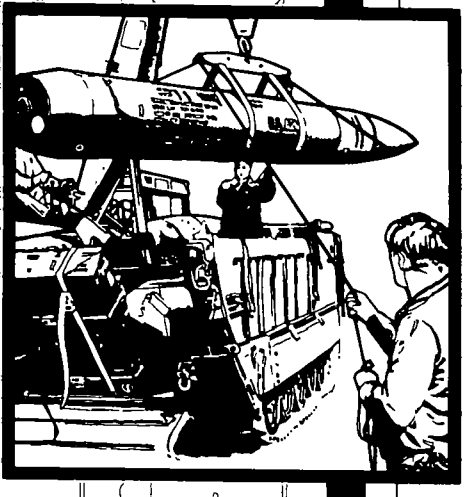
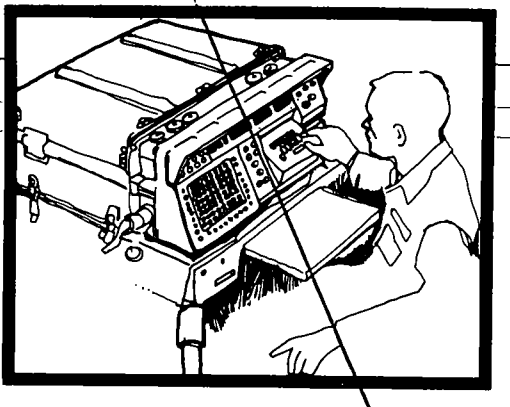
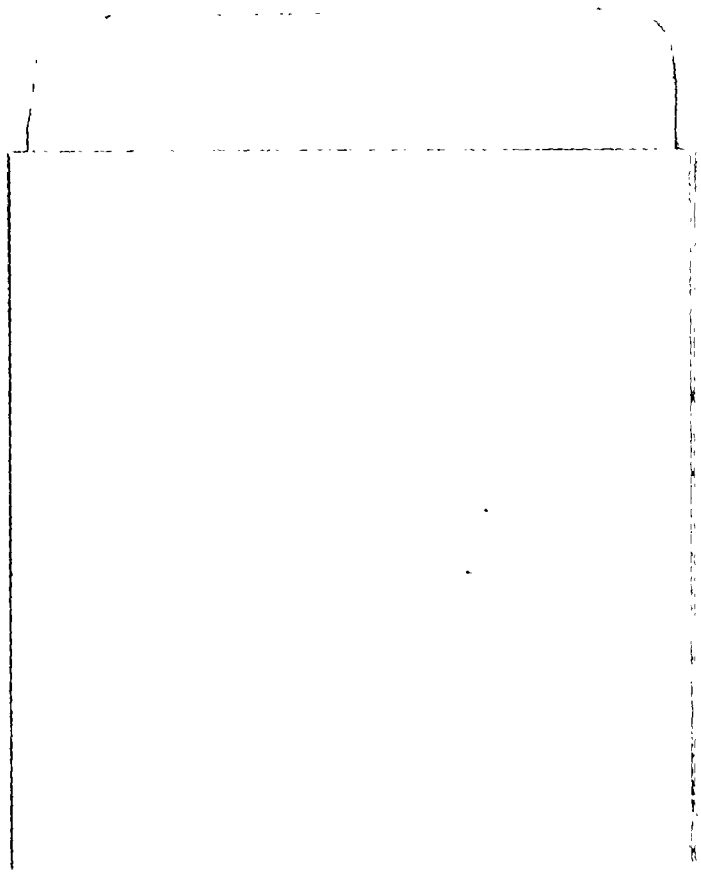
FM 6-40-4

FIELD ARTILLERY LANCE MISSILE GUNNERY





HEADQUARTERS, DEPARTMENT OF THE ARMY



Field Manual
No. 6-40-4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 16 April 1982

FIELD ARTILLERY LANCE MISSILE GUNNERY

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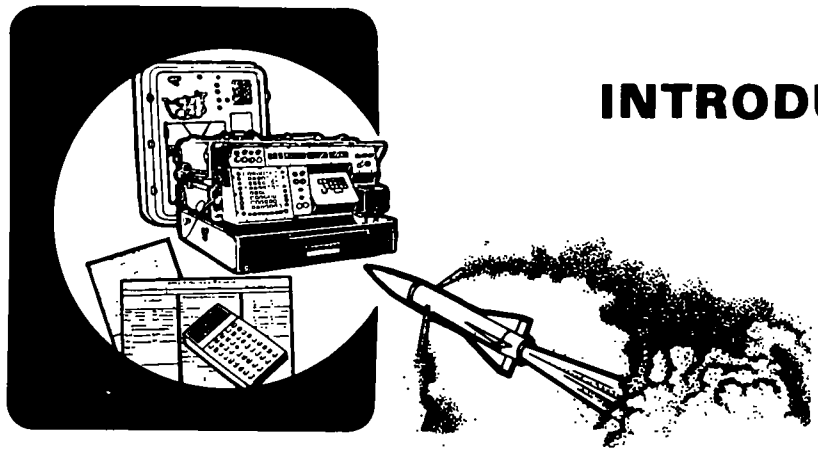

INTRODUCTION

Purpose

This manual presents a practical solution to the field artillery Lance gunnery problem. It is a guide for unit commanders, fire direction center personnel, and members of the corps, group, and battalion staffs.

Scope

This manual includes all aspects of the Lance gunnery problem and applies to units organized under the 06–595H series tables of organization and equipment (TOE). The material concerns both nuclear and nonnuclear warfare and agrees with applicable international standardization agreements. The manual presents fundamentals of ballistics and fire direction, including both manual and computer procedures.

Changes or Corrections

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 in which a change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the

Commandant
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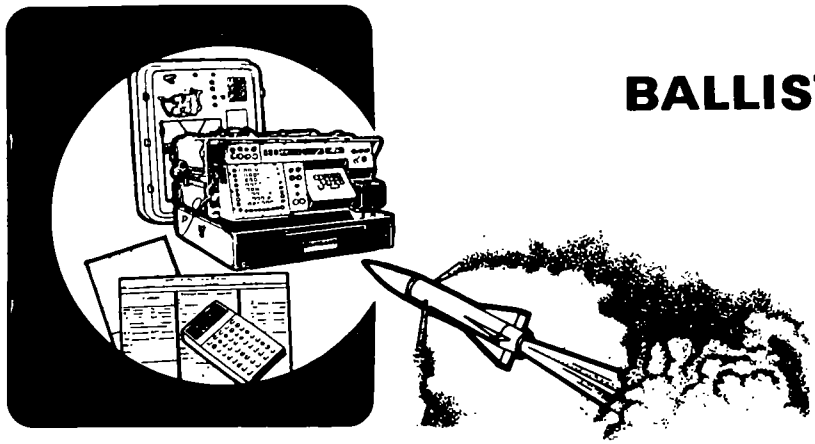
Summary

The primary means of determining firing data for Lance missions is to use the field artillery digital automatic computer/M18 gun direction computer (FADAC) and the associated Lance program tape as discussed in Chapter 3. The secondary means is the computer set, field artillery, missile (or general), and the associated Lance program module discussed in Chapter 4. The manual method of determining firing data is used only when the primary and secondary systems are out of action and there is no other fire direction center (FDC) available to compute the data. The manual solution takes approximately 15 to 20 minutes. Solutions with the computer set, field artillery, missile (or general), take 2 to 5 minutes and with FADAC, take only 2 to 3 minutes. All three methods of determining data provide accurate fire commands for the delivery of designated munitions on selected targets.

Note: *Hand-held calculators should be used as much as possible during manual computation to minimize computation time and reduce errors.*

Unless otherwise noted, where the third person singular is used in this publication, the word "he" will be understood to stand for both masculine and feminine genders.



BALLISTICS

CHAPTER 1

1-1. Trajectory

The Lance trajectory consists of three phases—a boost phase, a sustain phase, and a free-flight phase (Fig 1-1).

a. **Boost phase.** During the boost phase, the missile booster engine and sustainer engine deliver maximum thrust. At the end of the boost phase, boost engine cutoff (BECO), the guidance and control system causes the booster engine to shut down and the electronic timer to operate.

b. **Sustain phase.** During the sustain phase, the guidance and control system senses the effects of the atmosphere on the desired velocity and causes the sustainer engine to offset these effects exactly. At a preset time, the timer shuts off the sustainer engine. This is sustainer engine cutoff (SECO).

c. **Free-flight phase.** During this phase, the missile is subject to the inaccuracies that can be caused by the effects of nonstandard meteorological conditions. The free-flight phase ends with the warhead event.

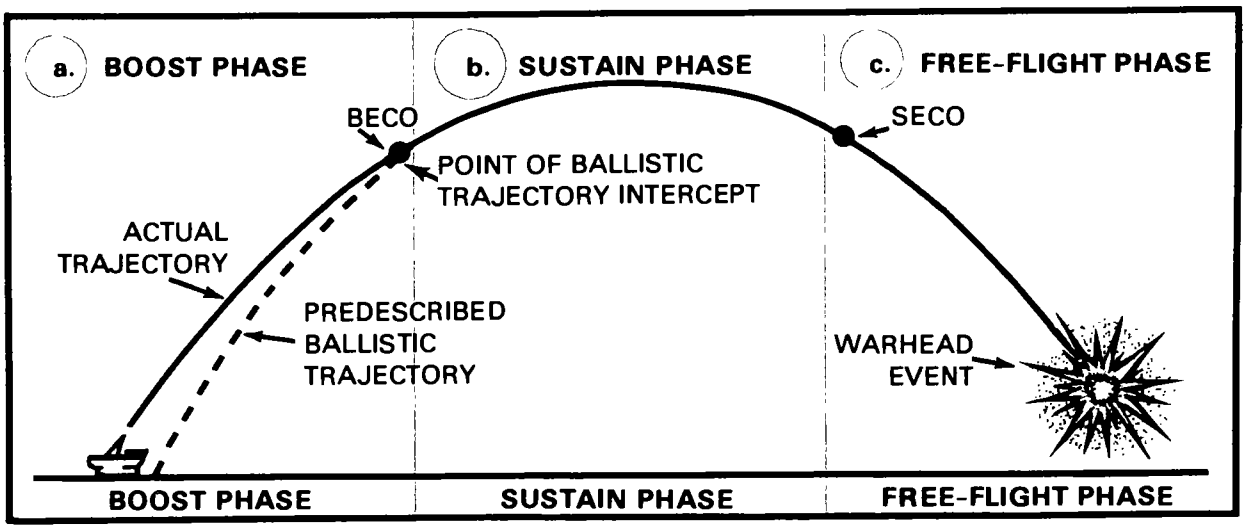


Figure 1-1. Lance trajectory.

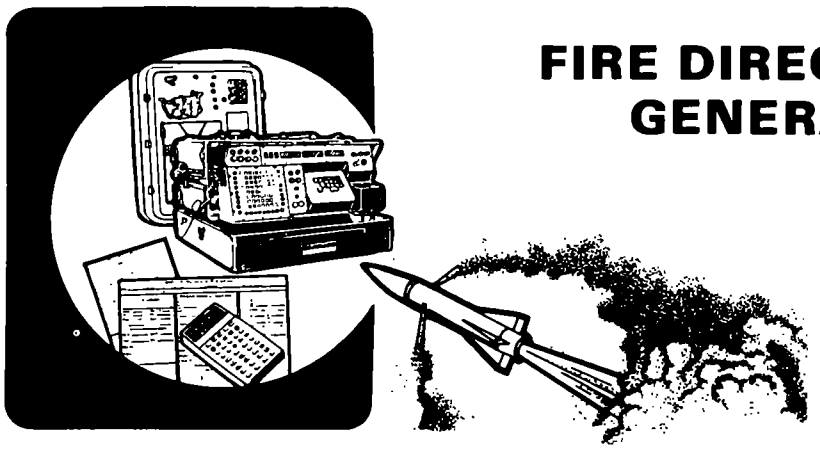
1-2. Warhead Event

a. **M251 high-explosive warhead.** The high-explosive warhead event is initiated by an electronic timer. A second trajectory phase occurs after the warhead event.

b. **M234 nuclear warhead.** This event is initiated by the M1140 fuze. Details are in TM 9-1115-485-12, *Operator and Organizational Maintenance (Prelaunch Procedures): M234, M234E1, M234E2 Atomic Warhead Sections; M240 Training Atomic Warhead Section.*

c. **M252 practice nuclear warhead.** There is no warhead event for the practice nuclear warhead. The flight of the practice nuclear warhead is terminated by the impact of the missile.

d. **Guidance and control system.** The Lance guidance and control system is a directional control and automatic meteorological compensation (DC-Autromet) system in a hermetically sealed unit. The DC system guides the missile during the boost phase to maintain the desired altitude and thereby establish the first portion of the desired trajectory to the target. The Autromet system has two functions: it terminates boost at the proper speed for the desired target range, and it regulates the sustainer engine thrust after boost termination so that the missile will maintain the required trajectory. Before launch, the desired boost phase end speed is preset into the guidance system. During the boost phase, the system accelerometer output is monitored to control the missile velocity and to initiate boost termination at the preset end speed. After boost cutoff, the Autromet system maintains sustainer thrust-equal-to-drag. Thus, the trajectory of the missile closely conforms to the hypothetical trajectory of a missile fired in a vacuum. The Autromet system, in conjunction with the aerodynamic stability of the missile, compensates for prevailing winds that could cause the missile to drift off the desired trajectory.



FIRE DIRECTION, GENERAL

CHAPTER 2

Section I. Fire Direction Organization

The FDCs at battalion and battery levels consist of sufficient gunnery and communications personnel to insure efficient fire direction. Fire direction personnel are responsible for computing the solutions to the gunnery problem and transmitting fire commands.

2-1. Personnel

a. The battalion FDC is composed of the following personnel:

S3
Assistant S3
Fire direction officer
Chief fire direction computer
Assistant chief fire direction computer
Fire direction computers
Recorders
Radiotelephone operators (RATELO)
Command post (CP) drivers

b. The battery FDC is composed of the following personnel:

Fire direction officer
Chief fire direction computer
Assistant chief fire direction computer
Fire direction computers
Recorders
Radiotelephone operators
CP driver

2-2. Duties

Fire direction duties are identical for personnel of battery and battalion FDCs. When FADAC is used, the duties prescribed in Chapter 3 are followed. Personnel are assigned specific duties and perform those duties in a prescribed sequence and manner to eliminate confusion and develop speed and accuracy. In manual computations, the following duties are performed by personnel at battery and battalion FDC:

a. **S3.** The S3 is responsible for the overall supervision and operation of the FDC. His duties include:

(1) Supervising the operation of the FDC and training of personnel.

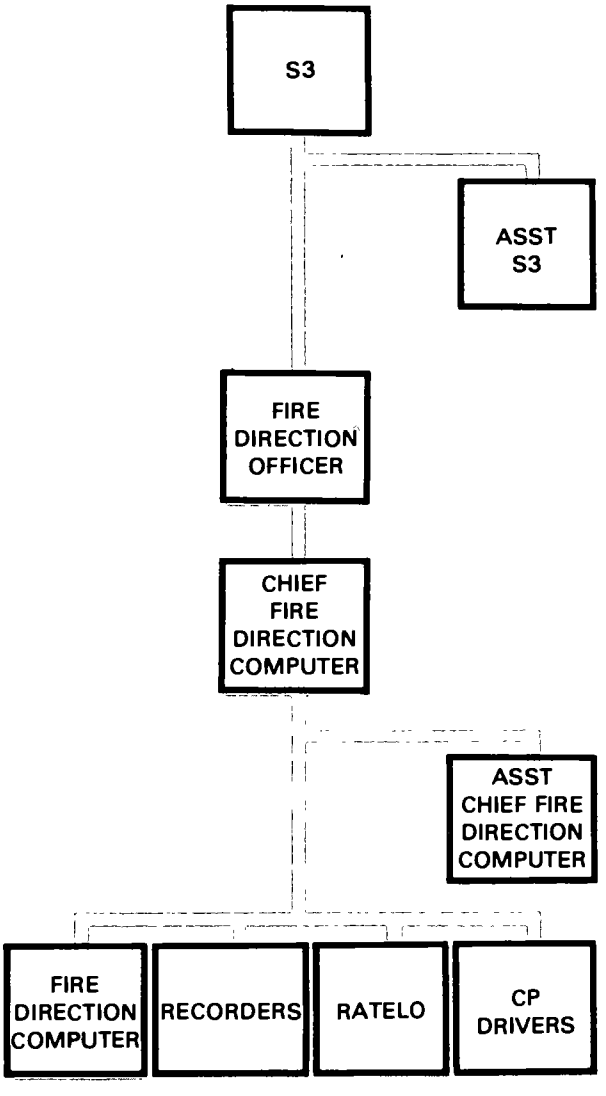
(2) Selecting the battery to fire when not specified by the supported force fire support element (FSE).

(3) Issuing fire orders.

(4) Maintaining a record of the readiness condition and location of weapons and components.

b. **Assistant S3.** In the absence of the S3, the assistant S3 performs the duties listed in *a* above.

c. **Fire direction officer.** In the absence of the S3 and assistant S3, the fire direction officer performs the duties listed in *a* above. He is primarily responsible, however, for the processing of fire missions.



d. **Chief fire direction computer.** The chief fire direction computer supervises the processing of fire missions. His duties include:

(1) Supervising the work of enlisted members of the FDC.

(2) Verifying the computations made by computers.

(3) Assigning duties to enlisted members of the FDC.

(4) Maintaining FDC records and reports.

e. **Assistant chief fire direction computer.** In the absence of the chief fire direction computer, the assistant chief fire direction computer performs the duties listed in *d* above.

f. **Fire direction computers.** The fire direction computers convert calls for fire and fire orders to fire commands for individual launchers. Specific duties of the fire direction computers are to—

(1) Compute azimuth (az), range (rg), sustainer cutoff (SCO) setting, elevation, range factor (RF), fuze setting (FS), orienting angle (OA), time to fire (TTF), and arm time (ARM).

(2) Record on the computer record and data correction sheet the time each mission is fired.

g. **Recorders.** Specific duties of the recorders are to—

(1) Decode classified fire missions and fire commands.

(2) Encode classified fire missions and fire commands.

(3) Plot firing points and targets on a map.

(4) Measure the approximate firing point-to-target azimuth on the map.

h. **Radiotelephone operators.** Specific duties of the radiotelephone operators are to—

(1) Operate FDC communication equipment; e.g., radio, telephone, switchboard.

(2) Record the call for fire, fire order, and warning order.

(3) Receive and transmit target and firing point (FP) information.

(4) Receive, record, and transmit surveillance information.

i. **CP drivers.** CP drivers operate the M577A1 command post carrier. Specific duties of the drivers are to—

(1) Perform operator/crew maintenance on the M577A1 carrier.

(2) Assist organizational maintenance personnel in performing preventive maintenance and scheduled services.

> **Note:** *This duty may be performed in conjunction with other enlisted duties of the FDC.*

Section II. Fire Direction Procedures

Fire direction is the tactical employment of firepower—tactical command of one or more units in the selection of targets, the concentration or distribution of fire, and the allocation of ammunition for each mission. Fire direction also includes the methods and techniques used to convert fire missions into appropriate fire commands. The objectives of fire direction are to insure—

a. Continuous, accurate, and timely fire support under all conditions of weather, visibility, and terrain.

b. Sufficient flexibility so that all types of targets over a wide area can be engaged.

c. Sufficient flexibility for prompt massing of fires of all available units in any area within range.

d. A continuous capability for prompt distribution of fires simultaneously on numerous targets.

Table 2-1. The Call for Fire

Element	Example (Nonnuclear Warhead)
Identification	THIS IS T8D24
Warning	FIRE MISSION
Unit to fire	T8E37
Launcher(s) to fire	ONE LAUNCHER
Firing point number	FIRING POINT NUMBER 1
Target number	TARGET XRAY ZULU 2100
Target grid	14 SIERRA NOVEMBER PAPA 31564 39611
Target altitude	393 METERS
Warhead	M251
Height of burst	(Not given for M251, see para *c* below)
Time on target	TIME ON TARGET 260500
Time on target no later than	TIME ON TARGET NO LATER THAN 260515
Remarks	.....

* 2-3. Call for Fire

a. The fire support element of the higher headquarters exercising tactical control over the fires of the Lance unit will order the mission to be fired. The fire mission will include those elements in Table 2-1.

b. Warheads will be designated in the call for fire by the agency exercising tactical control as follows:

(1) Nuclear—M234A, M234B, or M234C.

(2) Nonnuclear—M251.

(3) Practice—M252.

c. Heights of burst (HOB) are determined as follows:

(1) Nuclear (M234)—The FSE requesting the fire mission will specify the desired HOB as ground (G), air low (L), air low-ground (LG), air high (H), or air high-ground (HG) and will include the HOB in meters.

Note: *Appendix B provides HOB in meters for training purposes only and is not valid for any other use.*

(2) High-explosive (HE) (M251)—HOB is omitted from the call for fire. It is extracted from firing table, rocket (FTR) LANCE addendum (ADD)—A-1 and corrected in the second trajectory calculation.

(3) M252-HOB—Omitted; calculations are based on a zero HOB.

* 2-4. Fire Order

a. **Composition of fire order.** The fire order will consist of some or all of the following elements announced in the sequence indicated:

Element	**Example**
Unit to fire	T8E37
Launcher number	LAUNCHER NUMBER 2
Firing point number	FIRING POINT NUMBER 1
Target number	TARGET XRAY ZULU 2100

b. **Selection of launcher to fire and firing point.** Selection of the launcher(s) to

fire and the firing point(s) is based on the following considerations if not specified by the agency exercising tactical control:

- State of readiness.
- Time available.
- Location of launchers and firing points.
- Previous commitments.
- Availability of ammunition.

