burst location. The computer may be used in the survey mode to compute the location of the radar and the high burst. The purpose of this registration is to determine registration corrections. All known nonstandard conditions should be entered into the computer before the registration is conducted and corrections computed.

c. Continuing with the example in paragraph 17*f*, assume that all battery data have been entered into the computer.

(1) A short traverse is run from the base piece to the radar antenna. The coordinates of the antenna are 19360 36979, and the altitude is 320. These data are entered into the computer as an observer location.

(2) The high burst will be fired at coordinates 20000 30000, altitude 440. All known data to the high burst point (shell HE, fuze time, charge 5, and a DOWN 20 correction) are entered into the computer and the following firing data are displayed: Charge 5, deflection 2307, time 25.5 quadrant elevation 399.

(3) The radar section reports the following data to the high-burst point: Range 6850, azimuth 3092, vertical angle +17.

(4) With the computer in the traverse survey mode, the following high-burst location is displayed: Coordinates 20085 30167, altitude 438.

(5) Using the operator procedures outlined in FM 6-3-1 for computing high-burst registration corrections, the computer displays the following registration corrections:

Deflection correction: Right 13.1
Time correction: +1.0
Range correction: +33m/1000m.

(6) These corrections are stored for the registering battery and transferred to the nonregistering batteries, using the procedures outlined in FM 6-3-1.

22. Radar Chart With the Computer

a. To determine battery locations using radar only, each battery fires a high burst registration. The coordinates of the radar set are assumed and the radar section reports the range, azimuth, and vertical angle to the high burst.

b. With the computer in the traverse survey mode, and the assumed location of the radar set entered as a starting point, the coordinates and altitude of the high burst are computed. Using the computed high burst as the starting point, the battery location is backplotted by following the steps outlined in paragraph 17*b* through 17*e*.

c. If the registering piece is located with respect to the radar set, its coordinates and altitude may be computed from the radar by use of the traverse survey mode. In this case, the registration is used to determine registration corrections since both the battery and the high burst locations are known.

23. Transferral of Data After Completion of Survey

After the survey is completed, all data which are based on the assumed location of the registration point must be converted for use with the new grid.

a. Surveyed coordinates and altitudes are entered for the batteries and the registration point.

b. With surveyed data available, the registrations may be used to compute registration corrections. The data fired is used as "did hit" data, and the computer is used to compute registration corrections, with all known nonstandard conditions entered.

c. The surveyed azimuth on which the battery is laid is computed by subtracting the measured orienting angle from the azimuth of the orienting line. This azimuth is entered into the computer as the battery azimuth of lay.

d. Targets located by observers with respect to the assumed location of the registration point must be replotted with respect to the correct registration point coordinates determined by survey. The following steps are used to determine the target location:

(1) Before entering the surveyed location of the battery, compute the data to hit the target. Enter the nonstandard conditions at the time of firing into the computer.

(2) Compute the azimuth, distance, and vertical angle from the battery to the target.

(3) Enter the surveyed battery location into the computer.

(4) Enter the surveyed registration point location into the computer.

(5) Enter the surveyed azimuth on which the battery is laid.

(6) With the computer in the traverse survey mode and the battery location entered as the starting point, compute the target location using the data determined in (2) above.

(7) Using the registration corrections computed in (6) above and the nonstandard conditions as they existed at the time of firing, compute firing data to the target. If the computed deflection does not agree with the deflection fired, adjust the azimuth by an appropriate amount and repeat the computation as outlined in (6) above.

(8) When the computed deflection agrees with the deflection fired, note and record the fuze setting if fuze time was fired. Adjust the range along the gun-target line until the fuze setting used in fire-for-effect is displayed. Compare the quadrant elevation displayed with the fire-for-effect quadrant elevation. The difference is site. Compute the vertical interval manually or with the graphical site table. Algebraically add the vertical interval to the battery altitude to determine the target altitude.

(9) Recompute the data to the target. The data must agree within 1 mil in deflection and quadrant elevation and 0.1 second or less in time. If the time setting is not within the allowable tolerance, make an appropriate adjustment along the gun-target line and recompute. If the quadrant

elevation is not within the allowable tolerance, make an appropriate correction to the target altitude as outlined in (8) above.

(10) If fuze quick was fired, adjust along the gun-target line until the computed quadrant elevation agrees with the quadrant elevation fired.

e. Targets located by target acquisition devices which measure azimuth, distance, and vertical angle, such as radar, are replotted by polar plotting from the surveyed location of the acquisition device.

f. For example, assume that a 155-mm howitzer battery fired a time registration on a registration point the location of which was assumed to be at coordinates 200000 300000, altitude 400. The adjusted data was: Charge 5, deflection 2305, time 25.3, quadrant elevation 392. The battery location was computed to be coordinates 19341 36969, altitude 309 using the methods outlined in paragraph 20. The battery was laid on azimuth 3000 and aiming posts placed at deflection 2400. A radar set was located at coordinates 19360 36979, altitude 320, by a short traverse.

(1) At the time of registration and for subsequent firing, the following data were known (all other data were set to standard):

Powder temperature	+81°
Projectile weight	5 squares (96.1 lb)
Latitude	34° North

(2) The following targets were fired on:

Data From Computer's Record			Fire-For-Effect Data				
Concentration	*Acquired by*	*Location (assumed grid) coordinates, altitude*	*Fuze*	*CHG*	*DF*	*TI*	*QE*
AB101	Observer	19859 30326, 370	Time	5	2289	23.8	365
AB102	Observer	20085 29761, 420	Quick	5	2316		415
AB103	Radar	19779 29871, 359 (AZ 3140, RG 7120, Vert angle +5)	VT	5	2273	25.0	398

(3) The survey officer has completed the survey and provides the following data:

Location	*Coordinates*	*Altitude*	*Azimuth OL*
Registration point	25327 37568	365	
Battery	24660 44530	264	4314
Radar	24679 44540	275	

g. The S3 directs that a surveyed firing chart be prepared. The following procedure is followed:

(1) Polar coordinate data to each target located by an observer were computed and the following data determined:

Concentration	*Azimuth*	*Distance*	*Vertical angle*
AB101	3121	6663	+9
AB102	3095	7246	+15

(2) The surveyed battery, radar, and registration point locations are entered into the computer.

(3) The measured orienting angle is 1314 mils. The surveyed azimuth on which the battery is laid is, therefore, 3,000 mils (4314 − 1314). Since this is the same azimuth that was entered, no data change is necessary, and since the radar azimuth is also based on the same azimuth on which the battery was laid, it is not necessary to change the radar-target azimuth.

(4) Registration corrections are computed, using the adjusted data fired and the known nonstandard conditions. The computer displays the following corrections:

Deflection correction: Right 2.8

Time correction: −.2

Range correction: −3m/1000m

(5) With the computer in the traverse survey mode, the surveyed battery location entered as the starting point, and the polar coordinate data entered as observer, data, the following target locations are computed.

Concentration	*Coordinates*	*Altitude*
AB101	25176 37887	326
AB102	25406 37322	375

(6) The firing data is computed to the concentrations using the nonstandard conditions and registration corrections. The shell-fuze-charge combinations fired are:

Concentration	*Fuze*	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
AB101	Time	5	2286	23.7	365
AB102	Quick	5	2313	----	414

(7) Since the computed deflections do not agree within 1 mil of the deflections fired, the polar plot azimuths are adjusted as follows:

				Polar plot data		
Concentration	*Computed deflection*	*Deflection fired*	*Change*	*Old azimuth*	*Change*	*New azimuth*
AB101	2286	2289	L3	3121	L3	3118
AB102	2313	2316	L3	3095	L3	3902

(8) With the computer in the traverse survey mode and the surveyed battery location entered as the starting point, the target locations are recomputed. Observer data and locations computed are:

Concentration	Azimuth	Observer horizontal distance	Vertical angle	Computed Coordinates		Computed Altitude
AB101	3118	6663	+9	25196	37889	326
AB102	3092	7246	+15	25427	37325	375

(9) The following firing data are computed to the targets:

Concentration	Fuze	Charge	Deflection	Time	Quadrant elevation
AB101	Time	5	2289	23.7	365
AB102	Quick	5	2316	----	414

These data agree within 1 mil in deflection and quadrant and 0.1 second in time with the data fired. The target locations are accepted as correct and stored in the computer.