*2-5. Sequence of Fire Commands

Fire commands originate in the FDC and include all information necessary for positioning, laying, and firing the missile. Firing data are normally sent to the firing platoon in two phases—the warning order and fire commands:

a. **Warning order.** The first phase, the warning order to the firing platoon, includes the following elements:

Element	Example
Launcher number	LAUNCHER NUMBER 2
Firing point number	FIRING POINT NUMBER 1
Target number	TARGET XRAY ZULU 2100
Warhead	M251
Time on target	TIME ON TARGET 300500
Target azimuth (nearest 10 mils)	TARGET AZIMUTH 5050

b. **Fire commands.** The second phase, fire commands, includes the following elements:

Element	Example
Sustainer cutoff/ arm time	SUSTAINER CUTOFF CHARLIE, ARM TIME 40
Elevation	ELEVATION 853.3
Range factor	RANGE FACTOR 2066
Orienting angle	ORIENTING ANGLE 2613.32
Fuze setting	FUZE SETTING 50.0
Time to fire	TIME TO FIRE 300449.07

Note: *Arm time applies to the M251 warhead only.*

2-6. Lance Firing Tables

a. Lance firing tables consist of various tables and data for computation of fire commands. The introduction to each firing table and the addendum include an explanation of information contained in that publication and an example of the applicable solution to the gunnery problem. The firing tables and addendum used with this field manual are:

FTR LANCE-B-1, M251 warhead.
FTR LANCE ADD-A-1, M251 warhead.
FTR LANCE-A-1, M234 and M252 warheads.

b. Table 2-2 is a guide for determining the expression of entry arguments.

2-7. Computing Firing Data

a. The computation of firing data for a Lance missile includes determining an accurate orienting angle, fuze setting, range factor, and time of flight. In addition, SCO setting and elevation must be determined from the firing tables. No corrections are made for nonstandard materiel or meteorological conditions, since these corrections are made by the missile's guidance and control system.

b. The subsequent sample missions illustrate the detailed procedures for computing firing data. Computations are based on the locations of the launcher and the selected target. The bearing angle and the resultant launcher-target azimuth, the range to target, and the height of burst with respect to the launcher are computed first. Then the SCO setting and elevation are obtained from the firing tables. For the M251 a corrected range to burst and a corrected height relative to launcher are computed. Corrections to compensate for rotation of the earth, gravity vector variation, and drift are then computed and applied to initial data to determine the range factor, corrected time parameter, and firing azimuth. A correction is applied to the corrected time parameter to determine the fuze setting. The firing azimuth is used in

Table 2-2. Determining Expression of Entry Arguments

Argument	Entry Value	Examples
Average easting	10,000 meters	795,000 through 804,999 meters = 800,000 meters
Launcher-target azimuth	20 mils	1,230.00 through 1,249.99 mils = 1,240 mils
Latitude	1°	34° 30' 00" through 35° 29' 59" = 35°
Range	1,000 meters	36,500 through 37,499 meters = 37,000 meters
Launcher altitude	500 meters (Table A only)	499 meters and lower = 0 meters 500 meters and higher = 1,000 meters
	1,000 meters	1,250 through 1,749 meters = 1,500 meters
Height of target (burst) relative to launcher	500 meters	750 through 1,249 meters = 1,000 meters
Corrected range factor	50 units	2,125.00 through 2,174.99 units = 2,150 units

When the entry argument is exactly halfway between two listed entry values, the higher value will be used as the entry value.

conjunction with az of orienting line (OL) to compute the orienting angle. The time of flight and a time to fire are also computed for a time-on-target mission.

c. For a tactical mission (M234), the computer's record is classified CONFIDENTIAL FORMERLY RESTRICTED DATA (CFRD) except when an impact (0) HOB is required. It is then unclassified.

> **Note:** *Other information on the computer's record may have a higher classification.*

d. For a tactical nonnuclear mission (M251), the computer's record is unclassified.

e. A practice nuclear mission (M252) is unclassified.

Section III. Illustrative Problems Using Computer's Record

2-8. Preliminary Data

a. A call for fire with warhead and HOB entries omitted has been received in the FDC and entries are made on DA Form 4603, Computer's Record and Data Correction Sheet (Lance). This form will be known as the computer's record in subsequent discussion, and portions of it are illustrated beginning with Figure 2-1.

b. The following data are known:
Survey grid of FP 12: 455976-3832923
Altitude of FP 12: 254 meters
Latitude of FP 12: 34° 15′ 00″ N
Azimuth of OL: 0015.36 mils

COMPLETED COMPUTER'S RECORD IS SHOWN ON PAGE 2-13 FOLDOUT

COMPUTER'S REC

UNIT	Lchr Lat	Time and Date
A-1-16	34 (N) S	

CALL FOR FIRE

J3F7Ø FM

Unit to Fire 1-16 Lchr(s) to Fire 1

FP No 12 Tgt No XZ176Ø

Tgt Grid 14SNP10655 35275

Tgt Alt 217 m Whd M234B

HOB L TOT 191ØØ

TOT NLT 191415

Remarks

COM
Tgt Grid
Lchr Grid
Log dE
Log dN
Log Tar Bearing
Bearing
dE/2
Smaller
Averag

Figure 2-1. Call for fire.

FIRE ORDER

Unit to Fire A-1-16 Lchr No 2

FP No 12 Tgt No XZ1760

Log dE
Log Sin
Log Rg
Log Sca

Figure 2-2. Fire order.

WARNING ORDER

Lchr No 2 FP No 12

Tgt No XZ1760 Whd M234

HOB 2 TOT 191400

Tgt Az 1560 (10m)

Log Co
Range
Log dN
Log Cos
Log Rg
Log Sca
Log Co
Range

Figure 2-3. Warning order.

COMPUTATION OF RANGE AND BEARING		
Tgt Grid	510655	3835275
Lchr Grid	455976	3832923
	dE ⊕ − 54679	dN ⊕ − 2352
	BEARING	

Figure 2-4. Computation of dE and dN.

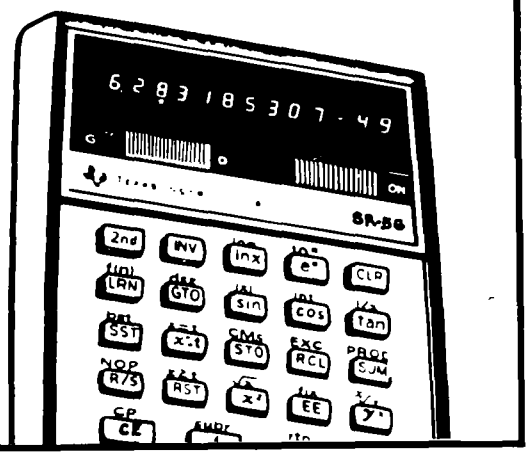
	dE ⊕ − 54679	dN ⊕ − 2352
	BEARING	
Log dE	4.737 8206	
Log dN −	3.371 4373	
Log Tan Bearing =	1.366 3833	
Bearing (0.01m)	1556.21 m	
AVERAGE EASTING		

Figure 2-5. Computation of bearing.

c. The fire order has been issued and recorded on the computer's record (Fig 2-2).

d. A warning order based on the information given in the call for fire and the fire order has been sent to the firing platoon and recorded on the computer's record. The target and the firing point were plotted on a map, and the azimuth from the firing point to the target was measured and reported (to the nearest 10 mils) in the warning order (Fig 2-3).

Note: *To insure accuracy, FADAC or a hand-held calculator may be used to obtain the azimuth.*



e. The first step in determining the missile and warhead presettings is to convert the military grid of the target to universal transverse mercator (UTM) by use of a map. The UTM grid of the target is 510655-3835275. Calculate and record the difference between the target and launcher eastings (dE) and the difference between the target and launcher northings (dN) (Fig 2-4).

f. To compute the bearing angle, first subtract the log of the difference in northing from the log of the difference in easting to determine the log of the tangent of the bearing angle. Then determine the antilog from TM 6-231, *Seven Place Logarithmic Tables*, and record the bearing angle (to the nearest 0.01 mil) on the computer's record (Fig 2-5).

g. Then determine the launcher-target azimuth. Since both the easting and northing are plus (+), the bearing is in the first quadrant. Draw an arrow in the first quadrant of the diagram in the upper right corner of the computer's record. Record the bearing and add 0 to obtain the launcher-target azimuth. Record the azimuth to the nearest 0.01 mil (Fig 2-6).

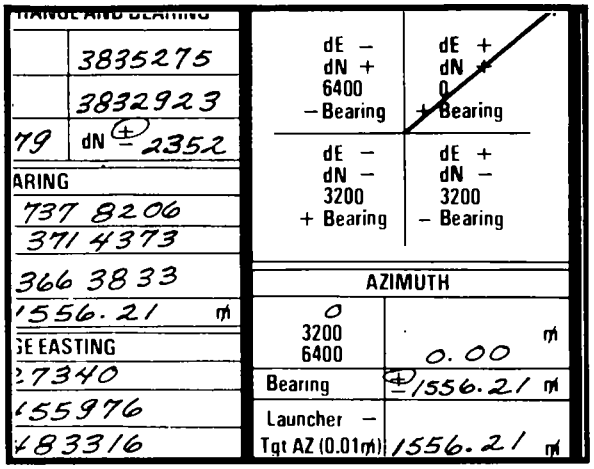


Figure 2-6. Computation of launcher-target azimuth.

h. Determine the average easting by adding the target easting or the launcher easting (whichever is smaller) to half of the dE determined in *e* above. In this case, the value of the launcher easting (455976) is the smaller value; therefore, add the launcher easting to half of the dE (27340) to determine the average easting. Use the average easting expressed to the nearest 10,000 meters for entering the table of scale factors (Fig 2-7(1) and (2)).

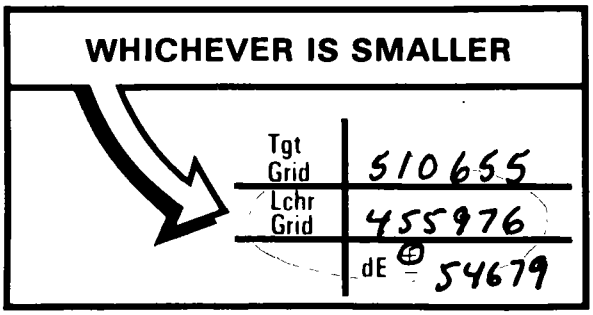


Figure 2-7(1). Determining the smaller easting.

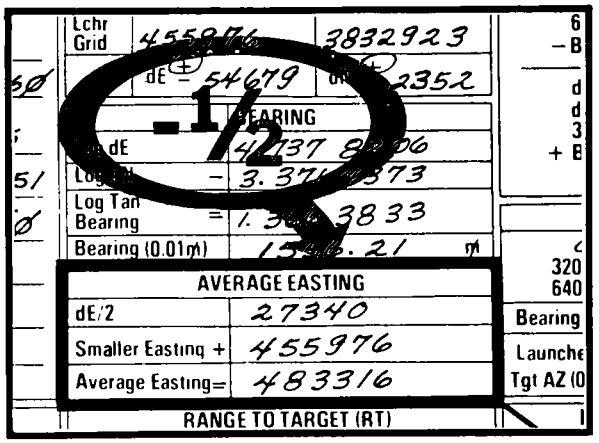


Figure 2-7(2). Computation of average easting.

i. To determine the range to target, subtract the log sine of the bearing angle from the log of the dE if the dE is greater than the dN, or subtract the log cosine of the bearing angle from the log of the dN if the dN is greater than the dE. In this case, the dE is greater than the dN; therefore, subtract the log sine of the bearing angle from the log of dE to determine the logarithm of the range. Obtain the log scale factor from the table of scale factors in the firing table by using the average easting computed in *h* above (to the nearest 10,000 meters). Subtract the log scale factor from the log range to convert the map distance to ground distance. The antilog of the corrected log range is the range to target to the nearest meter (Fig 2-8).

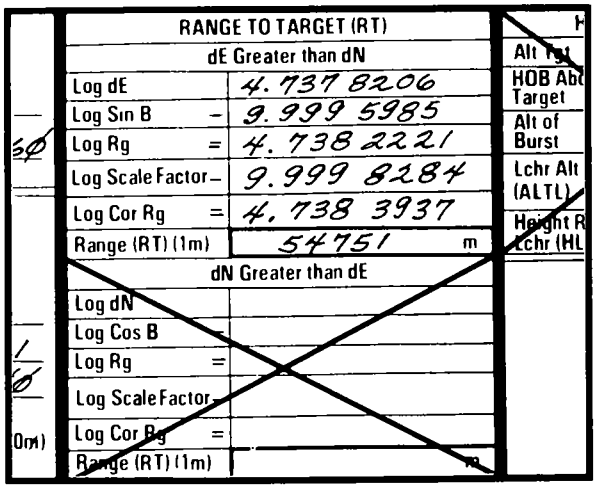


Figure 2-8. Computation of range to target.

j. Determine the firing data for this target for each of the three Lance warhead sections (para 2-9 through 2-11).

2-9. Nuclear Mission, M234 Warhead

a. The fire request specifies an M234B warhead and an HOB of air low (L). Obtain the corresponding HOB in meters from Appendix B and compute height relative to launcher as shown (Fig 2-9).

b. On the reverse side of the computer's record, enter the range to target, height relative to launcher, and launcher altitude in the appropriate spaces at the top of the form. Then record each of these values expressed to the proper firing table entry argument. Determine the differences between the expressed values and the actual values of range, height, and altitude. Divide each of the differences by 100 (i.e., move the decimal point two spaces to the left). Enter the results with appropriate signs in spaces ①, ②, and ③ (Fig 2-10).

c. Record the launcher-target azimuth to the nearest 20 mils and the firing point latitude to the nearest degree in the spaces provided. Using these data, enter part 1 of the firing tables and extract corrections to range factor and time parameter (TP) to compensate for rotation of the earth from Table 1 of Selected Trigonometric Functions (Cos 2 L, Cos L Sin Az). Enter these corrections in spaces ④ and ⑤. Using the same entry arguments, extract from Table 2 of Selected Trigonometric Functions (Sin L, Cos L Cos Az), corrections to azimuth to compensate for rotation of the earth. Enter these corrections in spaces ⑥ and ⑦ (Fig 2-11).

ng=	483316	Launcher – Tgt AZ (0.01π)	1556.21 π
RANGE TO TARGET (RT)		HEIGHT REL TO LCHR	
dE Greater than dN		Alt Tgt	217 m
	4.737 8206	HOB Above Target +	232 m
–	9.999 5985	Alt of Burst =	449 m
=	4.738 2221	Lchr Alt (ALTL) –	254 m
or –	9.999 8284	Height Rel to Lchr (HL)(1m)	± 195 m
=	4.738 3937		
m)	54751 m		

Figure 2-9. Determining height relative to launcher.

Range (RB or RT)	54751 m	Height Rel to Lchr (HL)	± 195 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) –	55000 m	Firing Table Entry HL (500m) –	0 m	Firing Table Entry ALTL (500m) –	500
① Δ Range/100	± 2.49	② Δ HL/100	± 1.95	③ Δ ALTL/100	± 2.46

Figure 2-10. Computation of values for spaces ①, ②, and ③.

Firing Table Entry Range (1000m) –	55000 m	Firing Table Entry HL (500m) –	0 m	Firing Table Entry ALTL (500m) –	500 a
① Δ Range/100	± 2.49	② Δ HL/100	± 1.95	③ Δ ALTL/100	± 2.46
Lchr-Tgt AZ (20π)	1560 π	④ Cos 2L	± 0.37	⑥ Sin L	± 0.56
Lat of Lchr (1°)	34 N/S	⑤ Cos L SIN Az	± 0.83	⑦ Cos L Cos Az	± 0.03
TRIAL RANGE FACTOR (Cos L 2)	3775.15	TRIAL TIME PARAMETER (Cos L)		116.43	sec

Figure 2-11. Determination of values for spaces ④, ⑤, ⑥, and ⑦.

d. With range to target (RT) and launcher altitude, enter part 2 of Table B and extract the appropriate elevation and SCO setting and pages to enter Table C. Record the SCO and elevation in the spaces of the FIRE COMMANDS block in the lower right corner of the computer's record. (See Figure 2-15.)

e. Extract the required data from Table C of FTR LANCE-A-1 and compute the range factor, fuze setting, and firing azimuth as described below:

(1) Using the page numbers obtained in Table B, enter Table C with the range to the nearest 1,000 meters, launcher altitude to the nearest 500 meters, and height relative to launcher to the nearest 500 meters. Extract a trial range factor from column 2 and interpolation factors from columns 3, 4, and 5. Enter these values in the appropriate spaces in the TRIAL RANGE FACTOR block of the computer's record (Fig 2-12). Extract a trial time parameter from column 6 and interpolation factors from columns 7, 8, and 9. Enter these values in the appropriate spaces in the TRIAL TIME PARAMETER block (Fig 2-12). Extract the correction coefficients for range factor from columns 10(A1) and 11(A2), and enter these values in the appropriate spaces in the TRIAL RANGE FACTOR block. Extract the correction coefficients for time parameter from columns 12(B1) and 13(B2) and enter these values in the appropriate spaces in the TRIAL TIME PARAMETER block. Extract the correction coefficients for azimuth from columns 14(C1), 15(C2), and 16(C3), and enter these values in the appropriate spaces in the FIRING AZIMUTH block (Fig 2-12). Correction coefficients A1 and B1 compensate for gravity vector variation. Correction coefficients A2, B2, C2, and C3 compensate for rotation of the earth. Correction coefficient C1 compensates for drift.

(2) In the appropriate spaces in the TRIAL RANGE FACTOR, TRIAL TIME PARAMETER, and FIRING AZIMUTH blocks, enter the values determined in *b* and *c* above and recorded in spaces ①, ②, ③, ④, ⑤, ⑥, and ⑦. Record the Launcher-Tgt Azimuth in the FIRING AZIMUTH block and perform the indicated algebraic computations to determine the Range Factor (Nearest Whole No), Corrected TP, and Firing Azimuth (0.01m) (Fig 2-12).

(3) Obtain the time parameter correction from Table D. Enter the correction in the TP Correction space of the TRIAL TIME PARAMETER block and determine the Fuze Setting. Note that the fuze setting for a nuclear warhead mission is computed to the nearest hundredth of a second but is expressed to the nearest whole second (Fig 2-12).

Range (RB or RT)	54751 m	Height Rel to Lchr (HL)	⊕⊖ 195 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) −	55000 m	Firing Table Entry HL (500m) −	0 m	Firing Table Entry ALTL (500m) −	500
① Δ Range/100	⊕⊖ 2.49	② Δ HL/100	⊕⊖ 1.95	③ Δ ALTL/100	⊕⊖ 2.46
Lchr-Tgt AZ (20m)	1560 m	④ Cos 2L	⊕⊖ 0.37	⑥ Sin L	⊕⊖ 0.56
Lat of Lchr (1°)	34 N/S	⑤ Cos L SIN Az	⊕⊖ 0.83	⑦ Cos L Cos Az	⊕⊖ 0.03

TRIAL RANGE FACTOR (Col 2)		3775.15 +	3775.15 −
⊕⊖ 3.58 Col 3 × ① ⊕⊖ 2.49			8.914
⊕⊖ 2.47 Col 4 × ② ⊕⊖ 1.95		4.816	
⊕⊖ 0.86 Col 5 × ③ ⊕⊖ 2.46		2.116	
(A1) ⊕⊖ 5.09 × ④ ⊕⊖ 0.37		1.883	
(A2) ⊕⊖ 7.59 × ⑤ ⊕⊖ 0.83			6.300
3775.15 − 6.40 = 3768.75		8.815	15.214
			8.815
			6.399
Corrected RF	=	3768.75	
Range Factor (Nearest Whole No)	=	3769	

TRIAL TIME PARAMETER (Col 6)		116.43 +	116.43 − sec
⊕⊖ 0.12 Col 7 × ① ⊕⊖ 2.49			0.299
⊕⊖ 0.20 Col 8 × ② ⊕⊖ 1.95			0.390
⊕⊖ 0.13 Col 9 × ③ ⊕⊖ 2.46		0.320	
(B1) ⊕⊖ 0.18 × ④ ⊕⊖ 0.37		0.067	
(B2) ⊕⊖ 0.68 × ⑤ ⊕⊖ 0.83		0.564	
116.43 + 0.26 = 116.69		0.951	0.689
		0.689	
		0.262	
Corrected TP	=	116.69	sec
TP Correction		⊕⊖ 12.00	sec
Fuze Setting (NUC 1.0 sec) ~~(HE 0.1 sec)~~	=	104.69 = 105.0	sec

FIRING AZIMUTH		1556.21 m +	1556.21 m −
Launcher-Tgt Azimuth			
(C1) 5.375		5.375	
(C2) ⊕⊖ 8.27 × ⑥ ⊕⊖ 0.56			4.631
(C3) ⊕⊖ 3.08 × ⑦ ⊕⊖ 0.03		0.092	
1556.21 + 0.84 = 1557.05		5.467	4.631
		4.631	
		0.836	
Firing Azimuth (0.01m)	=	1557.05 m	

TIME OF FLIGHT COMPUTATIONS	
Corrected RF (50 UNITS)	3750
Time to Boost Cut Off	3.88 sec
Corrected TP +	116.69 sec
Time of Flight (1.0 sec) 120.57 =	121 sec
Time on Target 191400	191359.60
Time of Flight (min & sec) −	2:01
Time to Fire (1.0 sec) =	191357.59

ORIENTING ANGLE		
Az of OL (0.01m)		0015.36 m
6400 (il nec)	+	6400.00 m
Sum	=	6415.36 m
Firing Azimuth (0.01m)	−	1557.05 m
Orienting Angle (0.01m)	=	4858.31 m

FIRE COMMANDS	
SCO/(ARM TIME HE ONLY)	T
Elevation	853.3
Range Factor	3769
Orienting Angle	4858.31
Fuze Setting	105.0
Time to Fire	191357:59

Figure 2-12. Computation of range factor, fuze setting, and firing azimuth.

		1557.05	0.836
Firing Azimuth (0.01mil)	=	1557.05	mil
ORIENTING ANGLE			
Az of OL (0.01mil)		0015.36	mil
6400 (if nec)	+	6400.00	mil
Sum	=	6415.36	mil
Firing Azimuth (0.01mil)	–	1557.05	mil
Orienting Angle (0.01mil)	=	4858.31	mil

Figure 2-13. Computation of the orienting angle.

TP Correction		± 12.00	sec
Fuze Setting (NUC 1.0 sec) ~~(HE 0.1 sec)~~ 104.69	=	105.0	sec
TIME OF FLIGHT COMPUTATIONS			
Corrected RF (50 UNITS)		3750	
Time to Boost Cut Off		3.88	sec
Corrected TP	+	116.69	sec
Time of Flight (1.0 sec) 120.5T	=	121	sec
Time on Target 191400		191359.60	
Time of Flight (min & sec)	–	2:01	
Time to Fire (1.0 sec)	=	191357:59	
FIRE COMANDS			

Figure 2-14. Time-of-flight computations.