(10) Concentration AB103 was located by radar and the surveyed location was polar plotted from the radar. With the computer in the traverse survey mode, the surveyed radar location entered as the starting point, and the azimuth, distance and vertical angle reported by the radar to the target entered as observer data, the following data are displayed for concentration AB103: Coordinates 25119 37442, altitude 328.

CHAPTER 4
COMPUTER APPLICATION, FREE ROCKETS

24. General

The gun direction computer M18, when integrated into the free rocket FDC, provides a capability for faster and more accurate computation of firing data. The capacity of the computer to store 16 firing positions, 32 targets, and 10 separate missions provide the S3 with a much greater capability for analyzing targets, computing firing data, and determining the probability of crest clearance than he has using manual methods.

25. Fire Direction Center Operation

a. Table VI contains a suggested sequence and distribution of duties for normal fire direction operation. Table VII contains a suggested sequence and distribution of duties for analyzing firing positions for future planning.

b. In the planning stage, firing position data, target information, and meteorological data are entered as received. After areas of responsibility are assigned, firing position locations are analyzed for coverage and dead space. These data are computed and reported to the target analyst as soon as input information is known or can be determined. When missions are assigned, firing data are computed using the data available and standard values as required. Missions are updated as new data are received by entering the new data into the computer and recomputing the firing data. Generally, one mission location (e.g., E2), firing position, and target location should be reserved for targets of opportunity.

c. General characteristics to be considered when using the computer free rocket programs are as follows:

(1) All targets and firing positions must be entered on the respective lists before they can be used for a particular mission.

(2) The M18 computer does not destroy data entered unless the operator causes the computer to CLEAR DATA or CLEAR MEMORY.

(3) Data inputs can be recalled.

(4) Ten separate missions can be computed, stored, and updated without reentering the mission data.

(5) The computer will use the last meteorological message entered unless directed to use standard met.

(6) Use of the CLEAR DATA function removes all mission data in a particular alphanumeric mission location. This function should be used before starting a new mission but not for updating an old mission since it would necessitate reentry of the complete mission data.

26. Dead Space Computations

a. Using the crest clearance computational features of the free rocket computer programs, the S3 may analyze a trajectory with respect to intervening crests and determine the probability of clearing a crest.

b. The crest clearance feature provides for analysis of dead space after computation of firing data. Each mission should be analyzed with regard to dead space before the mission is fired. Equally important is the fact that this feature can be used to analyze a firing position-target combination and thus be used as a consideration for selecting a firing position for a target, or selecting the firing points themselves.

c. Using the crest clearance feature the S3 can analyze assigned firing positions or alternate firing positions and construct dead space diagrams for areas in which he may fire. This analysis must be made as early as possible and should be a factor in selecting firing position locations. The results of this analysis should be forwarded to the nuclear target analyst for his use in fire planning. In the absence of specific data, the analysis is conducted using the unit mission (either actual or based on logical extension of the current situation), zones of responsibility, and representative targets in the zone of responsibility.

Table VI. Duties of Free Rocket Fire Direction Center Personnel (During Firing)

Sequence	S3	Chief of fire direction	Computer operator	Computer/recorder	Radiotelephone operator
1		Plots target on firing chart or map. Advises S3 concerning dead space.	Enters target on target list.	Records fire mission on the computer's record.	Receives and announces the fire mission.
2	Issues fire order.		Mission associates firing position and target.	Computes data for manual backup as directed.	Transmits fire order to the firing section.
3			Computes initial laying data, or recomputes present data using latest inputs.		Receives launcher data from the firing section. Transmits initial laying data to the firing section.
4			Enters launcher-rocket data and computes corrected data.		Transmits corrected data to the firing section.
5			Computes low-level wind corrections and/or final firing data.		Receives and announces low-level wind corrections from the firing section.
6			Recomputes crest clearance.		Transmits final data to the firing section.
7		Plots surveillance information.		Records surveillance information.	

d. The procedure for conducting the analysis is as follows:

(1) Select firing positions based on the unit mission and extension of the existing situation. If firing positions have been assigned, use these positions for the analysis.

(2) Perform a map inspection and determine intervening crests within the assigned zone of responsibility.

(3) Select likely target areas and/or representative targets for which clearance of intervening crests may be critical. Select targets which will facilitate the construction of the dead space overlays outlined in (6) below.

(4) Using the M18 computer, compute the firing data for the various firing position-target combinations. Current and/or standard meteorological conditions and approximate rocket values are normally used in these computations.

(5) Using the M18 computer, compute the crest clearance for the firing position-target combinations indicated in (4) above.

(6) Construct a dead space overlay containing the firing points and zone of responsibility

Table VII. Firing Position Analysis Free Rockets

Sequence	S3	Chief of fire direction	Computer operator	Computer/recorder
1	Selects targets (known or likely) and firing positions (assigned or recommended) for dead space analysis.	Determines crest altitude and range for selected firing positions and targets.	Enters targets and firing positions into the computer as directed.	Records data as directed.
2			Determines crest clearance probabilities for various firing position-target combinations.	
3		Develops dead space overlays for the situation map.		
4	Selects firing positions and launchers for assignment to known targets.			

for the unit. Shade those areas in which delivery of fire is not possible because of dead space from an intervening crest(s). Firing positions may be color coded or a separate overlay for each firing position may be used for easy identification. An analysis of additional targets and firing positions may be necessary for a complete development of these diagrams. The diagrams should be as complete as possible consistent with the time and information available. In addition, the diagrams may be coded to show areas in which varying degrees of the commander's guidance (e.g., 99 percent assurance, 76 percent assurance) for the delivery of fire on the target may be met.

e. Table VII outlines a sequence of events and the duties of personnel involved in the analysis of firing positions.

27. Distribution of Responsibility

a. When M18 computers are used at both battalion and battery levels, a more flexible operation is possible. The battery computer is normally used to compute firing data for that specific battery's missions, and the battalion computer is used to analyze firing position-target combinations. In addition, the battalion computer may be used to check selected mission firing data or to handle overflow missions from the batteries. This manner of operation permits maximum use of each computer and allows the battalion FDC sufficient time for future planning and for supervision of the battalion fires. All computations are performed, however, at the location that provides the most efficient use of resources.

b. If a launcher is separated from the battery to perform a mission, the battery M18 computer should accompany the launcher. The battalion computer is then used to compute firing data for the battery (—).

APPENDIX
REFERENCES

AR 611–201	Enlisted Military Occupational Specialties.
ATP 6–100	Army Training Program for Field Artillery Unit.
ATP 6–302	Army Training Program for Honest John and Little John Units.
DA Pam 310-series	Index of Military Publications.
FM 6–3	Gun Direction Computer M18.
FM 6–3–1	Operation of the Gun Direction Computer M18, Cannon Application.
FM 6–40	Field Artillery Cannon Gunnery.
FM 6–40–1	Field Artillery Rocket Gunnery.
FM 6–125	Qualification Tests for Specialists, Field Artillery.

By Order of the Secretary of the Army:

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General, United States Army,
Chief of Staff.

Official:

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Major General, United States Army,
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Ft Bragg (2)
Ft Carson (2)
Ft Devens (2)
Ft Hood (2)
Ft Lewis (2)
Ft Riley (2)
Ft Campbell (2)
Br Svc Sch (2)
Units org under fol TOE's:
6–156 (5)
6–157 (5)
6–166 (5)
6–167 (5)
6–168 (5)
6–176 (5)
6–177 (5)
6–186 (5)
6–216 (5)
6–217 (5)
6–228 (5)
6–286 (5)
6–346 (5)
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NG: State AG (3).
USAR: Units—same as active Army except allowance is one copy to each unit.
For explanation of abbreviations used, see AR 320–50.

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