Time of Flight (1.0 sec) 120.5T		121	sec
Time on Target 191400		191359.60	
Time of Flight (min & sec)	–	2:01	
Time to Fire (1.0 sec)	=	191357:59	
FIRE COMANDS			
SCO/(ARM TIME HE ONLY)		T	
Elevation		853.3	
Range Factor		3769	
Orienting Angle		4858.31	
Fuze Setting		105.0	
Time to Fire		191357:59	

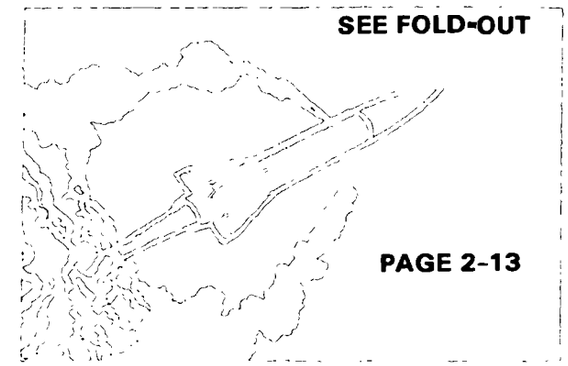
Figure 2-15. Fire commands.

f. Convert the firing azimuth to an orienting angle to a hundredth of a mil (0.01) by subtracting the firing azimuth from the az of the OL. If necessary, add 6,400 mils to the az of the OL before subtracting the firing azimuth (Fig 2-13).

g. Because a time on target has been ordered, the time to fire must be calculated. Enter Table E with the corrected range factor to the nearest 50 units to determine the time to boost cutoff. Time to boost cutoff plus the corrected time parameter equals the time of flight. Subtract the time of flight from the time on target to obtain the time to fire (Fig 2-14).

h. Enter in the FIRE COMMANDS block all fire commands not previously recorded. Send all commands to the firing platoon (Fig 2-15).

i. The completed computer's record for the nuclear mission is shown in Figure 2-16(1) and (2).



2-10. Nonnuclear Mission, M251 Warhead

a. Following the same situation given in paragraph 2-8, firing data will be determined for an M251 warhead mission.

b. The computation of range (RT) and launcher-target azimuth are the same as procedures outlined in paragraphs 2-8*e* through 2-8*i*.

COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

UNIT	Lchr Lat	Time and Date Fired	Target Number	Missile Serial Number
A-1-16	34 (N) S		XZ 176	

CALL FOR FIRE

J3F 70 FM

Unit to Fire 1-16 Lchr(s) to Fire 1

FP No 12 Tgt No XZ1760

Tgt Grid 14SNP10655 35275

Tgt Alt 217 m Whd M2348

HOB 2 TOT 191400

TOT NLT 191415

Remarks

COMPUTATION OF RANGE AND BEARING

Tgt Grid	510655	3835275
Lchr Grid	455976	3832923
	dE +54679	dN +2352

	BEARING
Log dE	4.737 8206
Log dN −	3.371 4373
Log Tan Bearing =	1.366 3833
Bearing (0 01m)	1556.21 m

AVERAGE EASTING	
dE/2	27340
Smaller Easting +	455976
Average Easting=	483316

dE − dN + 6400 − Bearing | dE + dN + 0 + Bearing

dE − dN − 3200 + Bearing | dE + dN − 3200 − Bearing

AZIMUTH

0 3200 6400	0.00 m
Bearing	+1556.21 m
Launcher − Tgt AZ (0.01m)	1556.21 m

FIRE ORDER

Unit to Fire A-1-16 Lchr No 2

FP No 12 Tgt No XZ1760

RANGE TO TARGET (RT)

dE Greater than dN

Log dE	4.737 8206
Log Sin B −	9.999 5985
Log Rg =	4.738 2221
Log Scale Factor −	9.999 8284
Log Cor Rg =	4.738 3937
Range (RT) (1m)	54751 m

dN Greater than dE

Log dN	
Log Cos B	
Log Rg =	
Log Scale Factor	
Log Cor Rg =	
Range (RT) (1m)	m

HEIGHT REL TO LCHR

Alt Tgt	217 m
HOB Above Target +	232 m
Alt of Burst =	449 m
Lchr Alt (ALTL) −	254 m
Height Rel to Lchr (HL)(1m)	+195 m

WARNING ORDER

Lchr No 2 FP No 12

Tgt No XZ1760 Whd M234

HOB 2 TOT 191400

Tgt AZ 1560 (10m)

SECOND TRAJECTORY COMPUTATIONS

Range (RT)	m	Trial RB (Col 2)	m			Trial HBL (Col 6)	m		
FTR Entry Range (1,000m) −	m					+ 100 × ΔHTL/100			
ΔRT/100	m	Col 3 × ΔRT 100							
Alt Tgt (ALTT)	m	Col 4 × ΔHTL 100				Total HBL Corr			
Lchr Alt (ALTL) −	m	Col 5 × ΔALTL 100				Corrected HL (1m) =	m		
Ht of Tgt Rel Lchr (HTL)	m								
HT of Tgt REL Lchr (500m) −	m								
ΔHTL/100									
ALTL/100	m	Total RB Corr							
		Corrected RB (1m) −	m						

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Figure 2-16(1). Computer's record for a nuclear mission—front side.

Range (RB or RT)	54751 m	Height Rel to Lchr (HL)	+195 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) −	55000 m	Firing Table Entry HL (500m) −	0 m	Firing Table Entry ALTL (500m) −	500
(1) Δ Range/100	±2.49	(2) Δ HL/100	+1.95	(3) Δ ALTL/100	+2.46
Lchr-Tgt AZ (20m)	1560 m	(4) Cos 2L	+0.37	(6) Sin L	+0.56
Lat of Lchr (1°)	34 (N) S	(5) Cos L SIN Az	+0.83	(7) Cos L Cos Az	+0.03

TRIAL RANGE FACTOR (Col 2)	+	−	TRIAL TIME PARAMETER (Col 6)	+	−
	3775.15			116.43 sec	
+3.58 (Col 3) × (1) ±2.49		8.914	+0.12 (Col 7) × (1) ±2.49		0.299
+2.47 (Col 4) × (2) +1.95	4.816		+0.20 (Col 8) × (2) +1.95		0.390
±0.86 (Col 5) × (3) ±2.46	2.116		±0.13 (Col 9) × (3) ±2.46	0.320	
(A1) +5.09 × (4) +0.37	1.883		(B1) +0.18 × (4) +0.37	0.067	
(A2) ±7.59 × (5) +0.83		6.300	(B2) +0.68 × (5) +0.83	0.564	
3775.15 −6.40	8.815	15.214	116.43 +0.26	0.951	0.689
		8.815		0.689	
3768.75		6.399	116.69	0.262	
Corrected RF =	3768.75		Corrected TP =	116.69 sec	
			TP Correction	±12.00 sec	
Range Factor (Nearest Whole No) =	3769		Fuze Setting (NUC 1.0 sec) (HE 0.1 sec) 104.69 =	105.0 sec	

FIRING AZIMUTH			TIME OF FLIGHT COMPUTATIONS	
Launcher-Tgt Azimuth	1556.21 m		Corrected RF (50 UNITS)	3750
(C1) 5.375	5.375		Time to Boost Cut Off	3.88 sec
(C2) ±8.27 × (6) +0.56		4.631	Corrected TP +	116.69 sec
(C3) +3.08 × (1) +0.03	0.092		Time of Flight (1.0 sec) 120.5T	121 sec
1556.21 +0.84	5.467	4.631	Time on Target 191400	191359.60
1557.05	4.631		Time of Flight (min & sec) −	2:01
	0.836			
Firing Azimuth (0.01m) =	1557.05 m		Time to Fire (1.0 sec) =	191357:59

ORIENTING ANGLE		FIRE COMANDS	
Az of OL (0 01m)	0015 36 m	SCO/(ARM TIME HE ONLY)	T
6400 (if nec) +	6400.00 m	Elevation	853.3
Sum =	6415.36 m	Range Factor	3769
Firing Azimuth (0.01m) −	1557.05 m	Orienting Angle	4858.31
Orienting Angle (0.01m) =	4858.31 m	Fuze Setting	105.0
		Time to Fire	191357:59

Figure 2-16(2). Computer's record for a nuclear mission—reverse side.

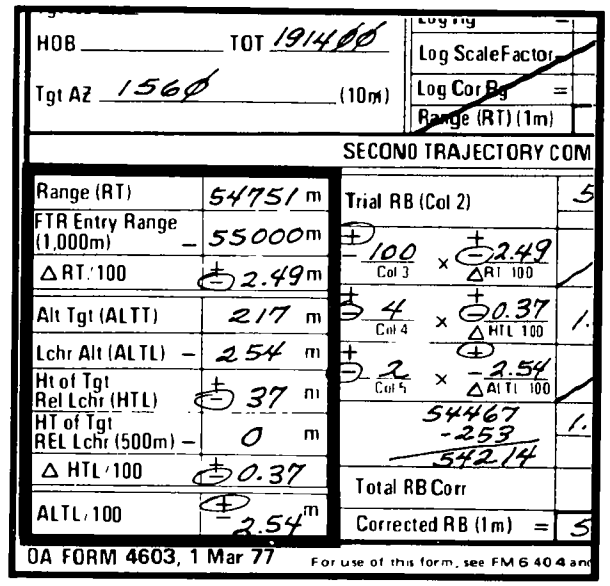


Figure 2-17. Computation of Δ RT/100, Δ HTL/100, and ALTL/100.

Note: *Make sure range (RB) and height relative to launcher (HL) are transferred from the second trajectory block to the back of the form.*

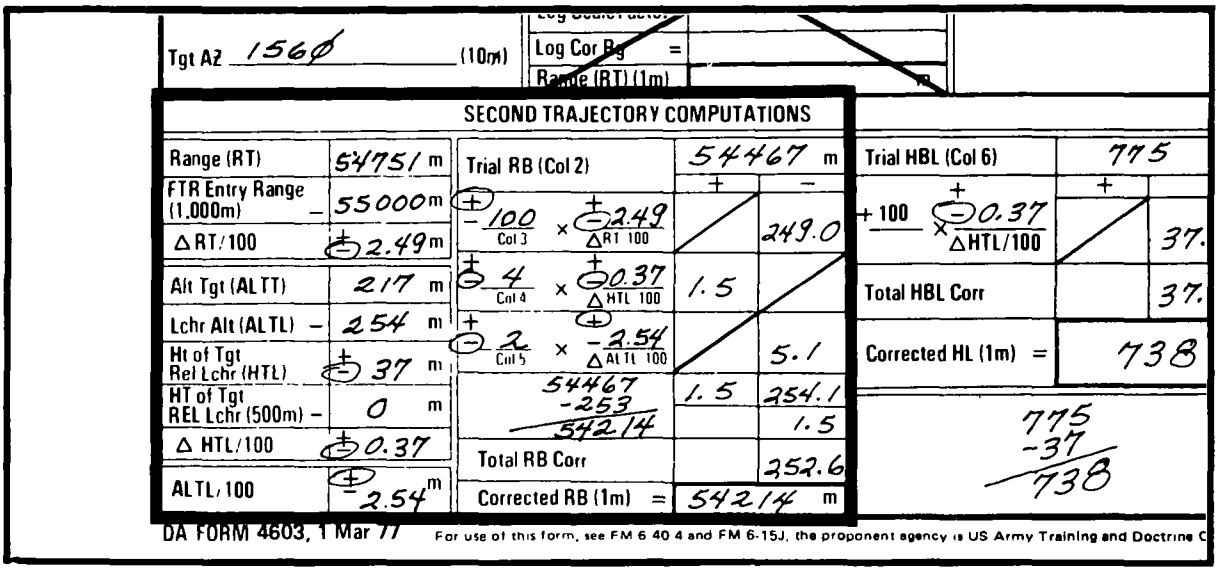
c. Since a high explosive mission requires second trajectory computations, the last step in completing the front of the computer's record is to determine the corrected range to burst and corrected height relative to launcher by completing the computations indicated in the SECOND TRAJECTORY COMPUTATIONS block. Use FTR LANCE ADD-A-1 in performing the second trajectory computations in this problem.

(1) Determine and record the differences between the actual values and the firing table addendum entry values for the range to target and height of target relative to launcher (HTL). Divide launcher altitude (ALTL) by 100 (Fig 2-17).

(2) With the launcher-target range and the launcher altitude, enter Table B of FTR LANCE ADD-A-1 and extract the appropriate elevation, SCO setting, and pages to enter Table C of FTR LANCE ADD-A-1 and FTR LANCE B-1. Enter SCO and Elevation in the spaces of the FIRE COMMANDS block. (See Figure 2-25.)

(3) Enter Table C of the firing table addendum with the entry range (55000) and the entry height relative to launcher (0). Obtain the trial range to burst (Trial RB (Col 2)), the corrections for the differences between actual values and entry values (Cols 3, 4, 5), and the trial height of burst relative to launcher (Trial HBL (Col 6)). Enter these values in the appropriate spaces on the computer's record. Multiply Columns 3, 4, and 5 by the corresponding values of Δ RT/100, Δ HTL/100, and ALTL/100, and algebraically add the resulting products to determine the total correction to the trial RB. Algebraically add the total correction to the trial RB to determine the corrected RB.

(4) Multiply Δ HTL/100 by 100 and algebraically add to the trial HOB relative to launcher to determine the corrected HBL. This will complete the computations on the front of the computer's record. FTR LANCE ADD-A-1 will not be required for the computations on the reverse side of the computer's record (Fig 2-18).



Tgt AZ 1560 (10m) | Log Cor Rg = | Range (RT) (1m) m

SECOND TRAJECTORY COMPUTATIONS

Range (RT)	54751 m	Trial RB (Col 2)	54467 m		Trial HBL (Col 6)	775
FTR Entry Range (1,000m) −	55000 m		+	−		+
ΔRT/100	±2.49 m	±100/Col 3 × ±2.49/ΔRT 100		249.0	+100 × −0.37/ΔHTL/100	37.
Alt Tgt (ALTT)	217 m	±4/Col 4 × −0.37/ΔHTL 100	1.5		Total HBL Corr	37.
Lchr Alt (ALTL) −	254 m	+2/Col 5 × −2.54/ΔALTL 100		5.1	Corrected HL (1m) =	738
Ht of Tgt Rel Lchr (HTL)	±37 m	54467 −253 / 54214	1.5	254.1		
HT of Tgt REL Lchr (500m) −	0 m			1.5	775 −37 / 738	
Δ HTL/100	±0.37	Total RB Corr		252.6		
ALTL/100	±2.54 m	Corrected RB (1m) =	54214 m			

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Figure 2-18. Computation of corrected RB and HL.

d. On the reverse side, determine the range/100, Δ HL/100, and ALTL/100 and enter these values in ①, ②, and ③ at the top of the form (Fig 2-19).

e. Enter the launcher-target azimuth to the nearest 20 mils and the firing point latitude to the nearest degree in the spaces provided. Enter part 1 of the firing tables and extract values for Cos 2L, Cos L Sin Az, Sin L, and Cos L Cos Az. Record these values in spaces ④, ⑤, ⑥, and ⑦ at the top of the form (Fig 2-20).

Range (RB or RT)	54214 m	Height Rel to Lchr (HL)	± 738 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) −	54000 m	Firing Table Entry HL (500m) −	500 m	Firing Table Entry ALTL (500m) −	500
① Δ Range/100	± 2.14	② Δ HL/100	± 2.38	③ Δ ALTL/100	± 2.46
Lchr-Tgt AZ (20mil)	1560 mil	④ Cos 2L	± 0.37	⑥ Sin L	± 0.56
Lat of Lchr (1°)	34 °N/S	⑤ Cos L SIN Az	± 0.83	⑦ Cos L Cos Az	± 0.03

Figure 2-19. Computation of values for spaces ①, ②, and ③.

Firing Table Entry Range (1000m) −	54000 m	Firing Table Entry HL (500m) −	500 m	Firing Table Entry ALTL (500m) −	500
① Δ Range/100	± 2.14	② Δ HL/100	± 2.38	③ Δ ALTL/100	± 2.46
Lchr-Tgt AZ (20mil)	1560 mil	④ Cos 2L	± 0.37	⑥ Sin L	± 0.56
Lat of Lchr (1°)	34 °N/S	⑤ Cos L SIN Az	± 0.83	⑦ Cos L Cos Az	± 0.03
TRIAL RANGE FACTOR (Col 2)	3128.33 + / −			TRIAL TIME PARAMETER (Col 6)	110.24 sec + / −

Figure 2-20. Determination of values for spaces ④, ⑤, ⑥, and ⑦.

f. Extract the required data from Table C of FTR LANCE-B-1 and compute the range factor, corrected time parameter, and firing azimuth (Fig 2-21). Enter Table D and obtain the TP correction. Add this to the corrected time parameter to determine the fuze setting. Note that the fuze setting for a high explosive warhead mission is computed to the nearest hundredth of a second and is expressed to the nearest tenth of a second (Fig 2-21).

① Δ Range/100	− 2.14	② Δ Alt/100	− 2.30	③ Δ Alt/100	− 2.46
Lchr-Tgt AZ (20-mil)	1560 mil	④ Cos 2L	± 0.37	⑥ Sin L	± 0.56
Lat of Lchr (1°)	34 N/S	⑤ Cos L SIN Az	± 0.83	⑦ Cos L Cos Az	± 0.03

TRIAL RANGE FACTOR (Col 2)	+	−
	3728.33	
± 3.54 (Col 3) × ① ± 2.14	7.576	
± 2.92 (Col 4) × ② ± 2.38	6.950	
± 0.19 (Col 5) × ③ ± 2.46	0.467	
(A1) ± 4.92 × ④ ± 0.37	1.820	
(A2) ± 7.75 × ⑤ ± 0.83		6.432
3728.33 + 10.38 = 3738.71	16.813	6.432
	6.432	
	10.381	
Corrected RF =	3738.71	
Range Factor (Nearest Whole No) =	3739	

TRIAL TIME PARAMETER (Col 6)	+	−	
	110.24		sec
± 0.12 (Col 7) × ① ± 2.14	0.257		
± 0.15 (Col 8) × ② ± 2.38		0.357	
± 0.06 (Col 9) × ③ ± 2.46	0.148		
(B1) ± 0.18 × ④ ± 0.37	0.067		
(B2) ± 0.67 × ⑤ ± 0.83	0.556		
110.24 + 0.67 = 110.91	1.028	0.357	
	0.357		
	0.671		
Corrected TP =	110.91		sec
TP Correction	± 0		sec
Fuze Setting ~~(NUC 1.0 sec)~~ (HE 0.1 sec) 110.91 =	110.9		sec

FIRING AZIMUTH	+	−
	1556.21 mil	
Launcher-Tgt Azimuth	4.191	
(C1) 4.191		4.609
(C2) ± 8.28 ⑥ ± 0.56	0.092	
(C3) ± 3.04 ⑦ ± 0.03	4.283	4.609
1556.21 − 0.33 = 1555.88		4.283
		0.326
Firing Azimuth (0.01 mil) =	1555.88 mil	

TIME OF FLIGHT COMPUTATIONS		
Corrected RF (50 UNITS)	3750	
Time to Boost Cut Off	4.60	sec
Corrected TP +	110.91	sec
Time of Flight (1.0 sec) 115.51 =	116	sec
Time on Target 191400	191359:60	
Time of Flight (min & sec) −	1:56	
Time to Fire (1.0 sec) =	191358:04	

ORIENTING ANGLE		
Az of OL (0.01 mil)	0015.36	mil
6400 (if nec)	+ 6400.00	mil
Sum	= 6415.36	mil

FIRE COMANDS	
SCO/(ARM TIME HE ONLY)	E/80
Elevation	853.3
Range Factor	3739
Orienting Angle	1050.48

Figure 2-21. Computation of range factor, fuze setting, and firing azimuth.

g. Enter Table E to obtain the arm time and place it in the appropriate FIRE COMMANDS block (Fig 2-25②).

h. Convert the firing azimuth to an orienting angle (Fig 2-22).

i. Because a time on target has been ordered, compute the time to fire (Fig 2-23).

j. Enter in the FIRE COMMANDS block all fire commands not previously recorded. Send all commands to the firing platoon (Fig 2-24).

1555.88		0.326
Firing Azimuth (0.01 mil)	=	1555.88 mil

ORIENTING ANGLE		
Az of OL (0.01 mil)		0015.36 mil
6400 (if nec)	+	6400.00 mil
Sum	=	6415.36 mil
Firing Azimuth (0.01 mil)	–	1555.88 mil
Orienting Angle (0.01 mil)	=	4859.48 mil

Figure 2-22. Computation of the orienting angle.

Corrected TP	=	110.91 sec
TP Correction		± 0 sec
Fuze Setting ~~(NUC 1.0 sec)~~ (HE 0.1 sec) 110.91	=	110.9 sec

TIME OF FLIGHT COMPUTATIONS		
Corrected RF (50 UNITS)		3750
Time to Boost Cut Off		4.60 sec
Corrected TP	+	110.91 sec
Time of Flight (1.0 sec) 115.51	=	116 sec
Time on Target 191400		191359:60
Time of Flight (min & sec)	–	1:56
Time to Fire (1.0 sec)	=	191358:04

Figure 2-23. Time-of-flight computations.

Time of Flight (1.0 sec) 115.51	=	116 sec
Time on Target 191400		191359:60
Time of Flight (min & sec)	–	1:56
Time to Fire (1.0 sec)	=	191358:04

FIRE COMANDS	
SCO/(ARM TIME HE ONLY)	E/80
Elevation	853.3
Range Factor	3739
Orienting Angle	4859.48
Fuze Setting	110.9
Time to Fire	191358:04

Figure 2-24. Fire commands.

k. The completed computer's record for the nonnuclear mission is shown in Figure 2-25 ① and ②.

COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

UNIT	Lchr Lat	Time and Date Fired	Target Number	Missile Serial Number
A-1-16	34 (N) S		XE176	

CALL FOR FIRE

J3F70 FM

Unit to Fire 1-16 Lchr(s) to Fire 1

FP No 12 Tgt No XE176Ø

Tgt Grid 14SMP1Ø655335275

Tgt Alt 217 m Whd M251

HOB ____ TDT 191400

TDT NLT 191415

Remarks ____

FIRE ORDER

Unit to Fire A-1-16 Lchr No 2

FP No 12 Tgt No XE176Ø

WARNING ORDER

Lchr No 2 FP No 12

Tgt No XE176Ø Whd M251

HOB ____ TDT 191400

Tgt AZ 156Ø (10m)

COMPUTATION OF RANGE AND BEARING

Tgt Grid	510655	3835275
Lchr Grid	455976	3832923
	dE (+) 54679	dN (+) 2352

BEARING	
Log dE	4.737 8206
Log dN −	3.371 4373
Log Tan Bearing =	1.366 3833
Bearing (0.01m)	1556.21 m

AVERAGE EASTING

dE/2	27340
Smaller Easting +	455976
Average Easting =	483316

dE − dN + 6400 − Bearing	dE + dN + 0 + Bearing
dE − dN − 3200 + Bearing	dE + dN − 3200 − Bearing

AZIMUTH

0 3200 6400	0.00 m
Bearing	(±) 1556.21 m
Launcher −	
Tgt AZ (0.01m)	1556.21 m

RANGE TO TARGET (RT)

dE Greater than dN

Log dE	4.737 8206
Log Sin B −	9.999 5985
Log Rg =	4.738 2221
Log Scale Factor −	9.999 8284
Log Cor Rg =	4.738 3937
Range (RT) (1m)	54751 m

dN Greater than dE

Log dN	
Log Cos B	
Log Rg =	
Log ScaleFactor −	
Log Cor Rg =	
Range (RT) (1m)	m

HEIGHT REL TO LCHR

Alt Tgt	m
HOB Above Target +	m
Alt of Burst =	m
Lchr Alt (ALTL) −	m
Height Rel to Lchr (HL)(1m) (±)	m

SECOND TRAJECTORY COMPUTATIONS

Range (RT)	54751 m	Trial RB (Col 2)	54467 m	Trial HBL (Col 6)	775 m
FTR Entry Range (1,000m) −	55000 m	(±) 100 / Col 3 × (±) 2.49 / ΔRT 100	249.0	+ 100 / Col 6 × (±) 0.37 / ΔHTL/100	37.0
ΔRT/100	(±) 2.49 m	(±) 4 / Col 4 × (±) 0.37 / ΔHTL 100	1.5	Total HBL Corr	37.0
Alt Tgt (ALTT)	217 m	(±) 2 / Col 5 × (±) 2.54 / ΔALTL 100	5.1	Corrected HL (1m) =	738 m
Lchr Alt (ALTL) −	254 m	54467 −253 = 54214	1.5 / 254.1		
Ht of Tgt Rel Lchr (HTL)	(±) 37 m		1.5		
HT of Tgt REL Lchr (500m) −	0 m	Total RB Corr	252.6		
Δ HTL/100	(±) 0.37	Corrected RB (1m) =	54214 m	775 −37 = 738	
ALTL/100	(±) 2.54 m				

DA FORM 4603, 1 Mar 77 For use of this form, see FM 6-40-4 and FM 6-15J, the proponent agency is US Army Training and Doctrine Command.

Figure 2-25(1). Computer's record for nonnuclear warhead (M251)—front side.

Range (RB or RT)	54214 m	Height Rel to Lchr (HL)	± 738 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) −	54000 m	Firing Table Entry HL (500m) −	500 m	Firing Table Entry ALTL (500m) −	500
① Δ Range/100	± 2.14	② Δ HL/100	± 2.38	③ Δ ALTL/100	± 2.46
Lchr-Tgt AZ (20‰)	1560 ‰	④ Cos 2L	± 0.37	⑥ Sin L	± 0.56
Lat of Lchr (1°)	34 N/S	⑤ Cos L SIN Az	± 0.83	⑦ Cos L Cos Az	± 0.03

TRIAL RANGE FACTOR (Col 2)	+	−
	3728.33	
± 3.54 (Col 3) × ① ± 2.14	7.576	
± 2.92 (Col 4) × ② ± 2.38	6.950	
± 0.19 (Col 5) × ③ ± 2.46	0.467	
(A1) ± 4.92 × ④ ± 0.37	1.820	
(A2) ± 7.75 × ⑤ ± 0.83		6.432
3728.33 + 10.38	16.813	6.432
	6.432	
3738.71	10.381	
Corrected RF =	3738.71	
Range Factor (Nearest Whole No) =	3739	

TRIAL TIME PARAMETER (Col 6)	+	−
	110.24 sec	
± 0.12 (Col 7) × ① ± 2.14	0.257	
± 0.15 (Col 8) × ② ± 2.38		0.357
± 0.06 (Col 9) × ③ ± 2.46	0.148	
(B1) ± 0.18 × ④ ± 0.37	0.067	
(B2) ± 0.67 × ⑤ ± 0.83	0.556	
110.24 + 0.67	1.028	0.357
	0.357	
110.91	0.671	
Corrected TP =	110.91 sec	
TP Correction	± 0 sec	
Fuze Setting ~~(NUG 1.0 sec)~~ (HE 0.1 sec) 110.91 =	110.9 sec	

FIRING AZIMUTH	+	−
	1556.21 ‰	
Launcher-Tgt Azimuth		
(C1) 4.191	4.191	
(C2) ± 8.23 × ⑥ ± 0.56		4.609
(C3) ± 3.04 × ⑦ ± 0.03	0.092	
1556.21 − 0.33	4.283	4.609
		4.283
1555.88		0.326
Firing Azimuth (0.01‰) =	1555.88 ‰	

TIME OF FLIGHT COMPUTATIONS	
Corrected RF (50 UNITS)	3750
Time to Boost Cut Off	4.60 sec
Corrected TP +	110.91 sec
Time of Flight (1.0 sec) 115.51 =	116 sec
Time on Target 191400	191359:60
Time of Flight (min & sec) −	1:56
Time to Fire (1.0 sec) =	191358:04

ORIENTING ANGLE	
Az of OL (0.01‰)	0015.36 ‰
6400 (if nec) +	6400.00 ‰
Sum =	6415.36 ‰
Firing Azimuth (0.01‰) −	1555.88 ‰
Orienting Angle (0.01‰) =	4859.48 ‰

FIRE COMANDS	
SCO/(ARM TIME HE ONLY)	E/80
Elevation	853.3
Range Factor	3739
Orienting Angle	4859.48
Fuze Setting	110.9
Time to Fire	191358:04

Figure 2-25(2). Computer's record for nonnuclear warhead (M251)—reverse side.

2-11. Practice Nuclear Mission, M252 Warhead

a. FTR LANCE-A-1 is used in the manual computation of firing data for a practice nuclear warhead mission. Computational procedures for a practice nuclear warhead mission are identical to those used for the tactical nuclear warhead mission except that a height-of-burst option is not specified in the call for fire. The height of burst selected by the firing unit must always be zero (0 meters), since there is no warhead event.

COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

UNIT | Lchr Lat 34 (N/S) | Time and Date Fired | Target Number XZ176 | Missile Serial Number

CALL FOR FIRE
J3F70 FM
Unit to Fire 1-16 Lchr(s) to Fire 1
FP No 12 Tgt No XZ1760
Tgt Grid 14SMP1065535275
Tgt Alt 217 m Whd M252
HOB IMPACT TOT 191400
TOT NLT 191415
Remarks

FIRE ORDER
Unit to Fire A-1-16 Lchr No 2
FP No 12 Tgt No XZ1760

WARNING ORDER
Lchr No 2 FP No 12
Tgt No XZ1760 Whd M252
HOB IMPACT TOT 191400
Tgt AZ 1560 (10m)

COMPUTATION OF RANGE AND BEARING

Tgt Grid	510655	3835275
Lchr Grid	455976	3832923
	dE ± 54679	dN ± 2352

BEARING	
Log dE	4.737 8206
Log dN −	3.371 4373
Log Tan Bearing =	1.366 3833
Bearing (0.01m)	1556.21 m

AVERAGE EASTING

dE/2	27340
Smaller Easting +	455976
Average Easting =	483316

RANGE TO TARGET (RT)
dE Greater than dN

Log dE	4.737 8206
Log Sin B −	9.999 5985
Log Rg =	4.738 2221
Log Scale Factor −	9.999 8284
Log Cor Rg =	4.738 3937
Range (RT) (1m)	5475 m

dN Greater than dE

Log dN	
Log Cos B −	
Log Rg =	
Log Scale Factor −	
Log Cor Rg =	
Range (RT) (1m)	m

dE − / dN + / 6400 − Bearing | dE + / dN + / 0 + Bearing
dE − / dN − / 3200 + Bearing | dE + / dN − / 3200 − Bearing

AZIMUTH

0 / 3200 / 6400	m
	0.00
Bearing	1556.21 m
Launcher −	
Tgt AZ (0.01m)	1556.21 m

HEIGHT REL TO LCHR

Alt Tgt	217 m
HOB Above Target +	0 m
Alt of Burst =	217 m
Lchr Alt (ALTL) −	254 m
Height Rel to Lchr (HL) (1m)	037 m

SECOND TRAJECTORY COMPUTATIONS

Range (RT)	m	Trial RB (Col 2)	m
FTR Entry Range (1,000m) −	m		
△RT 100 ±	m	Col 2 × △RT 100	
Alt Tgt (ALTT)	m	Col 4 × △HTL 100	
Lchr Alt (ALTL) −	m	Lchr × △Alt Tgt 100	
Ht of Tgt Rel Lchr (HTL) + −			
HT of Tgt REL Lchr (500m) −	m		
△HTL 100 ±			
Alt Tgt 100 ±	m	Total RB Corr	
		Corrected RB (1m) =	m

Trial HBL (Col 6)	m	
+ 100 × △HTL/100	+	+ / −
Total HBL Corr		
Corrected HL (1m) =	m	

DA FORM 4603, 1 Mar 77 For use of this form, see FM 6-40-4 and FM 6-15J; the proponent agency is US Army Training and Doctrine Command

Figure 2-26(1). Computer's record for practice nuclear warhead—front side.

Although fuze setting is not required for firing the M252 warhead, fuze setting computations should be completed to have realistic training.

b. Following the same situation given in paragraph 2-8, firing data will be determined for the M252 warhead mission. (See Figures 2-26, ① and ②.

Range (RB or RT)	54751 m	Height Rel to Lchr (HL)	+ 37 m	Lchr Alt (ALTL) (1m)	254 m
Firing Table Entry Range (1000m) −	55000 m	Firing Table Entry HL (500m) −	0 m	Firing Table Entry ALTL (500m) −	500
① △ Range/100	+ 2.49	② △ HL/100	+ 0.37	③ △ ALTL/100	+ 2.46
Lchr-Tgt AZ (20㍰)	1560 ㍰	④ Cos 2L	− 0.37	⑥ Sin L	− 0.56
Lat of Lchr (1°)	34 N S	⑤ Cos L SIN Az	− 0.83	⑦ Cos L Cos Az	− 0.03

TRIAL RANGE FACTOR (Col 2)	+	−
	3775.15	
− 3.58 (Col 3) × ① + 2.49		8.914
− 2.47 (Col 4) × ② + 0.37		0.914
+ 0.86 (Col 5) × ③ + 2.46	2.116	
(A1) − 5.09 × ④ − 0.37	1.883	
(A2) + 7.59 × ⑤ − 0.83		6.300
	3.999	16.128
		3.999
		12.129
Corrected RF =	3763.02	
Range Factor (Nearest Whole No) =	3763	

TRIAL TIME PARAMETER (Col 6)	+	−	sec
	116.43		
− 0.12 (Col 7) × ① + 2.49		0.299	
+ 0.20 (Col 8) × ② + 0.37	0.074		
+ 0.13 (Col 9) × ③ + 2.46	0.320		
(B1) − 0.18 × ④ − 0.37	0.067		
(B2) − 0.68 × ⑤ − 0.83	0.564		
	1.025	0.299	
116.43 + 0.73 = 117.16	0.299		
	0.726		
Corrected TP =	117.16		sec
TP Correction	+ 12.00		sec
Fuze Setting (NUC 1.0 sec) (~~HE 0.1 sec~~) =	105.16		sec
	105.0		sec

FIRING AZIMUTH	+	−
Launcher-Tgt Azimuth	1556.21 ㍰	
(C1) 5.375	5.375	
(C2) + 8.27 × ⑥ − 0.56		4.631
(C3) − 3.08 × ⑦ − 0.03	0.092	
1556.21 + 0.84 = 1557.05	5.467	4.631
	4.631	
	0.836	
Firing Azimuth (0.01㍰) =	1557.05 ㍰	

TIME OF FLIGHT COMPUTATIONS		
Corrected RF (50 UNITS)	3750	
Time to Boost Cut Off	3.88	sec
Corrected TP +	117.16	sec
Time of Flight (1.0 sec) =	121	sec
Time on Target	19 1359 : 60	
Time of Flight (min & sec) −	2 : 01	
Time to Fire (1.0 sec) =	19 1357 : 59	

ORIENTING ANGLE	
Az of OL (0.01㍰)	0015.36 ㍰
6400 (if nec) +	6400.00 ㍰
Sum =	6415.36 ㍰
Firing Azimuth (0.01㍰) −	1557.05 ㍰
Orienting Angle (0.01㍰) =	4858.31 ㍰

FIRE COMANDS	
SCO/(ARM TIME HE ONLY)	T
Elevation	853.3
Range Factor	3763
Orienting Angle	4858.31
Fuze Setting	105.0
Time to Fire	19 1357 : 59

Figure 2-26②. Computer's record for practice nuclear warhead—reverse side.

FIRE DIRECTION WITH THE FADAC

CHAPTER 3

Section I. Organization and Equipment

The FADAC is used to compute the necessary laying and firing data for the Lance missile. FADAC may also be used to solve specific survey problems and to store target, firing point, and observer information.

3-1. Fire Direction Personnel

a. The Lance battalion and firing battery FDCs provide personnel required for operating the FADAC. The fire direction computer is assigned the duties of FADAC operator. The duties of the other personnel are essentially the same as in the manual FDC organization discussed in Chapter 2.

b. A minimum of two personnel is necessary to set up or to march order the FADAC and its associated equipment.

3-2. Duties of the FADAC Operator

a. The FADAC operator is responsible for the emplacement, march order, operation, and operator maintenance of the FADAC and the teletypewriter. His duties are to—

(1) Insure that the correct procedures are followed in setting up the FADAC and the teletypewriter.

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

(3) Record data in accordance with the unit standing operating procedures.

(4) Report discrepancies or shortcomings in the performance of the FADAC or its associated equipment.

b. The duties of the generator operator are normally performed as additional duties by members of the FDC. These duties are to—

(1) Emplace the generator properly.

(2) Start, stop, and monitor the operation of the generator on a standby basis.

(3) Insure that the generator is providing the correct voltage.

(4) Perform operator maintenance.

(5) Maintain the prescribed records on generator operation.

3-3. Description of FADAC

a. The FADAC is a solid state digital automatic computer with a nonvolatile rotating magnetic disc memory. It is used to solve the gunnery problem for the Lance missile, rockets, and cannon artillery.

b. When the Lance missile program is inserted into the memory by means of the signal data reproducer (SDR), the FADAC will solve the ballistic problem. It will compute and display range, azimuth of fire, orienting angle, sustainer cutoff, range factor, fuze setting, quadrant elevation, arm time, and time to fire or time of flight. The TT-537/G or the TT-297A/UG teletypewriter, when connected to the FADAC, will print out these firing data as well as the target, observer, and firing point lists. The teletypewriter is required to obtain the results of several types of survey problems—traverse, zone-to-zone transformation, azimuth-by-altitude, geographic-to-UTM, and UTM-to-geographic conversions. The FADAC will check its internal operations as well as test the nixie tubes, the teletypewriter operation, and the validity of the program.

3-4. Components and Associated Equipment

a. The FADAC is of modular construction, consisting of four major components: the power supply chassis, the rotating magnetic disc memory, the control panel assembly, and the circuit boards. The FADAC weighs approximately 210 pounds and is housed in a watertight case that has removable front and rear covers. FADAC parts are cooled by two blowers that draw air through replaceable filters located under the front panel and exhaust it through a louvered section in the rear of the FADAC. Frequent cleaning of these filters is essential. See TM 9-1220-221-10/1, *Operator's Manual for Computer, Gun Direction, M18 (FADAC).*

b. Associated equipment consists of the teletypewriter TT-537/G or the TT-297A/UG, a 58-pound FADAC table with an integral power connection panel, a power cable and reel assembly, and a 3-kilowatt (KW), 120/208-volt, 400-hertz, 3-phase, 4-wire generator (Fig 3-1).

c. Auxiliary equipment consists of a signal data reproducer AN/GSQ-64 and a computer logic unit test (CLUT) AN/GSM-70.

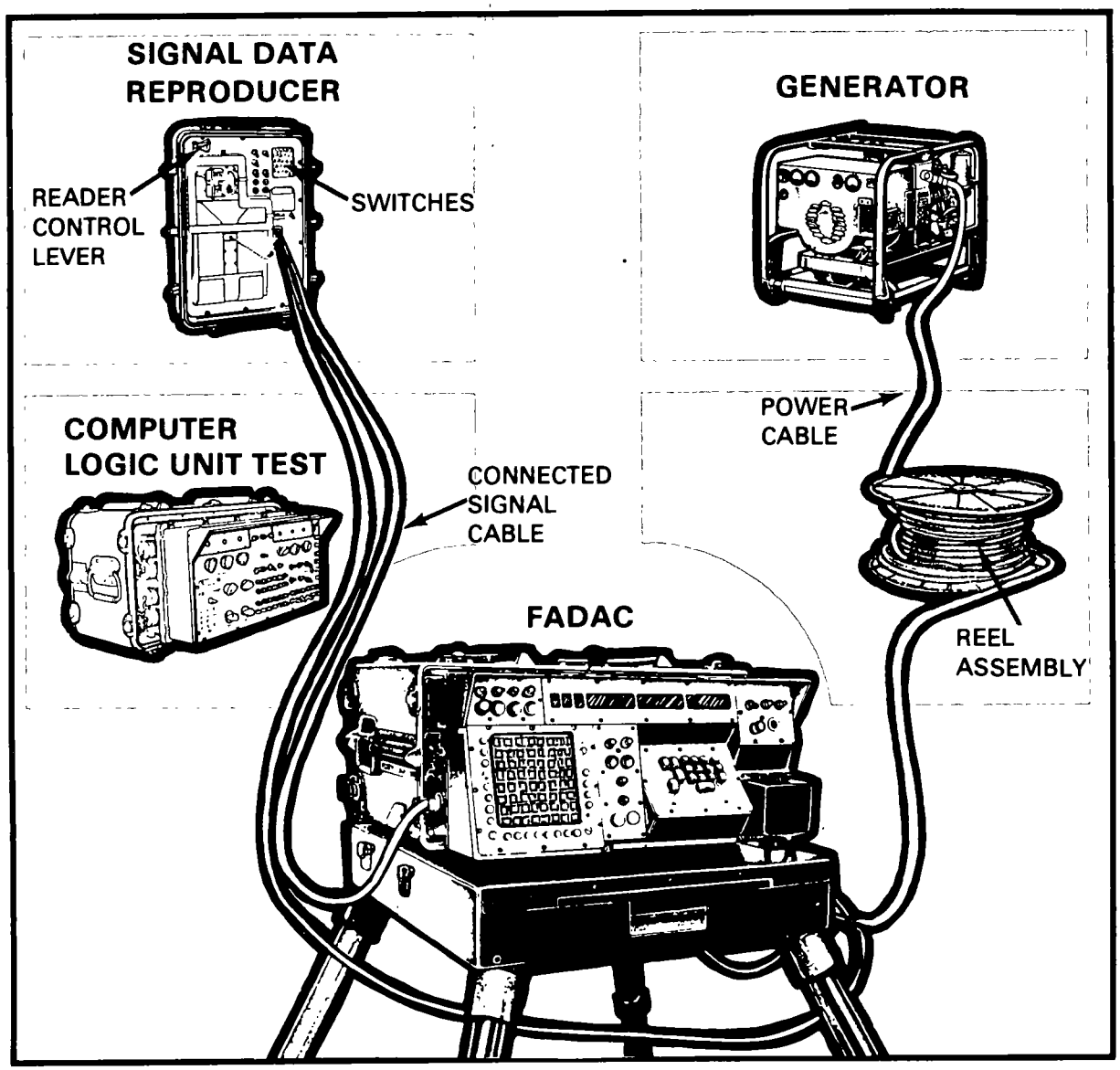


Figure 3-1. FADAC components.

3-5. The Lance Program Tape

a. The program is coded on punched paper tape. The Lance missile program is inserted into the permanent storage section of the FADAC memory known as cold storage by means of the SDR.

b. In addition to the Lance program tape, two diagnostic tapes are issued to maintenance personnel. Loading the program tape into the FADAC is discussed in paragraph 3-6.

3-6. Loading the Program

a. The Lance program is entered into the FADAC by means of the SDR. When connected to the FADAC, the SDR energizes the recording heads on the disc in the cold storage section of memory. When the SDR is disconnected, these cold storage recording heads are deenergized; thus, the program, once loaded, will remain unchanged. Figure 3-1 1 shows the SDR connected to the FADAC for memory loading.

b. After the SDR has been connected to the FADAC, the following procedures are used to load the program into memory. (For further details, see TM 9-1290-326-34, *Operator's and Organizational Maintenance Manual: Reproducer, Signal Data AN/GSQ-64*, and TM 9-1220-221-20&P, *Organizational Maintenance Manual: Computer, Gun Direction: M18.*)

Note: *The duties listed in steps 1 through 11 below are the responsibility of the FADAC repairman assigned to headquarters battery.*

STEP	ACTION
①	Remove the top of the PROGRAM TAPE CARTRIDGE and place the cartridge in the metal canister with the wide side of the tape toward the face of the SDR. The cardboard tab on the cartridge should be in the slot of the canister.
②	Set all switches in the DOWN position (Fig 3-1②) and open the read head using the READER CONTROL LEVER.
③	Pull the tape from the top of the cartridge and thread the tape through the read head. Insure that the verify code (two small holes on the narrow side of the tape) is beyond the read head and that the first punched holes of the program tape are above the read head.
④	Turn the SDR power on by placing the CIRCUIT BREAKER in the ON position and the SIGNAL switch in the ON position. CAUTION: Do not close the read head gate.
⑤	Turn on the FADAC circuit breaker and energize the FADAC by placing the ON-OFF switch in the ON position.

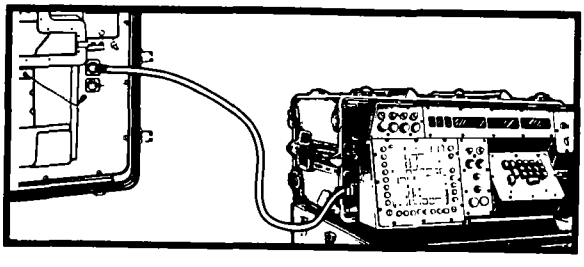


Figure 3-1 ①. Connected signal cable.

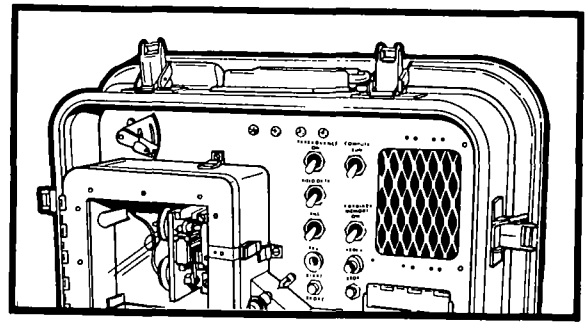


Figure 3-1 ②. Signal data reproducer switches.

STEP	ACTION
(6)	When the FADAC POWER READY indicator lights, press the RESET button.
(7)	Slowly close the SDR read head gate while insuring that the program tape is threaded properly through the guides. Press the control lever firmly down to a completely closed position.
(8)	Press the START button on the SDR. The SDR will start reading the tape. During the reading process, the FADAC IN-OUT indicator will be lit.
(9)	If it is necessary to stop the loading process at any time, press the STOP button on the SDR. To restart, press the FADAC RESET button and reload the tape as described in the above steps and then press the START button on the SDR.
(10)	When the tape stops at the last code, first turn off the FADAC and then turn off the SDR.

Note: *This shutdown sequence is important to prevent a stray signal from affecting the program.*

(11)	Disconnect the signal cable from the SDR.
(12)	Energize the FADAC and perform program tests 1 and 2 (para 3-10). The successful completion of these tests will verify that the program has been loaded correctly.

3-7. Preparation for Operation

a. The following actions are required to prepare the FADAC equipment for operations:

STEP	ACTION
(1)	Turn the FADAC table upside down and release the screwlock fasteners on the legs.
(2)	Extend each leg so that the height will be comfortable for the operator. The top will be level.
(3)	Secure each leg in position by tightening the leg locking ring and then place the table in an upright position.
(4)	Have two men place the FADAC on the table.
(5)	Press 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 FADAC case.
(8)	Remove the caps and connect the cable from the bottom of the table to the FADAC. (See TM 9-1220-221-10/1)
(9)	Connect the power cable from the generator to the table and insure that the circuit breaker is in the OFF position.
(10)	Remove the teletypewriter cover and release the carriage and platen locks. Then connect the teletypewriter power cable to the receptacle on the table. Then connect the teletypewriter signal cable to the receptacle on the side of the FADAC. (See TM 9-1220-221-10/1)
(11)	Start the generator and insure that it is producing the correct voltage and hertz.
(12)	Check the condition of the air filters and the air intake for obstructions.
(13)	Place the FADAC circuit breaker in the ON position.
(14)	Place the POWER switch on the power panel in the POWER ON position until you hear the FADAC start to energize, then release the switch. When the POWER READY

STEP	ACTION
	indicator lights, the FADAC is ready to operate.

> **Note:** *If the POWER ON-OFF switch is accidentally triggered after the POWER READY indicator lights, the POWER READY indicator will go out and the FADAC will not function in any way. The correct procedure for reestablishing power is to momentarily hold the POWER ON-OFF switch in the OFF position to deenergize the FADAC. After a wait of 30 seconds (to allow the memory position to stabilize), again hold the switch momentarily in the ON position. When the POWER READY indicator lights, the FADAC will once more be ready to operate.*

(15)	Turn the teletypewriter power on.

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

c. When it becomes necessary to clear classified data from the FADAC memory, a tape, part number P/N 8213315-119, must be loaded through the signal data reproducer AN/GSQ-64. This tape contains a special program that will delete and clear all classified data.

STEP	ACTION
(1)	With the SDR connected to the FADAC, turn all SDR switches off.
(2)	Insert the leader of the clear memory tape through read head without closing the gate.
(3)	Turn the SDR CIRCUIT BREAKER on and then turn the SIGNAL switch on.
(4)	Turn the FADAC on and wait for the POWER READY indicator to light.
(5)	Press the FADAC RESET button.
(6)	Insure that the matrix buttons are in the A-1 position and the mission association buttons are in the A-1 position.
(7)	Close the gate on the SDR and press the FADAC START button.
(8)	When the tape stops on the SDR, turn on COMPUTE RUN switch.

> **Note:** *Tape will intermittently stop, and data will be displayed on the FADAC display panel.*

(9)	When the final display reads 0101010101010101, the FADAC memory will be cleared.
(10)	Shut off the FADAC, SDR, and FADAC generator and disconnect them.

3-8. March Order Actions

The FADAC and teletypewriter are prepared for traveling as follows:

STEP	ACTION
(1)	Move the POWER switch and the FADAC circuit breaker to their OFF positions.
(2)	Stop the generator and disconnect the power cable; replace the receptacle covers; and replace the cable.
(3)	Unfasten the four latches that secure the FADAC to the table.
(4)	Disconnect all other cables from the FADAC; replace the receptacle covers; and replace the front and rear covers.
(5)	Secure the carriage and platen locks on the teletypewriter and replace the cover.
(6)	Remove the FADAC from the table.
(7)	Turn the table upside down and release the telescoping portion of each leg by turning the leg locking ring counterclockwise.

8. Secure the plug of the FADAC power cable to the clamp under the table and replace all receptacle covers on the table.
9. Retract and fold the legs.
10. Place the FADAC, FADAC table, teletypewriter, and cable and reel assembly in the transport vehicle.

Section II. Operator Controls and Tests

3-9. The Control Panel

The operator controls the FADAC program through the use of buttons, switches, and keys. These controls are located on the front panel (Fig 3-2). Each of the seven sections of the control panel is identified on this figure.

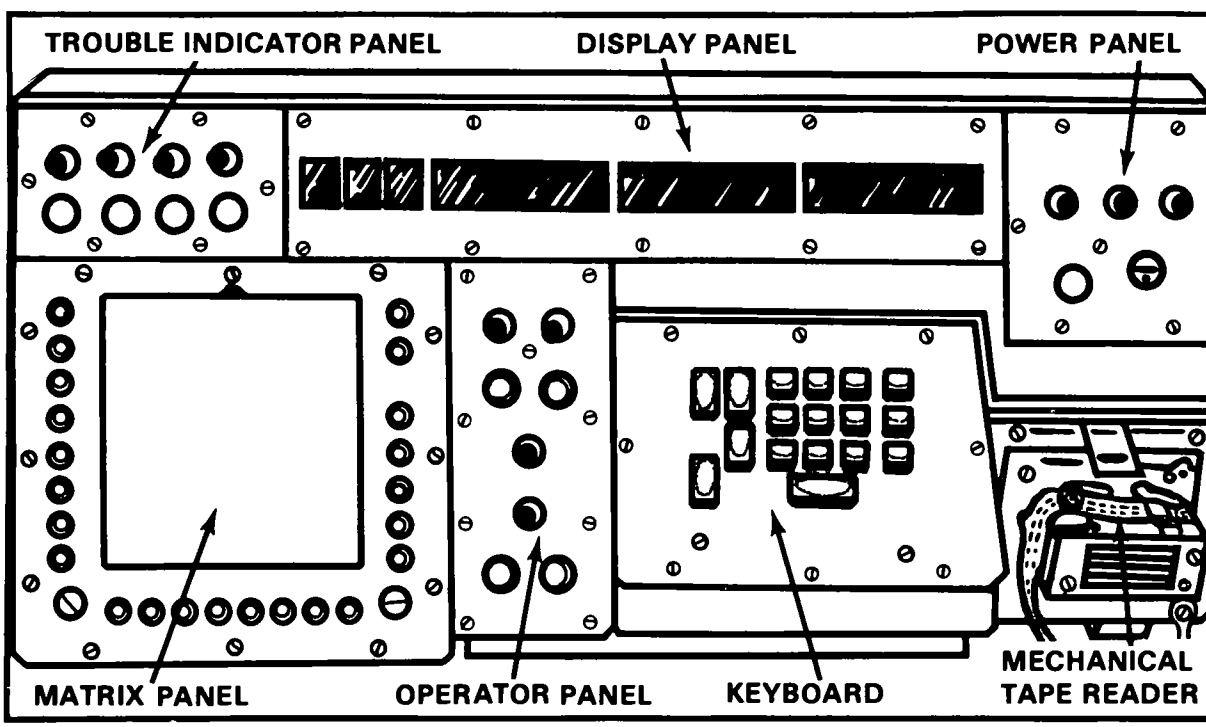


Figure 3-2. Computer control panel.

a. **The matrix panel.** The primary means of controlling the computer program, including the entry or recall of data, is by the matrix panel (Fig 3-2①) and the keyboard. The matrix panel overlay is used with matrix location selection buttons. Along the left side of the matrix are eight buttons lettered A through H; along the bottom are eight buttons numbered 1 through 8. By pressing one letter button and one number button, the operator can select any 1 of 64 different locations. As the operator selects a location, the appropriate window of the matrix panel lights. Each Lance missile fire mission normally is preplanned for a specific firing point and a specific target. All the data pertaining to a firing point-target combination are called mission-associated data. Ten possible missions can be identified by a letter-number combination using the two buttons numbered 1 and 2 and five buttons lettered A, B, C, D, and E located on the right side of the matrix panel. These buttons are used to associate all specific mission data. By pressing a numbered button and a lettered button simultaneously (e.g., A-1, B-1, E-1, E-2), the operator can cause the FADAC to compute 10 independent sets of firing data and store these in 10 separate memory locations.

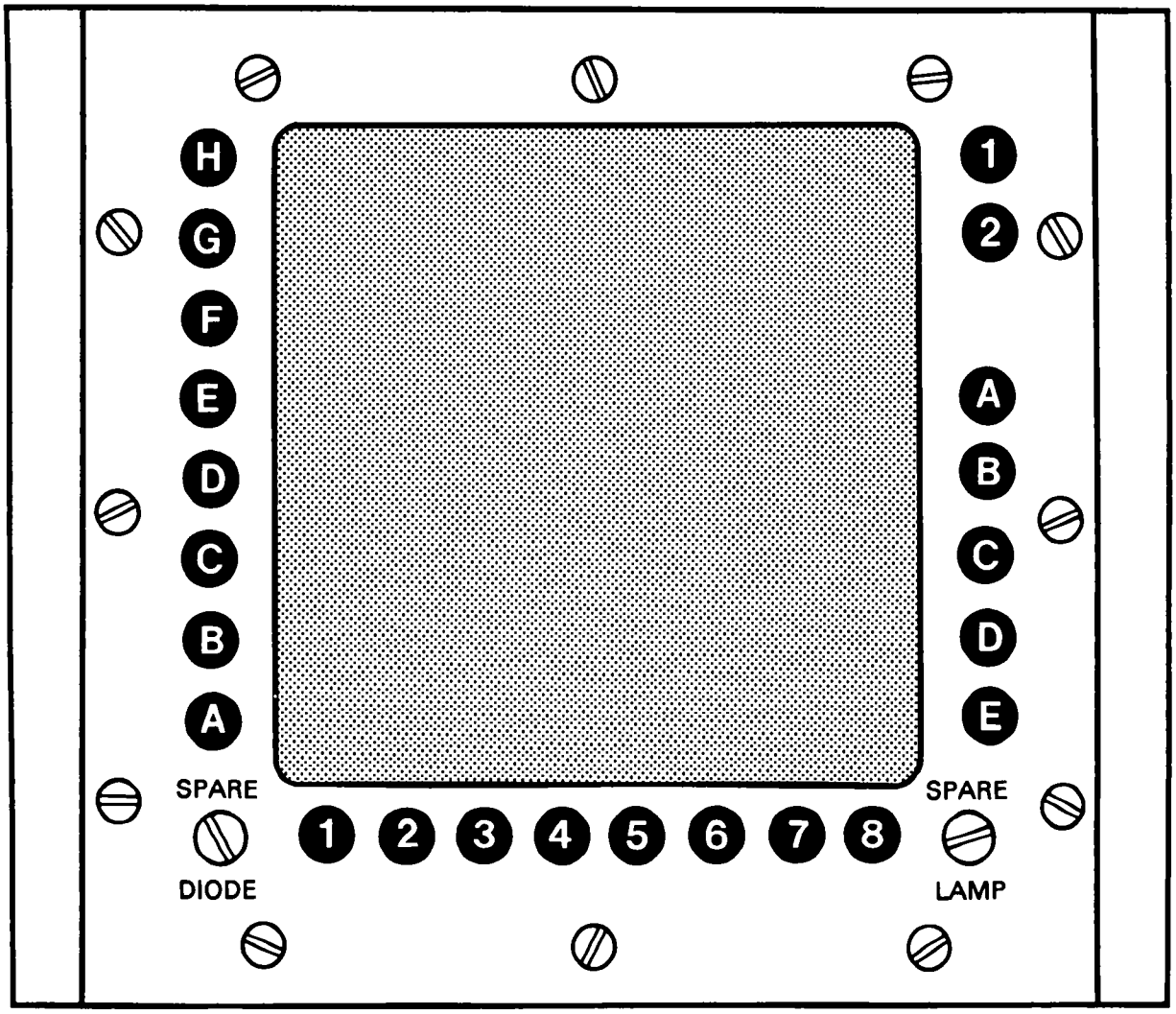


Figure 3-2①. Matrix panel.

b. **Operator panel.** The operator panel (Fig 3-2 2), in the lower center of the control panel, has four program-controlled indicators and four buttons. Their description and use are detailed in the following tables:

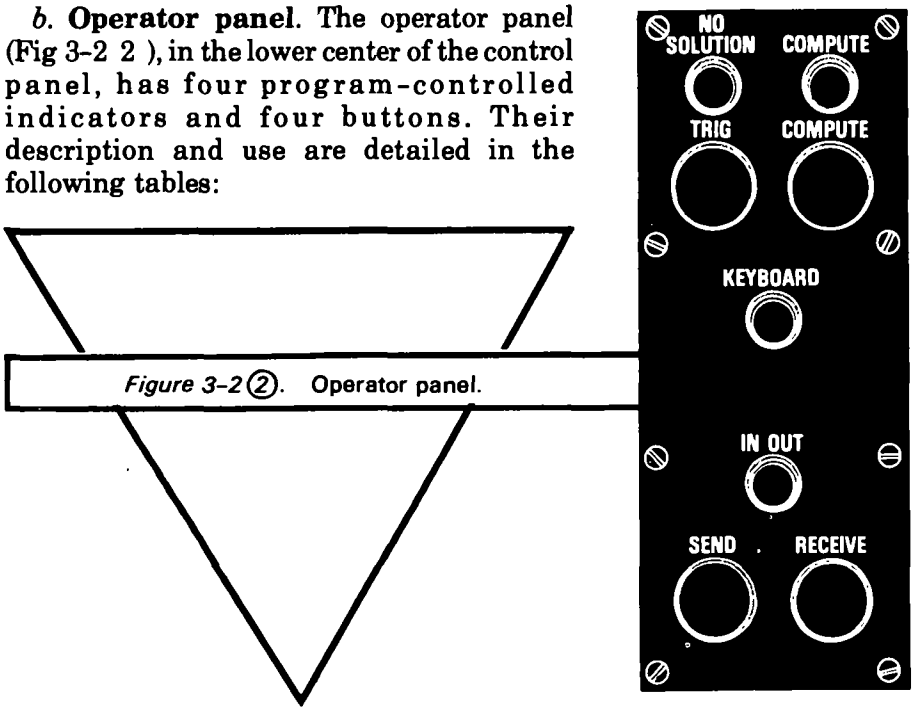


Figure 3-2 ②. Operator panel.

Table 3-1. Program-Controlled Indicators

Indicator Name	Description and Use
NO SOLUTION	The NO SOLUTION indicator normally is lighted and will flash if the data entered for a particular problem produce no solution. For most situations, a numerical display defines the cause. See paragraph 3-24.
COMPUTE	The COMPUTE indicator lights when the FADAC is in the compute mode.
IN/OUT	The IN/OUT indicator lights when data are transferred to or from an input-output device such as the keyboard or the display panel.
KEYBOARD	The KEYBOARD indicator lights when a keyboard entry is required.

Table 3-2. Operator Panel Buttons

Indicator Name	Description and Use
TRIG	The TRIG button is not used with the Lance program. Pressing this button will cause the NO SOLUTION indicator to flash. This action will not affect any of the data that have been entered.
COMPUTE	Pressing the COMPUTE button causes the FADAC to compute the trajectory data for the gunnery problem.
SEND	The SEND button is not used in the Lance program.
RECEIVE	The RECEIVE button is not used in the Lance program.

c. **The keyboard.** The keyboard assembly (Fig 3-2③) has five groups of keys. The description and use of each key are detailed in the following table:

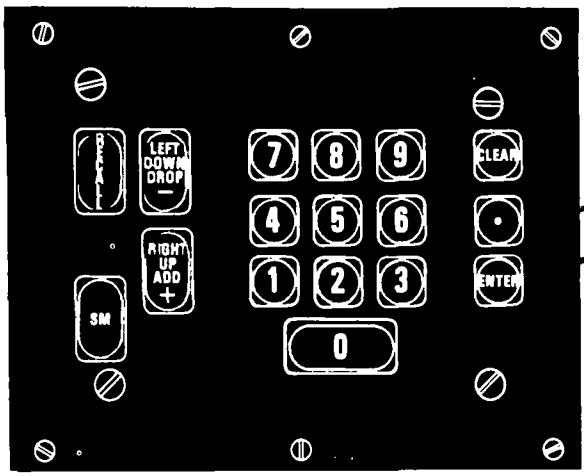


Figure 3-2③. Keyboard assembly.

Table 3-3. Keyboard Assembly Keys

Indicator Name	Description and Use
SM and RECALL	Pressing the SM (sample matrix) key or the RECALL key causes the FADAC to follow the commands in that portion of the program indicated by the matrix position selected. Normally, these commands will require a keyboard entry, in which case the KEYBOARD indicator will light. The SM key is used to initiate input, and the RECALL key is used to recall from memory the data indicated by the matrix position selected.
LEFT, DOWN, DROP, −	Pressing the LEFT, DOWN, DROP, − (minus) key causes a negative sign to be associated with the numerical value entered through the keyboard.
RIGHT, UP, ADD, +	Pressing the RIGHT, UP, ADD, + (plus) key causes a positive sign to be associated with the numerical value entered through the keyboard.
Numerical Keys and the Decimal Point	The numerical keys 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 and the decimal point key (•) are used to enter numerical values, including those with decimal points. The keys are interlocked so that two keys cannot be pressed simultaneously. As each numerical key is pressed, the numerical value entered is displayed on the display panel. The 0 key may also be used to indicate "yes" to the FADAC. The 9 key may be used to indicate "no" to the FADAC. The (•) key will terminate multiple display.
CLEAR	The CLEAR key is used to clear an erroneous keyboard input and to erase the display before the value has been permanently entered into memory. After the CLEAR key has been pressed, the correct data can be entered without pressing the SM key again.
ENTER	The ENTER key is used to enter the values displayed.

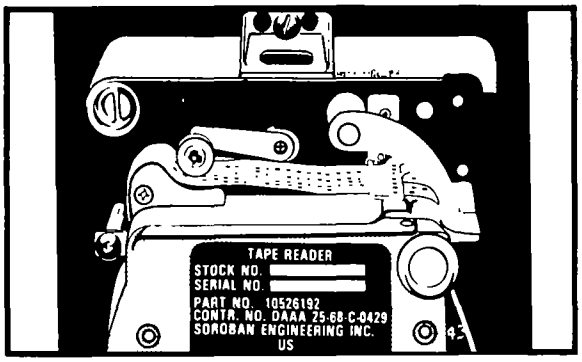


Figure 3-2④. Mechanical tape reader.

d. **Mechanical tape reader.** The mechanical tape reader (Fig 3-2④), in the lower right section of the control panel, is a mechanical device capable of reading five-hole punched paper tape by which data are read into the hot storage memory section. It has no function in the Lance missile application.

e. **Trouble indicator panel.** The trouble indicator panel (Fig 3-2⑤) has four indicators and three program control buttons. The description and use are detailed in the following tables:

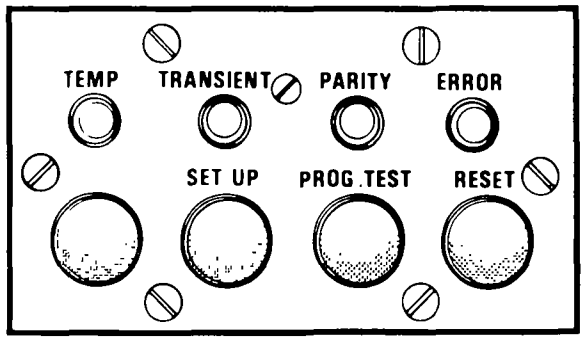


Figure 3-2⑤. Trouble indicator panel.

Table 3-4. Trouble Indicators

Indicator Name	Description and Use
TEMP	The temperature indicator lights when the internal operating temperature is correct. The indicator flashes when the operating temperature is not correct.
TRANSIENT	The TRANSIENT indicator lights when the line voltage is correct. The indicator flashes when the power supply voltage fluctuates or approaches the operating limits.
PARITY	A PARITY indicator is provided to indicate an internal error in the transfer of data.
ERROR	The ERROR indicator normally is lighted and flashes if there is an accumulator overflow or underflow that is caused by the internal use of a number too large or too small for the FADAC to handle.

Table 3-5. Program Control Buttons

Indicator Name	Description and Use
SET UP	The SET UP button is not used in the Lance program.
PROG TEST	When the PROG TEST button is pressed and a keyboard numbered key (1, 2, 3, or 4) is pressed, the computation of a stored test routine begins. The numbered key pressed selects the type of test to be made. Keys 1 and 2 initiate tests of the program, key 3 initiates a test of the Nixie tube display, and the 4 key initiates a test of the teletypewriter. See paragraph 3-10, Program Tests.
RESET	The RESET button is pressed to terminate the input/output or compute mode. Pressing this button will also terminate flashing of the PARITY, TRANSIENT, or ERROR indicator if the indicated malfunction is not recurring.

f. **Display panel.** The display panel (Fig 3-2⑥) in the upper center section of the control panel consists of 18 Nixie tube indicators that display information in the form of letters, numbers, and signs as it is entered in the FADAC or as an output display. In most instances, the data entered through the keyboard will be displayed on this panel and will be erased when the ENTER key is pressed. The panel is divided into six windows that will display specific data, depending on the type of problem.

(1) The first window, BATTERY, has one Nixie tube. It will display a letter (A through E), depending on which lettered mission association button is pressed.

(2) The second window, SIGN, has one Nixie tube. It will display the algebraic sign (+ or -) associated with a numerical input or output.

(3) The third window, CHARGE, has one Nixie tube. It will display security classification of the program entered when program test 1 is conducted. It will also display certain entry flags.

(4) The fourth window has five Nixie tubes and is labeled DEFLECTION, AZIMUTH, and EASTING. It will display

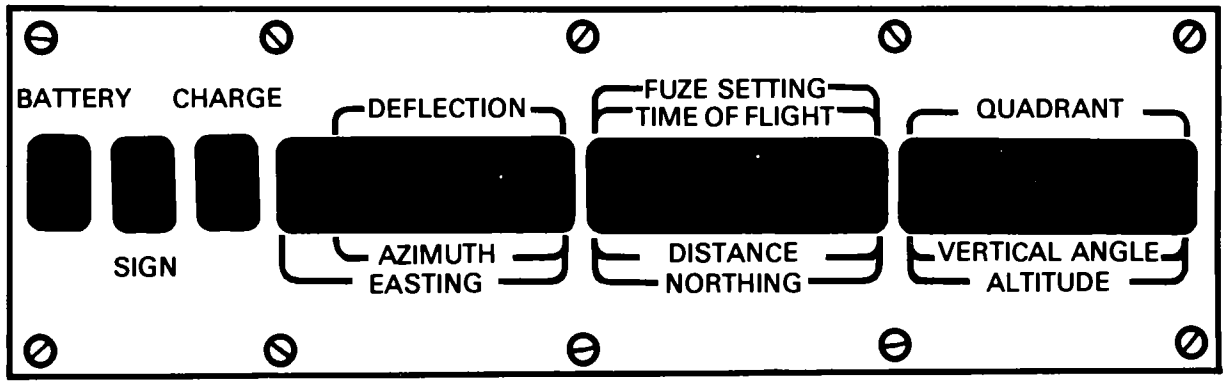


Figure 3-2⑥. Display panel.

the input or output data for the matrix position selected. When coordinates are entered in the normal sequence, the easting will be displayed in this window, the northing will be displayed in the fifth window, and the altitude will be displayed in the sixth window.

(5) The fifth window has five Nixie tubes and is labeled FUZE SETTING, TIME OF FLIGHT, DISTANCE, and NORTHING. The data displayed depends on the matrix position selected. Normally, the fuze setting, time of flight, range, or northing input or recalled data will be displayed in this window.

(6) The sixth window has five Nixie tubes and is labeled QUADRANT, VERTICAL ANGLE, and ALTITUDE. Normally, the quadrant elevation or altitude input will be displayed in this window. The az of the OL is also displayed in this window. A keyboard entry normally will be displayed in the leftmost Nixie tubes, and subsequent entries will cause each digit to shift to the next Nixie on the right. When the ENTER key is pressed, the digits entered will be displayed in the proper sequence. NO SOLUTION flags will be displayed in the rightmost two Nixie tubes of this window.

g. **The power panel.** The power panel (Fig 3-2⑦), located in the upper right section of the control panel, has a toggle switch that controls two night lights, another toggle switch to turn the computer on and off, and a POWER READY indicator that lights approximately 20 seconds after the FADAC is energized. The indicator blinks when the FADAC is in the marginal test mode or when the lower blower motor is not operating. The lower blower motor does not operate when the back cover is installed for cold weather operations. If the indicator blinks when the back cover has been removed and the MARGINAL TEST switch is off, a malfunction of the lower blower is indicated. A time meter that records the cumulative hours the FADAC has been in operation is also provided.

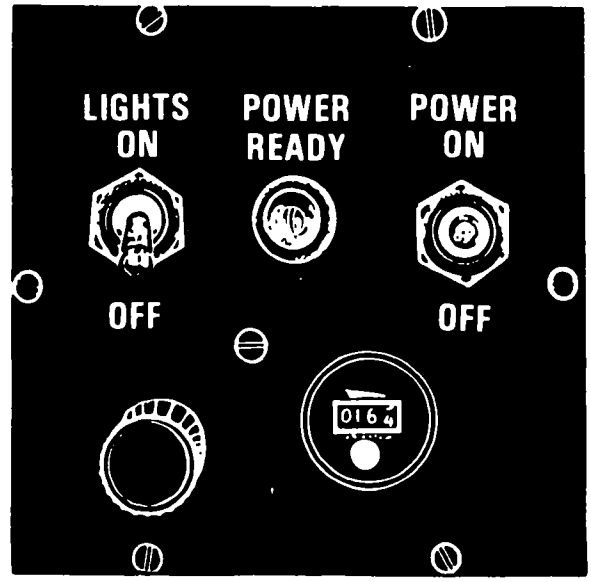


Figure 3-2 7 . Power panel.

3-10. Program Tests

a. The Lance program provides four internally stored program tests that are used to insure that the FADAC and the teletypewriter are operating properly and that the correct program has been entered in memory. These tests should be made when the FADAC is first set up for operation, when there is a loss of power, or when there is reason to believe that the FADAC is not operating properly. The program must be entered in the FADAC before the program tests can be made. The four tests are:

(1) Program test 1, which tests the validity of the program stored in the cold storage section of memory.

(2) Program test 2, which tests the conditions in the hot storage section of memory.

(3) Program test 3, which tests all of the numeric filaments of the Nixie tubes and the operation of the display circuits.

(4) Program test 4, which tests the teletypewriter for proper operation.

b. Program test 1 (SUM) check procedures are:

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

(2) Type 1 on the keyboard, and the computer will automatically test the program entered in the memory. The Nixie display tubes will flicker while the test is being made. If the test is successful, the following program identification number will appear on the display panel: A 2 00000 00000 00559. (This display is for the tactical program. The display for the training program is A 1 00000 00000 00559.) If the test is unsuccessful, the NO SOLUTION light will blink and a series of numbers other than zeros will be displayed on the 10 Nixie tubes following the classification code numbers.

(3) Repeat the test if the first attempt is not successful. The second or third attempt may be successful. However, if several attempts are frequently required for successful completion of the test, faulty computer parts may be the cause and maintenance checks should be performed.

c. Program test 2 procedures are:

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

(2) Type 2 on the keyboard. The FADAC will automatically test the hot storage portion of the memory. During the test, the three rightmost Nixie tubes in the QUADRANT window of the display panel will rapidly display the channel numbers being checked and, if the test is successful, will finally display the number 136. If the test is not successful, the PARITY indicator will flash and the channel number in which the error occurred will be displayed.

(3) If the test is unsuccessful, the indicated channel must be cleared by using the procedure described in Table 3-6 for matrix location D-7 (CLEAR CHANNEL). After the channel has been cleared and the correct data for that channel have been entered, repeat the test. Figure 3-3, the memory map, should be studied to determine what data must be reentered.

d. Program test 3 procedures are:

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

(2) Type 3 on the keyboard. The FADAC will automatically test all of 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 be lighted in turn. The operator should observe the display panel and insure that each filament lights properly. Defective tubes should be replaced at once.

e. Program test 4 procedures are:

(1) Connect and turn on the teletypewriter.

(2) Press the PROG TEST button; the KEYBOARD indicator will light.

(3) Type 4 on the keyboard, and the FADAC will automatically cause the teletypewriter to print out the following letters and numbers seven times and then halt: ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789.

(4) If the printout includes illegible letters or if the teletypewriter misprints, adjustment and synchronization are required.

f. A marginal test also has been built into the FADAC that provides the operator with a means of performing a limited check of the FADAC's operation with various voltages. Successful completion of program test 1 when the MARGINAL TEST switch is placed in the 1 through 5 positions assures the operator that the FADAC will operate under normal conditions. The procedures for the marginal tests are:

(1) When the POWER READY indicator lights, perform program test number 1 as shown below. After successful completion of program test 1, place the MARGINAL TEST switch in the 1 position. The POWER READY indicator will blink. Blinking of the POWER READY indicator does not indicate a malfunction at this time.

(2) Press the PROG TEST button and type 1 on the keyboard. Blinking of the PARITY or ERROR indicator indicates that the computer has malfunctioned under the marginal conditions induced when the

MARGINAL TEST switch was set at the 1 position.

(3) Repeat the procedures in the paragraph above with the MARGINAL TEST switch in positions 2, 3, 4, and 5. If neither the PARITY nor the ERROR indicator blinks when the switch is placed in positions 1, 2, 3, 4, and 5, the operator is assured that the FADAC will operate under normal conditions.

> **Note:** *The MARGINAL TEST switch must be in the OFF position during operations other than marginal test.*

CHANNEL NUMBER	DATA STORED IN MEMORY			
70	MISSION A-1	MISSION A-2	MISSION B-1	MISSION B-2
72	MISSION C-1	MISSION C-2	MISSION D-1	MISSION D-2
74	MISSION E-1	MISSION E-2	TEMPORARY DATA	CLEAR
76	TEMPORARY DATA			
110	TARGET LIST (1-22)			
112	TARGET LIST (22-43)			
114	TARGET LIST (43-64)			
116	TEMPORARY DATA			
130	TEMPORARY DATA			
132	TEMPORARY DATA	FIRING POINT LIST (1-17)		
134	FIRING POINT LIST (18-39)			
136	FIRING POINT LIST (39-48)	TEMPORARY DATA	OBSERVER LIST	

Figure 3-3. Memory map.

Section III. Input

3-11. FADAC Input, General

a. The data needed for the solution of a problem are entered through the keyboard into the hot storage section of memory. Twelve channels are allocated for these data, and the recording heads in this section of memory are always energized.

b. Input is controlled by the selection of specific matrix functions from the 64 matrix locations shown on the matrix overlay, Figure 3-4. The input selection matrix and keyboard simplify operator input. By selecting a specific matrix function and then pressing the SM or the RECALL key, the operator is able to enter or recall specific data or to initiate a designated computational routine.

c. The operator uses the FADAC controls to issue instructions to the FADAC in

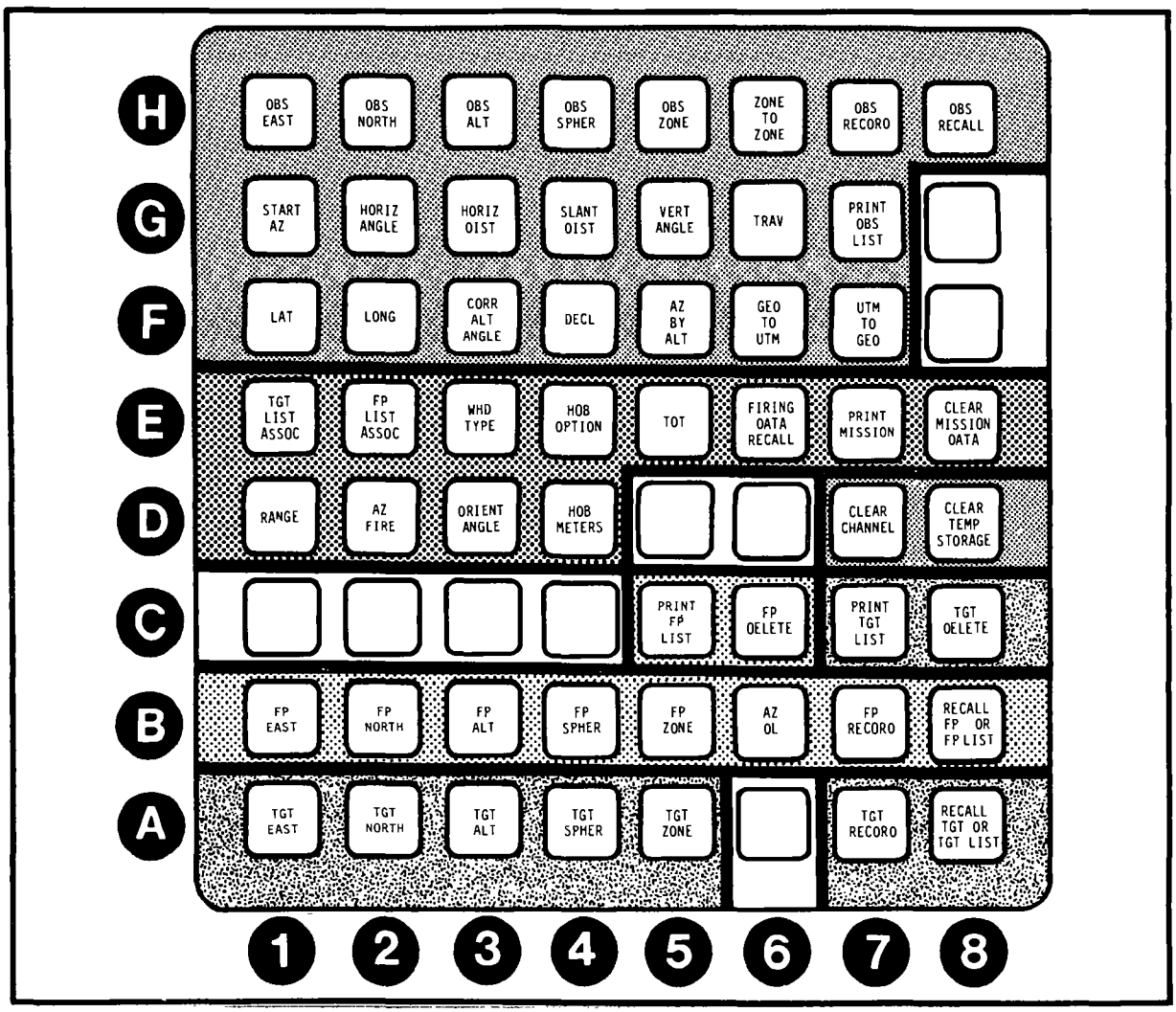


Figure 3-4. The matrix overlay.

standard artillery terminology. When necessary, one- or two-digit codes, called flags, are used to identify input data or to recall data for display or printout. The flags used in the Lance program are shown on the flag card, Figure 3-6.

3-12. Target and Firing Point Data Input

a. The bottom two rows of the input selection matrix are used to enter data for 64 targets and 48 firing points into the FADAC memory. Each target and firing point are entered on their storage lists. Targets are assigned a sequential file number from 1 through 64, and firing points are assigned numbers from 1 through 48. The grid and altitude of each firing point and each target and the az of the OL associated with each firing point are entered on the storage list.

b. Because the range of the Lance missile may require that the missile be fired from one grid zone into another, a spheroid flag and a UTM grid zone number for each target and firing point must be entered into the FADAC. Separate matrix locations are used for these entries. Six-digit easting and seven-digit northing grid coordinates must be entered for each target and firing point. The FADAC high order digits are necessary to identify the specific lettered 100,000-meter grid location of the target and the firing point in the UTM system. See TM 5-241-2, *Universal Transverse Mercator Grid: Zone to Zone Transformation Tables.*

3-13. Observer Data Input

The procedures for entering the grid and altitude of observer locations (survey stations) into memory using the functions in row H of the matrix are the same as those for entering target and firing point data using the functions in rows A and B. Eight observer locations can be stored.

3-14. Survey Data Input

a. Observer grid, altitude, spheroid, and UTM grid zone are required in three of the survey applications. If these data have been previously stored in memory, recall function H-8 (OBS RECALL) may be used to initiate the problem solution.

b. Survey problems are normally solved in a prescribed input sequence, which is explained in Table 3-6 in the description of matrix functions.

3-15. Input Checks

a. To insure that the correct data are being entered, the operator should carefully check input on the display panel before he presses the ENTER key. Further, when there is any doubt about what has been previously entered, the data in memory should be recalled for verification.

b. The teletypewriter print functions (C-5, C-7, and G-7) may be used to check the target, firing point, and observer data stored in memory. See paragraph 3-23, Printed Output.

3-16. Functions Requiring a Signed Input

a. Some input values must be preceded by a plus or minus sign. The FADAC will not accept these inputs unless the plus or minus key is pressed before the numerical value is entered.

b. The following is a list of inputs that require a plus or minus sign and the matrix functions that are used to enter the values.

Input	Matrix Function
Target (TGT) altitude (ALT)	A-3 (TGT ALT)
Target zone	A-5 (TGT ZONE)
Firing point	

Input	Matrix Function
Altitude	B-3 (FP ALT)
Firing point zone	B-5 (FP ZONE)
Latitude	F-1 (LAT)
Longitude	F-2 (LONG)
Star or sun Declination	F-4 (DECL)
Vertical angle	G-5 (VERT ANGLE)
Observer altitude	H-3 (OBS ALT)
Observer's zone	H-5 (OBS ZONE)
Adjacent zone	H-6 (ZONE TO ZONE)
Azimuth by altitude	F-5 (AZ BY ALT)

Section IV. Special Procedures

3-17. Enabling Procedures

a. An enabling procedure has been designed as a safeguard against inadvertent entry of an error. This procedure allows the operator to activate or cancel certain critical functions as desired. When the operator has selected a function requiring an enabling procedure and has pressed the SM key, he must then type 0 or 9 on the keyboard to enable or dismiss the function. This procedure precludes the accidental deletion of information stored in memory by the selection of the wrong matrix button. For each function requiring an enabling procedure, a keyboard entry of 0 enables the function, whereas an entry of 9 dismisses the function and terminates the input mode.

b. Four input functions require the enabling procedure.

Function	Matrix Location
FP DELETE	C-6
TGT DELETE	C-8
CLEAR TEMP STORAGE	D-8
CLEAR MISSION DATA	E-8

3-18. Function Values Set to Minus Zero

a. When certain matrix functions are used, the data entered in their complementary functions are set to an unrecognizable form which, when recalled, will be displayed as five zeros preceded by a minus sign. This form is referred to in this manual as minus zero. Some functions are automatically reset to minus zero during the compute mode of most survey routines. This is a programed safety feature to avoid errors caused when the operator fails to make a complete entry. For example, when locations A-1 through A-5 are used to enter the northing, altitude, spheroid, and zone and matrix location A-7 is used to record the target data, the recording process resets the locations A-1 through A-5 to minus zero. If the operator then enters another target, he will automatically be prevented from using any part of the data entered previously, since those values have been reset to minus zero, a value which the FADAC will not use. Therefore, the operator must enter new data in matrix locations A-1 through A-5 before he can use matrix location A-7 (TGT RECORD).

b. In the solution to survey problems, the matrix functions used to enter the required

data are set to minus zero during computations. Each type of survey problem is computed by using a specific matrix location that causes the data entered in the other locations used for that problem to be reset.

c. Use of the following functions will cause the data in their complementary functions to be set to minus zero.

Function	Complementary Functions
A-7 (TGT RECORD)	A-1 (TGT EAST) A-2 (TGT NORTH) A-3 (TGT ALT) A-4 (TGT SPHER) A-5 (TGT ZONE)
B-7 (FP RECORD)	B-1 (FP EAST) B-2 (FP NORTH) B-3 (FP ALT) B-4 (FP SPHER) B-5 (FP ZONE) B-6 (AZ OL)
C-6 (FP DELETE)	Specific locations in B-8 (RECALL FP OR FP LIST)
C-8 (TGT DELETE)	Specific locations in A-8 (RECALL TGT OR TGT LIST)
D-8 (CLEAR TEMP STORAGE)	All locations in temporary storage
E-8 (CLEAR MISSION DATA)	All mission-associated data in D-1 through D-5 and E-1 through E-6
F-5 (AZ BY ALT)	H-1 (OBS EAST) H-2 (OBS NORTH) H-4 (OBS SPHER) F-1 (LAT) G-2 (HORIZ ANGLE) F-3 (CORR ALT ANGLE) F-4 (DECL) F-2 (LONG)
F-6 (GEO TO UTM)	F-1 (LAT) F-2 (LONG) H-4 (OBS SPHER)
G-6 (TRAV)	G-2 (HORIZ ANGLE) G-3 (HORIZ DIST) or G-4 (SLANT DIST) G-5 (VERT ANGLE) replaces G-6 (TRAV) for subsequent legs as the control function
H-6 (ZONE-TO ZONE)	H-1 (OBS EAST) H-2 (OBS NORTH) H-3 (OBS ALT) H-4 (OBS SPHER) H-5 (OBS ZONE)
F-7 (UTM TO GEO)	H-1 (OBS EAST) H-2 (OBS NORTH) H-3 (OBS ALT) H-4 (OBS SPHER) H-5 (OBS ZONE)
H-7 (OBS RECORD)	H-1 (OBS EAST) H-2 (OBS NORTH) H-3 (OBS ALT) H-4 (OBS SPHER) H-5 (OBS ZONE)

Section V. Use of the Matrix Functions

3-19. Detailed Instructions

Table 3-6 contains detailed instructions on using each of the 64 matrix functions. The information presented in Table 3-6 is as follows:

a. The Matrix Function column identifies each function by the abbreviated designation that appears on the matrix overlay template.

b. The Matrix Location column indicates the location of each function on the input selection matrix by the letter button (A

through H) and the number button (1 through 8) used to select the function. The input functions are listed in the table in alphabetical and numerical order from A-1 through H-8.

c. The column headed Mission Assoc specifies whether or not data controlled by the function are mission associated. The word "yes" in this column means that specific mission buttons must be pressed before the function can be used. If the word "no" appears in the column, it does not matter which mission buttons are pressed when the function is used.

d. The Entry Procedures column presents detailed instructions on entering data for each function.

e. The Recall Procedures column presents detailed instructions for recalling data stored in memory. The abbreviation NA indicates that data cannot be recalled.

f. The Remarks column contains information about each function and special information as to its use.

3-20. Accuracy of Input

Whenever an input is in meters, it must be entered to the nearest meter. Whenever an input is in mils, it must be entered to the nearest mil. Whenever an input deals with latitude or longitude, it must be entered to the nearest second. However, for greater accuracy, these values may be input to the decimal accuracy indicated under Entry Procedures.

Table 3-6. Detailed Matrix Functions

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
TGT EAST	A-1	No	1. Press the SM key. 2. Type in the target easting. See remarks 1 and 2. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the target has been recorded. See remark 3 and refer to function A-8.	1. Range of input is from 127000 through 873000. 2. Six digits must be used. The high order digit identifies the 100,000-meter grid square in which the target is located. 3. Set to minus zero by function A-7.
TGT NORTH	A-2	No	1. Press the SM key.	1. Press the RECALL key.	1. Input values for the Northern Hemisphere must

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			2. Type in the target northing. See remarks 1 and 2. 3. Press the ENTER key.	2. Data cannot be recalled after the target has been recorded. See remark 3 and refer to function A-8.	not be more than 9385039 and, for the Southern Hemisphere must not be less than 1060912. Values outside these limits exceed the limit of the UTM grid system. 2. Seven digits must be used. The high order digits identify the 100,000 - meter grid square in which the target is located. 3. Set to minus zero by function A-7.
TGT ALT	A-3	No	1. Press the SM key. 2. Press the + or - key and type in the target altitude. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the target has been recorded. See remark 2 and refer to function A-8.	1. Range of input is from -2000 through +6500 meters. 2. Set to minus zero by function A-7.
TGT SPHER	A-4	No	1. Press the SM key.	1. Press the RECALL key.	1. Range of input is from 1 through 5.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			2. Type in the appropriate one-digit spheroid flag. Clarke 1866 1 International 2 Clarke 1880 3 Everest 4 Bessel 5	2. Target spheroid flag cannot be recalled after the target has been recorded. See remark 2 and refer to function A-8.	2. Set to minus zero by function A-7.
TGT ZONE	A-5	No	1. Press the SM key. 2. Type in a plus sign if the target is in the Northern Hemisphere or a minus sign if the target is in the Southern Hemisphere. 3. Type in the UTM grid zone number. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the target has been recorded. See remark 2 and refer to function A-8.	1. Range of input is from 1 through 60. 2. Set to minus zero by function A-7.
(Blank)	A-6				Not used.
TGT RECORD	A-7	No	1. Press the SM key. 2. Type in the assigned target list number (1 through 64).	NA	1. Inputs for functions A-1 through A-5 must have been made.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. Press the ENTER key. Grid and altitude will be displayed, and the KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the UTM 100,000-meter grid square high order digits (three digits), and the UTM grid zone number.		2. Use of this function sets the values in functions A-1 through A-5 to minus zero.
RECALL TGT OR TGT LIST	A-8	No	1. Press the SM key. 2. Type in the target list number (1 through 64). 3. Press the ENTER key and the designated target grid and altitude will be displayed. The KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will	1. Use the entry procedures to recall a specific target or use steps 2 and 3 below to recall a mission associated target. 2. Press the appropriate mission association buttons and then press the RECALL key. The mission target grid and altitude will be displayed. The KEYBOARD indicator will light.	After the target data have been recalled, the individual recall procedures for functions A-1 through A-5 will be valid.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			be displayed: Spheroid flag (one digit), the UTM 100,000-meter grid square high order digits (three digits), and the UTM grid zone (one or two digits).	3. Same as entry procedures step 4.	
FP EAST	B-1	No	1. Press the SM key. 2. Type in the FP easting. See remark 1. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the FP has been recorded. See remark 3 and refer to function B-8.	1. The remarks for function A-1 also apply to this function. 2. Entry and recall procedures are the same as for function A-1. 3. Set to minus zero by function B-7.
FP NORTH	B-2	No	1. Press the SM key. 2. Type in the FP northing. See remark 1. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the FP has been recorded. See remark 3 and refer to function B-8.	1. Remarks 1 and 2 of function A-2 also apply to this function. 2. Entry and recall procedures are the same as for function A-2. 3. Set to minus zero by function B-7.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
FP ALT	B-3	No	1. Press the SM key. 2. Press the + or - key and type in the FP altitude. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the FP has been recorded. See remark 3 and refer to function B-8.	1. Range of input is from 0 through +3,000 meters. When a negative launcher altitude is encountered, it must be manually adjusted because FADAC will not accept it. The procedure is as follows: change the sign of the launcher altitude to positive (+) and add this to the target altitude. Launcher altitude then becomes zero (0). Enter a zero launcher altitude and the modified target altitude. 2. Entry and recall procedures are the same as for function A-3. 3. Set to minus zero by function B-7.
FP SPHER	B-4	No	1. Press the SM key. 2. Type in the appropriate one-digit flag. (Spheroid flags are shown under the	1. Press the RECALL key. 2. Firing point spheroid flag cannot be recalled after the FP has been recorded.	1. Entry and recall procedures are the same as for function A-4. 2. Set to minus zero by function B-7.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			entry procedures for function A-4.) 3. Press the ENTER key.	See remark 2 and refer to function B-8.	
FP ZONE	B-5	No	1. Press the SM key. 2. Type in a plus sign if the FP is in Northern Hemisphere or a minus sign if the firing point is in the Southern Hemisphere. 3. Type in the UTM grid zone number. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the FP has been recorded. See remark 2 and refer to function B-8.	1. Range of input is from 1 through 60. 2. Set to minus zero by function B-7.
AZ OL	B-6	No	1. Press the SM key. 2. Type in the az of the OL. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the FP has been recorded. See remark 2 and refer to function B-8.	1. Range of input is from 0 through 6,400 mils. 2. Set to minus zero by function B-7.
FP RECORD	B-7	No	1. Press the SM key. 2. Type in the	NA	1. Inputs for functions B-1 through B-6 must have been made.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			assigned firing point list number (1 through 48). 3. Press the ENTER key. Grid and altitude will be displayed and the KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the 100,000 - meter grid square high order digits (three digits), the UTM grid zone number (one or two digits), and the az of the OL (from one to four digits).		2. Use of this function sets the values in functions B-1 through B-6 to minus zero.
RECALL FP OR FP LIST	B-8	No	1. Press the SM key. 2. Type in the FP list number (1 through 48). 3. Press the ENTER key and the designated FP grid and altitude will be displayed. The KEYBOARD indicator will light.	1. Use the entry procedures to recall a specific FP or use steps 2 and 3 below to recall a mission associated FP. 2. Press the appropriate mission association buttons and then press the RECALL key. The mission FP grid and altitude will be displayed and the	After the FP data have been recalled, the individual recall procedures for functions B-1 through B-6 will be valid.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the UTM 100,000-meter grid square high order digits (three digits), the UTM grid zone number (one or two digits), and the az of the OL (from one to four digits).	KEYBOARD indicator will light. 3. Same as entry procedures, step 4.	
(Blank)	C-1				Not used.
(Blank)	C-2				Not used.
(Blank)	C-3				Not used.
(Blank)	C-4				Not used.
PRINT FP LIST	C-5	No	1. Press the SM key. 2. To print data for all 48 FPs, see step 3 below; or, to print only the data for a specific FP, type the number of that FP. 3. Press the ENTER key.	NA	The teletypewriter must be turned on before using this function.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
FP DELETE	C-6	No	1. Press the SM key. 2. Type in the FP list number. 3. Press the ENTER key. The KEYBOARD indicator will light. 4. Type 0.	NA	The data stored in the memory location assigned by the list number entered in step 2 is set to minus zero by this function.
PRINT TGT LIST	C-7	No	1. Press the SM key. 2. To print data for all 64 targets, see step 3 below; or, to print only the data for a specific target, type the number of that target. 3. Press the ENTER key.	NA	The teletypewriter must be turned on before using this function.
TGT DELETE	C-8	No	1. Press the SM key. 2. Type in the target list number. 3. Press the ENTER key and the KEYBOARD indicator will light. 4. Type 0.	NA	The data stored in the memory location assigned by the list number entered in step 2 are set to minus zero by this function.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
RANGE	D-1	Yes	Press the SM key. The FADAC will compute and display the FP-target range in meters.	Press the RECALL key.	1. Before this function can be used, a target and a FP must have been mission associated. 2. Set to minus zero by function E-8.
AZ FIRE	D-2	Yes	Press the SM key. The FADAC will compute and display the FP target azimuth.	Press the RECALL key.	The remarks for function D-1 also apply to this function.
ORIENT ANGLE	D-3				Not used.
HOB METERS	D-4				Not used.
(Blank)	D-5				Not used.
(Blank)	D-6				Not used.
CLEAR CHANNEL	D-7	No	1. Press the SM key. 2. Type in the appropriate three-digit channel number. See remark 2.	NA	1. See paragraph 3-10, program test 2 procedures, and figure 3-3. 2. Three digits must always be entered in step 2;

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. Press the ENTER key. The KEYBOARD indicator will remain lit. 4. Type 0 to clear the channel or type 9 to dismiss the function. 5. Reenter the data in the cleared channel.		e.g., channel 76 must be entered 076. 3. The contents of each channel of the hot storage section of memory are shown graphically in Figure 3-3, Memory map.
CLEAR TEMP STORAGE	D-8	No	1. Press the SM key. 2. Type 0.	NA	This function sets all values in the hot storage section of memory to minus zero.
TGT LIST ASSOC	E-1	Yes	1. Press the SM key. 2. Type in the target list number (1 through 64). 3. Press the ENTER key. The grid and altitude of the mission target will be displayed and the KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed:	NA	A target must be recorded on the target list before it can be mission associated.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			Spheroid flag (one digit), the UTM 100,000-meter grid square high order digits (three digits), and the UTM grid zone number.		
FP LIST ASSOC	E-2	Yes	1. Press the SM key. 2. Type in the FP list number (1 through 48). 3. Press the ENTER key. The grid and altitude of the firing point will be displayed and the KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the 100,000 - meter grid square high order digits (three digits), the UTM grid zone number (one or two digits), and the az of the OL (from one to four digits).	NA	1. An FP must be recorded on the FP list before it can be mission associated. 2. Set to minus zero by function E-8.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
WHD TYPE	E-3	Yes	1. Press the SM key. 2. Type in the appropriate warhead flag (see flag card). 3. Press the ENTER key.	Press the RECALL key.	1. Set to zero by function E-8. 2. Flags 1, 2, and 3 are used for M234, M234E1, and M234E2 warheads. 3. Flags 6, 7, and 8 are used for M234E3 and M234E4 warheads.
HOB OPTION	E-4	Yes	1. Press the SM key. 2. Type in the appropriate height-of-burst option flag (see flag card). 3. Press the ENTER key.	Press the RECALL key.	Set to minus zero by function E-8.
TOT	E-5	Yes	1. Press the SM key. 2. Type in the time on target. Use two digits for the hour and two digits for minutes. 3. Press the ENTER key.	Press the RECALL key.	Set to minus zero by function E-8.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
FIRING DATA RECALL	E-6	Yes	1. Insure that the appropriate mission association buttons have been pressed. 2. Press SM key. The mission-orienting angle and arm time (depending on the warhead) will be displayed. 3. Press the ENTER key and the SCO flag, range factor, fuze setting, and elevation will be displayed. 4. Press the ENTER key a second time and the time to fire or the time of flight will be displayed depending on the mission TOT entry.	NA	See Figure 3-5 for the firing data display format.
PRINT MISSION	E-7	Yes	1. Insure that the teletypewriter is connected and turned on. 2. Press the SM key.	NA	The printout format is illustrated in paragraph 3-29*f*(3).

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
CLEAR MISSION DATA	E-8	Yes	1. Insure that the appropriate mission association buttons are pressed. 2. Press the SM key. 3. Type 0.	NA	This function erases all of the data input for a specific mission and sets all mission - associated functions to minus zero.

Note: *The output for the solution to all survey computations is by teletypewriter. See paragraph 3-7a, step 10, for the procedure to connect the teletypewriter to the FADAC.*

LAT	F-1	No	1. Press the SM key. 2. Type in a plus sign to indicate north latitude or a minus sign to indicate south latitude. 3. Type in the latitude to the nearest 0.001 second, separating the degrees, minutes, and seconds, with decimal points. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after a problem has been computed. See remark 2.	1. Range of input is -80.30.00—+84.30.00. 2. Set to minus zero during computations.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
LONG	F-2	No	1. Press the SM key. 2. Type in a plus sign to indicate east longitude or a minus sign to indicate west longitude. 3. Type in the longitude to the nearest 0.001 second, separating the degrees, minutes, and seconds, with decimal points. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after a problem has been computed. See remark 2.	1. Range of input is 00.00.00—180.00.00. 2. Set to minus zero during computations.
CORR ALT ANGLE	F-3	No	1. Press the SM key. 2. Type in the observed altitude angle to 0.001 mil. The angle must have been corrected for parallax and/or refraction. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. Used only to enter the corrected altitude angle of the celestial body in the azimuth-by-altitude survey computations. 2. Set to minus zero during computations.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
DECL	F-4	No	1. Press the SM key. 2. Type in a plus sign to indicate north or a minus sign to indicate south declination. 3. Type in the declination of the celestial body to the nearest 0.01 mil. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. Used only to enter the declination of the celestial body in azimuth-by-altitude survey computations. 2. Set to minus zero during computations.
AZ BY ALT	F-5	No	1. The procedures for computing azimuth by altitude with UTM coordinates are: *a.* Using matrix locations H-1, H-2, H-4, and H-5, enter the observer's easting, northing, spheroid, and zone. *b.* Using matrix location G-2, enter the clockwise horizontal angle from the azimuth mark to the celestial body.	NA	1. Used to indicate the position of the celestial body relative to the observer and to initiate the azimuth-by-altitude survey computations. 2. Geographic coordinates may be entered in lieu of the UTM data. See entry procedures 2*a*-2*b* below.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			c. Using matrix locations F-3 and F-4, enter the corrected altitude angle and the declination of the celestial body. *d.* Using matrix location F-5, type in a plus sign if the celestial body is east of the observer's meridian or a minus sign if the celestial body is west of the observer's meridian. The FADAC will enter the compute mode, and verify that all data required for the solution of the problem have been entered. Then the teletypewriter will print out the input data and the following solution data: True azimuth, grid convergence, and grid azimuth. 2. The procedures for computing azimuth by altitude using geographic coordinates are:		

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			a. Using matrix locations F-1, F-2, and H-4, enter the latitude, longitude, and observer's spheroid. *b.* Using matrix location G-2, enter the clockwise horizontal angle from the azimuth mark to the celestial body. *c.* Using matrix locations F-3 and F-4, enter the corrected altitude angle and the declination of the celestial body. *d.* Using matrix location F-5, type in a plus sign if the celestial body is east of the observer's meridian or a minus sign if the celestial body is west of the observer's meridian. The FADAC will enter the compute mode and verify that all data required for the solution of the problem have been entered. Then the teletypewriter will print out the		

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			input data and the following solution data: True azimuth, grid and convergence, and grid azimuth.		
GEO TO UTM	F-6	No	The procedures for computing UTM coordinates from geographic coordinates are: *a.* Using matrix locations F-1 and F-2, enter the latitude and the longitude to be converted. *b.* Using matrix location H-4, enter the appropriate spheroid flag. (Spheroid flags are shown under the entry procedures for function A-4.) *c.* Press the matrix buttons and then press the SM key. The FADAC will enter the compute mode and verify that all data required for the	NA	1. Used only to initiate the computation of UTM grid coordinates from geographic coordinates. 2. See note on page 3-35.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			solution of the problem have been entered. Then the teletypewriter will print out the input geographic coordinates and the following output: UTM easting, UTM northing, spheroid flag, and UTM grid zone number.		
UTM TO GEO	F-7	No	The procedure for computing geographic coordinates from UTM grid coordinates is: *a.* Using matrix locations H-1, H-2, H-4, and H-5, enter the observer's grid, spheroid, and grid zone that are to be converted. *b.* Press the matrix buttons and then press the SM key. The FADAC will enter the compute mode, and the teletypewriter will print out the input UTM data and the	NA	

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			converted latitude and longitude.		
(Blank)	F-8				Not used.
START AZ	G-1	No	1. Press the SM key. If the starting location was recalled from the observer list, the number of the observer for whom the azimuth is being entered will be displayed. 2. Type in the grid azimuth to the reference mark to the nearest 0.001 mil. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the traverse mode has been terminated. The value displayed will be the last entered value or the computed back-azimuth of the last computed traverse leg. 3. See remarks 2 and 3.	1. This function is used only to enter the starting azimuth in a traverse computation. 2. The value entered in function G-2 is added by the FADAC to the value entered or stored in this function to determine the azimuth to the next traverse station. 3. See function G-6. 4. Set to minus zero when the traverse mode is terminated.
HORIZ ANGLE	G-2	No	1. Press the SM key. 2. Type in the horizontal angle to the nearest 0.001 mil.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. This function is used only to enter the horizontal angle in traverse and azimuth-by-altitude survey procedures.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. Press the ENTER key.		2. Set to minus zero during computations.
HORIZ DIST	G-3	No	1. Press the SM key. 2. Type in the horizontal distance to the nearest 0.01 meter. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. Function G-4 (SLANT DIST) may not be used if this function is used; conversely, this function may not be used if slant distance is entered in function G-4. 2. Set to minus zero during computations.
SLANT DIST	G-4	No	1. Press the SM key. 2. Type in the slant distance to the nearest 0.01 meter. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. Function G-3 (HORIZ DIST) may not be used if this function is used; conversely, this function may not be used if horizontal distance is entered in function G-3. 2. Set to minus zero during computations.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
VERT ANGLE	G-5	No	1. Press the SM key. 2. Press the + or - key and type in the value of the vertical angle to the nearest 0.01 mil.	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been computed. See remark 2.	1. Range of input is from +1600 through -1600 mils. 2. Set to minus zero during computations.
TRAV	G-6	No	The procedure for solving a traverse problem is: *a.* Press the SM key. *b.* Type in 0 to indicate a normal traverse leg computation or type in a digit 1 through 9 to indicate the number of legs to be computed if an offset traverse is being run. *c.* Using functions H-1, H-2, and H-3, enter the starting grid and altitude of the initial traverse station; or use function H-8 to recall these data from the observer list. *d.* Using function G-1, enter the starting azimuth.	NA	1. Used only to initiate the traverse problem. A flag entry of 0 is used to indicate a normal traverse leg computation. The entry of a digit 1 through 9 is used to indicate the number of legs to be computed in an offset traverse. 2. The grid and altitude of each traverse station are automatically entered in functions H-1, H-2, and H-3 at each end of computations for each leg. If the grid is recorded using function H-7, it must be recalled using function H-8 before the traverse can be continued.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			e. Using function G-2, enter the horizontal angle. *f.* Using function G-3 or G-4, enter either the horizontal distance or the slant distance. *g.* Using function G-5, enter the vertical angle. When the ENTER key is pressed, the FADAC will enter the compute mode, verify that all data required in the solution of the problem have been entered, and cause the teletypewriter to print the input data and the following output data: Station number, UTM easting coordinate, UTM northing coordinate, station altitude, azimuth of the last leg, and back azimuth. *h.* If the KEYBOARD indicator lights, repeat step *b* (if the KEYBOARD indicator		3. During the computation of an offset traverse, the KEYBOARD indicator will not light after the printout. Refer to step *h*. 4. Set to minus zero when the traverse mode is terminated. 5. See note on page 3-35.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			does not light, an offset traverse is being computed. In this case, enter the data for the next offset leg, starting with step *e.)* *i.* Return to step *e* or terminate the mode by pressing the decimal point key.		
PRINT OBS LIST	G-7	No	1. Press the SM key. 2. To print the entire observer list, proceed to step 3; to print only the data for a specific observer, type in the number of that observer. 3. Press the ENTER key.	NA	
(Blank)	G-8				Not used.
OBS EAST	H-1	No	1. Press the SM key.	1. Press the RECALL key.	1. Remarks 1 and 2 of function A-1 also apply to this function.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			2. Type in the observer easting. See remark 1. 3. Press the ENTER key.	2. Data cannot be recalled after the observer has been recorded. See remark 3 and refer to function H-8.	2. Entry and recall procedures are the same as for function A-1. 3. Set to minus zero by function B-7.
OBS NORTH	H-2	No	1. Press the SM key. 2. Type in the observer northing. See remark 1. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the observer has been recorded. See remark 3 and refer to function H-8.	1. Remarks 1 and 2 of function A-2 also apply to this function. 2. Entry and recall procedures are the same as for function A-2. 3. Set to minus zero by function H-8.
OBS ALT	H-3	No	1. Press the SM key. 2. Press the + or - key and type in the observer altitude. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the observer has been recorded. See remark 3 and refer to function H-8.	1. Range of input is from -300 through +4000. 2. Entry and recall procedures are the same as for function A-3. 3. Set to minus zero by function H-7.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
OBS SPHER	H-4	No	1. Press the SM key. 2. Type in the appropriate one-digit flag. (Spheroid flags are shown under the entry procedures for function A-4.) 3. Press the ENTER key.	1. Press the RECALL key. 2. Observer spheroid flag cannot be recalled after the observer has been recorded. See remark 2 and refer to function H-8.	1. Entry and recall procedures are the same as for function A-4. 2. Set to minus zero by function H-7.
OBS ZONE	H-5	No	1. Press the SM key. 2. Type in a plus sign if the observer is in the Northern Hemisphere or a minus sign if the observer is in the Southern Hemisphere. 3. Type in the UTM grid zone number. 4. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the observer has been recorded. See remark 2 and refer to function H-8.	1. Range of input is from 1 through 60. 2. Set to minus zero by function H-7.
ZONE TO ZONE	H-6	No	The procedures for solving a zone - to - zone coordinate transformation are as follows:	NA	1. Used only to enter the UTM grid zone number of the zone to which coordinates are being transformed.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			a. Using matrix functions H-1 through H-5, enter the coordinates, altitude, spheroid, and grid zone to be transformed. *b.* Press the matrix buttons and then press the SM key. *c.* Type in a plus sign if the station is in the Northern Hemisphere or a minus sign if the station is in the Southern Hemisphere. *d.* Type in the number of the UTM grid zone to which the coordinates are to be transformed. *e.* Press the ENTER key. *f.* The teletypewriter will print the input grid, spheroid, and zone and the transformed grid, spheroid, and zone.		2. Transformation can be computed only between adjacent zones. 3. See note on page 3-35.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
OBS RECORD	H-7	No	1. Press the SM key. 2. Type in the assigned observer number (1 through 8). 3. Press the ENTER key. Grid and altitude will be displayed and the KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the 100,000 - meter grid square high order digits (three digits), the UTM grid zone number (one or two digits), and the list number assigned to the observer.	NA	1. Inputs for functions H-1 through H-5 must have been made. 2. Use of this function sets the values in functions H-1 through H-5 to minus zero.
OBS RECALL	H-8	No	1. Press the SM key. 2. Type in the observer list number (1 through 8). 3. Press the ENTER key and the designated ob-	NA	

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			server grid and altitude will be displayed. The KEYBOARD indicator will light. 4. Press the ENTER key a second time and the following data will be displayed: Spheroid flag (one digit), the 100,000 - meter grid square high order digits (three digits), the UTM grid zone number (one or two digits), and the list number of the observer being recalled.		

Section VI. Output

3-21. Displayed Output

a. **Nixie tubes.** Output for the Lance missile program is displayed on the Nixie tubes in the display panel or by means of the teletypewriter printer. The display panel is divided into six windows. They display the data being input through the keyboard or the data being recalled or being output as the result of the FADAC solution to a specific problem.

Note: *One lettered and one numbered mission association button must be pressed for the display to appear on the Nixie tubes.*

(1) The first window, BATTERY, contains one Nixie tube that displays the letter A, B, C, D, or E, depending on the lettered mission association button being used.

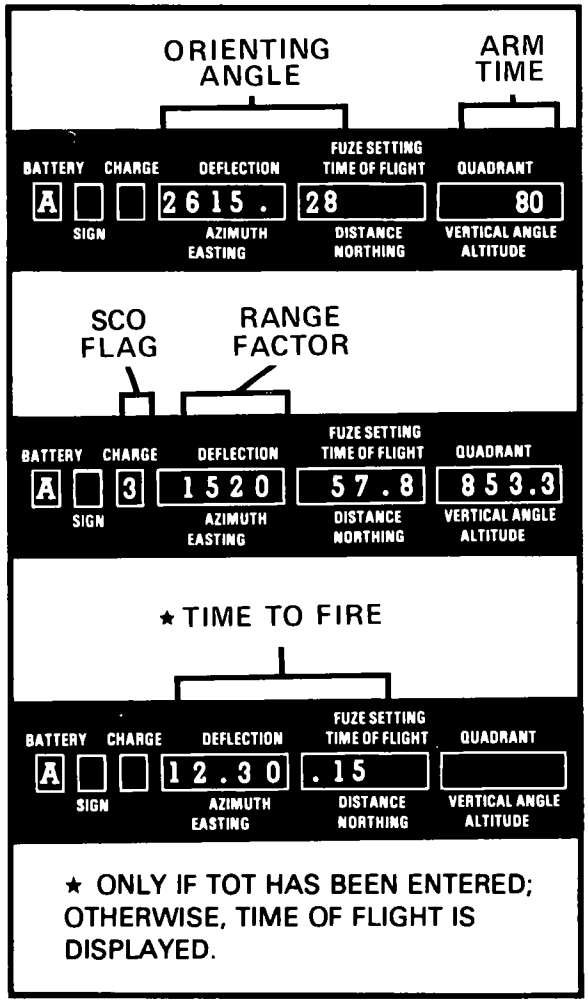


Figure 3-5. Firing data displayed in three parts.

(2) The second window, SIGN, contains one Nixie tube that displays the sign (+ or -) for the numerical output or input. The sign may also designate the hemisphere ((+) for Northern and Eastern, (-) for Southern and Western) in which the input or output data are located.

(3) The third window, CHARGE, contains one Nixie tube that displays a single number. Normally, this number is a flag associated with the input or output. When firing data are displayed, the number represents the SCO setting flag.

(4) The fourth window, DEFLECTION, AZIMUTH, EASTING, has five Nixie tubes that display numerical input or output depending on the matrix function being used.

(5) The fifth window, FUZE SETTING, TIME OF FLIGHT, DISTANCE, NORTHING, has five Nixie tubes that display numerical input or output data depending on the matrix function being used.

(6) The sixth window, QUADRANT, VERTICAL ANGLE, ALTITUDE, has five Nixie tubes that display numerical input or output data depending on the matrix function being used.

b. **Firing data display.** The computed firing data are displayed in three parts on the display panel. The three-part display is illustrated in Figure 3-5. When firing data are computed, the orienting angle is displayed in the fourth and fifth windows and the arm time is displayed in the sixth window as the first part of these data. The KEYBOARD and IN/OUT indicators will remain lit. When the ENTER key is pressed, the second part of the firing data is displayed. The SCO flag is displayed in the third window, the range factor is displayed in the fourth window, the fuze setting is displayed in the fifth window, and the quadrant elevation is displayed in the sixth window. The KEYBOARD and IN/OUT indicators will remain lit. When the ENTER key is pressed, the third and last part of the firing data is displayed in the fourth and fifth windows. Time to fire is displayed, if a time on target (TOT) entry was made in matrix location E-5. Otherwise, time of flight is displayed.

3-22. Recalled Output

Any data entered into memory through the keyboard may be recalled by use of the RECALL key. After data are used in a computation, however, the values may be set to minus zero as discussed in paragraph 3-18. There are four matrix functions that are used to recall data. They are matrix functions A-8 (RECALL TGT OR TGT LIST), B-8 (RECALL FP OR FP LIST), H-8 (OBS RECALL), and E-6 (FIRING DATA RECALL).

3-23. Printed Output

a. The Lance program provides for the printout of all input and output data and, in the case of survey problem solution, printed solutions are the only output. Complete fire mission data may be printed to provide a hard copy record for the unit journal. Matrix function E-7 (PRINT MISSION) is used. See Table 3-6 for the detailed procedures. The observer, firing point, and target lists may be printed using the appropriate matrix function: G-7 (PRINT OBS LIST), C-5 (PRINT FP LIST), or C-7 (PRINT TGT LIST). In each case, the entire list may be printed or any single list location may be printed. Unused list numbers are not printed.

b. Survey problem solutions are output only by the teletypewriter. Both input and solutions are printed for the following problems:

(1) Azimuth by altitude.
(2) Geographic-to-UTM conversion.
(3) UTM-to-geographic conversion.
(4) Zone-to-zone transformation.
(5) Traverse.

Printed output is illustrated in the example problems in Section VII.

3-24. Flags and No Solution Displays

a. Information to designate the type warhead, the SCO setting, the location of a point in the Northern or Southern Hemisphere, or which spheroid data are to be used in computations is input or output by using a number code called a flag. These flags are shown in Section I of the flag card illustrated in Figure 3-6.

b. When an input item is entered by an erroneous procedure or the data being entered cannot be accepted by the FADAC (e.g., a number larger to smaller than should be input or the problem cannot be solved using the input data), the NO SOLUTION indicator flashes and a code number (flag) is displayed in the Nixie tubes to identify the error. No solution display flags and a description of the problem causing the indicator to flash are shown in Section II of the flag card illustrated in Figure 3-6.

FLAG CARD—MISSILE LANCE

THIS CARD IS AN EXTRACT OF FM 6-40-4. PROGRAM WILL DISPLAY 200000 00000 00559 FOLLOWING A SUCCESSFUL SUM CHECK.

CAUTION. WORKING STORAGE SELECT SWITCH MUST BE SET TO 12 POSITION WHEN LOADING AND OPERATING THIS PROGRAM.

SECTION I—FLAGS

1. WARHEAD TYPE(E3)	FLAG	2. HOB OPTION(E4)	FLAG
*M-234A/M-252A	1	IMPACT	0
*M-234B/M-252B	2	LOW AIR	1
*M-234C/M-252C	3	HIGH AIR	2
M-251	4		
M-198	5		
**M-234E3A/M-252A	6		
**M-234E3B/M-252B	7	IMPACT	0
**M-234E3C/M-252C	8	LOW/HIGH AIR	1
**M-234E3X/M-252X	8		

5. HE	NUC	FLAG
OFF	N	0
A	P	1
B	R	2
C	T	3
D	U	4
E	V	5
F	W	6
G	X	7
H	Y	8
J	Z	9

3. HEMISPHERE (A5, B5, H5, F1, F2)	
NORTHERN	+
SOUTHERN	-
EASTERN	+
WESTERN	-
4 SPHEROID (A4, B4, H4)	
CLARKE 1866	1
INTERNATIONAL	2
CLARKE 1880	3
EVEREST	4
BESSEL	5

6. MULTIPLE DISPLAY	
TERMINATE	•
INITIATE NEXT DISPLAY	ENTER
7. ENABLE/DISABLE	
ENABLE	0
DISABLE	9
8. PROGRAM TEST	
SUM CHECK	1
PARITY CHECK	2
NIXIE TEST	3
TELETYPE TEST	4

SECTION II—ERROR DISPLAYS

NSL & 00	USE OF UNASSIGNED MATRIX POSITION OR COMPUTATION BUTTON, ENTRY OF IMPROPER ENABLE/DISABLE OR MULTIPLE DISPLAY FLAG
NSL & 1	INPUT NOT WITHIN ALLOWABLE LIMITS OR IMPROPER NUMBER OF DIGITS ENTERED
NSL & 2	INVALID TRANSFORMATION OF COORDINATES IN ZONE TO ZONE COMPUTATION
NSL & 3	MATRIX OR MISSION BUTTONS IMPROPERLY CHANGED EITHER DURING INPUT OR COMPUTATION
NSL & 4	RECALL OF MISSILE PRESETTINGS FOR A MISSION WHICH HAS NOT BEEN COMPUTED
NSL & 5	IMPROPER COMBINATION OF NORTHING AND ZONE ENTRIES FOR TARGET, FIRING POINT, OR OBSERVER
NSL & 6	RANGE OR RANGE FACTOR NOT WITHIN ALLOWABLE LIMITS
NSL & 7	HEIGHT OF BURST RELATIVE TO LAUNCHER NOT WITHIN ALLOWABLE LIMITS
NSL & ..... -00000	RECALL OF NONEXISTENT DATA
NSL&DATA DISPLAY	IMPROPER ENTRY OF LATITUDE OR LONGITUDE, UNSUCCESSFUL SUM CHECK; IMPROPER ENTRY OF HOT MEMORY CHANNEL NUMBER
NSL & ..... XY	MATRIX POSITION ENTRY MISSING OR FUNCTION NOT EXECUTED X IS DIGIT REPRESENTING NUMERICALLY LABELED VERTICAL COLUMN OF MATRIX Y IS DIGIT REPRESENTING ALPHABETICALLY LABELED HORIZONTAL ROW OF MATRIX
NSL&NO DISPLAY	MATRIX OR MISSION ALPHA BUTTONS NOT PRESSED

*Applies to model M234E1 and M234E2

**Applies to model M234E3 and M234E4

Figure 3-6. The flag card (front).

Section VII. Solving Problems

The Lance missile program is used to compute firing data for the missile and solve survey problems. Thus, the fire direction center has a limited capability to compute survey problems inherent in Lance battalion operations. Computations are performed with exceptional speed and produce survey problem solutions to the degree of accuracy needed. The types of survey problems that can be solved are traverse, UTM zone-to-zone grid coordinate transformation, azimuth-by-altitude computations, and geographic-to-UTM and UTM-to-geographic coordinate conversion. The FADAC will solve the Lance ballistic problem in about 6 seconds. Firing data are displayed for immediate transmission to the firing platoon, and the complete mission data may be output in printed form using the teletypewriter.

Note: *Solutions to survey problems and fire missions are computed using Lance training program tape P/N 8213315/121/M, dated 1 April 1976.*

3-25. Solving Fire Mission Problems

The FADAC operator procedures usually follow the same sequence in the solution of the Lance fire mission problems. The steps in processing a fire mission using the FADAC should be performed in the sequence indicated in steps 1 through 11 below. This sequence is designated to eliminate lost motion and redundant actions. Details in the use of each matrix function used are contained in Table 3-6.

STEP	ACTION
1	Record the call for fire and fire order on the computer record.
2	The FADAC operator presses the appropriate mission association buttons on the right side of the matrix panel. Insure one lettered button (A through E) and one numbered button (1 or 2) are pressed.
3	By following the procedures detailed in Table 3-6 for matrix function E-8 (CLEAR MISSION DATA), the operator clears the section of memory where the input data will be stored.
4	The operator then uses matrix functions E-1 (TGT LIST ASSOC) and E-2 (FP LIST ASSOC) to associate the mission target with a specific firing point. Both target and firing point data must have been previously entered and stored in memory before this step. See Table 3-6.
5	Using the appropriate matrix functions in row E, color-coded red, the operator follows the entry procedures described in Table 3-6 and enters the warhead type flag, height-of-burst option, if required, and the time on target.
6	The operator then presses the COMPUTE button. The FADAC calculates and displays the firing data in three parts as described in paragraph 3-21.
7	The operator announces the firing data determined in step 6 above.
8	Using matrix functions D-1 (RANGE) and D-2 (AZ FIRE), the operator may compute the range and azimuth of fire. (This azimuth is expressed to 10 mils and entered into the warning order.)

STEP	ACTION
(9)	The firing data are transmitted to the firing platoon.
(10)	The operator then uses matrix function E-7 (PRINT MISSION) to obtain a printout of all the mission data.
(11)	After the mission has been fired, the fire direction officer, using the printout obtained in step 10 above, submits the mission-fired report to the higher headquarters.

3-26. Solving Survey Problems

The operator procedures required to solve a survey problem depend on the type of survey problem being solved. The sequence of steps is detailed in Table 3-6 under the Entry Procedures column for matrix functions F-5 (AZ BY ALT), F-6 (GEO TO UTM), F-7 (UTM TO GEO), G-6 (TRAV), and H-6 (ZONE TO ZONE). These procedures are also illustrated in the example problems in paragraph 3-28.

3-27. Initiating Computations

The COMPUTE button is used only to initiate the computations for a ballistic solution. Survey computations and the calculation of range, azimuth of fire, and the orienting angle are initiated by the SM key in conjunction with the appropriate matrix function. The Lance program is designed to check the input parameters during computations to insure that all the data needed for the solution have been entered. Whenever a computation is initiated that cannot be solved by the FADAC because of a missing or invalid input parameter, the program will cause the NO SOLUTION light (NSL) to flash and a two-digit number (flag) to be displayed that will identify the matrix location where an entry has been omitted or indicate that an invalid entry has been made. See flag card, Figure 3-6.

3-28. Example Survey Problems

a. **Traverse survey.** The Lance program traverse function is designed to solve a normal traverse and also provides for the solution of offset traverses from each station. Data must be entered in sequence shown in Entry Procedures column of Table 3-6 for matrix function G-6 (TRAV). A normal traverse is initiated by entering a 0 (flag) in this function. Each leg of the traverse is computed as soon as the vertical angle has been entered. When the output is printed by the teletypewriter, the FADAC returns to the keyboard input mode. If the traverse continues normally, the 0 key is pressed; however, if an offset traverse is to be computed from the traverse station, a numbered key 1, 2, 3, 4, 5, 6, 7, 8, or 9 is pressed to indicate the number of legs in the offset. At the conclusion of the offset traverse computation, the FADAC again returns to the keyboard input mode and the procedure is repeated. Whenever an offset traverse is to be computed from the initial point, the numbered key indicating the number of legs in the offset must be pressed after activating matrix function G-6 (TRAV). In this case, the starting azimuth must be reentered at the conclusion of the offset computation. A traverse problem is terminated by pressing the decimal point key after the last leg has been computed.

b. **Example problem, traverse.**

(1) *Situation.* The battery survey section has recorded the following data for a traverse from a survey control point (SCP) to firing points 1 and 4.

(a) Survey control point grid: 546963.6 3831694.5, altitude +418.8.

(b) Field data:

Traverse (station)	Azimuth (mils)	Horizontal Angle (mils)	Distance (meters)	Vertical Angle (mils)
SCP to Mark	4216.000			
SCP to TS 1		1382.100	218.06	-2.6
TS 1 to TS 2		4694.402	221.87	-4.4
TS 2 to TS 3		1966.198	195.08	-3.3
TS 3 to FP 1	(Offset)	1749.603	220.62	-2.5
TS 3 to TS 4		4019.586	491.66	-1.8

(2) *Requirement.* The computation of the coordinates of each station and the two firing points.

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	H-1 OBS EAST	SM; 546963.6;	ENTER
2	H-2 OBS NORTH	SM; 3831694.5;	ENTER
3	H-3 OBS ALT	SM; +418.8;	ENTER
4	G-6 TRAV	SM; 0;	ENTER
5	G-1 START AZ	SM; 4216.000;	ENTER
6	G-2 HORIZ ANGLE	SM; 1382.100;	ENTER
7	G-3 HORIZ DIST	SM; 218.06;	ENTER
8	G-5 VERT ANGLE	SM; -2.6;	ENTER

(4) *Solution.* The teletypewriter will print out the following input data and the solution to the first traverse leg:

OBE 546963.60 OBN 3831694.50 OBA 418.8
START AZ 4216.00
HORIZ ANGLE 1382.10 HORIZ DIST 218.06
VERT ANGLE -2.6 NORMAL LEG NO. 1
OBE 546809.18 OBN 3831848.34 OBA 418.25
FWD AZ 5598.10 BACK AZ 2398.10

Note: *At this point, the FADAC will return to the input mode. The operator must now enter one of the flags indicated above to indicate whether the next leg is an offset or a normal continuation of the traverse. In this example, a normal traverse will continue from this station.*

(5) *FADAC procedures continued.* Type 0 on the keyboard and repeat the procedures of steps 6, 7, and 8, above, entering the appropriate data from (1)(b) above to compute the legs to TS 2 and TS 3.

(6) *Solution.* The teletypewriter will print the following:

HORIZ ANGLE 4694.40 HORIZ DIST 221.87
VERT ANGLE -4.40
NORMAL LEG NO. 2
OBE 546948.61 OBN 3832020.81 OBA 417.29
FWD AZ 692.50 BACK AZ 3892.50
HORIZ ANGLE 1966.20 HORIZ DIST 195.08
VERT ANGLE -3.30
NORMAL LEG NO. 3
OBE 546849.79 OBN 3832188.92 OBA 416.66
FWD AZ 5858.70 BACK AZ 2658.70

(7) *FADAC procedures continued.* The next computation is an offset traverse of one leg; therefore, type 1 on the keyboard and repeat steps 6, 7, and 8, entering the appropriate data from (1)(b) above.

(8) *Solution continued.* The teletypewriter will print the following:

HORIZ ANGLE 1749.60 HORIZ DIST 220.62
VERT ANGLE -2.50
OFFSET LEG NO. 1
OBE 546645.36 OBN 3832106.19 OBA 416.12
FWD AZ 4408.30 BACK AZ 1208.30

(9) *FADAC procedures continued.* The last leg of the traverse is a normal leg; therefore, type 0 on the keyboard and repeat steps 6, 7, and 8, entering the final traverse leg data from (1) (b) above.

(10) *Solution continued.* The teletypewriter will print the final traverse leg as follows:

HORIZ ANGLE 4019.59 HORIZ DIST 491.66
VERT ANGLE -1.80
NORMAL LEG NO. 4
OBE 546982.40 OBN 3832662.16 OBA 415.81
FWD AZ 278.29 BACK AZ 3478.29

(11) *FADAC procedures continued.* Press the decimal point key to terminate the mode.

c. **Zone-to-zone grid coordinate transformation.** The Lance program will transform the UTM grid coordinates in any grid zone to the UTM grid coordinates of an adjacent grid zone. Any easting coordinates between 127000 and 873000 and any northing grid coordinates between 0 and 9385039 for the Northern Hemisphere and between 1060912 and 9999999 for the Southern Hemisphere may be entered.

d. **Example problem, zone-to-zone.**

(1) *Situation.* A map in UTM grid zone 14S was used for reporting the grid coordinates of an enemy position. These UTM coordinates, 14S NP 7524035470, altitude 400, were sent to the Lance battalion FDC. The Lance battalion survey control had been established from UTM grid zone 15S data. All map projections are based on the Clarke 1866 spheroid. The fire direction officer noted that the lower left-hand corner of the NP 100,000-meter grid square is labeled 600000 mE, 3800000 mN (Northern Hemisphere). This means that the grid may be written 675240 3835470. The higher order digits identify the NP 100,000-meter grid square.

(2) *Requirement.* Transform the 14S grid coordinates to 15S grid coordinates.

(3) *FADAC procedures.*

(4) *Solution.* The teletypewriter will print out the following:

OBE 675240.00 OBN 3835470.00 OBA 400.00
OBS 1 OBZ 14
OBE 125258.08 OBN 3841415.26 OBA 400.00
OBS 1 OBZ 15

e. **Azimuth-by-altitude.** The Lance program will compute the true azimuth, the grid convergence, and the grid azimuth of a line from survey data determined by astronomical observations using the azimuth-by-altitude method. Either the observer's UTM grid location or geographic coordinates may be used. If both are entered, the FADAC program uses only the UTM grid for the calculation.

f. **Example problem, azimuth-by-altitude.**

(1) *Situation.* The survey officer has obtained the following data to establish an

azimuth for an orienting line from one of the firing points.

(a) Observer's easting: 625900.00
(b) Observer's northing: 3941000.00
(c) Observer's spheroid flag: 1
(d) Observer's zone: 40
(e) Horizontal angle: 2926.11 mils
(f) *Corrected altitude angle: 382.14
(g) Declination: +269.88 mils
(h) Celestial body: East of the SCP

*Corrected for parallax and refraction.

(2) *Requirements.* Determine the azimuth of the orienting line.

Step	Activate Button or Matrix Position	Keyboard	
1	H-1 OBS EAST	SM; 675240;	ENTER
2	H-2 OBS NORTH	SM; 3835470;	ENTER
3	H-3 OBS ALT	SM; +400;	ENTER
4	H-4 OBS SPHER	SM; 1;	ENTER
5	H-5 OBS ZONE	SM; +14;	ENTER
6	H-6 ZONE TO ZONE	SM; +15;	ENTER

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	H-1 OBS EAST	SM; 625900	ENTER
2	H-2 OBS NORTH	SM; 3951000	ENTER
3	H-4 OBS SPHER	SM; 1;	ENTER
4	H-5 OBS ZONE	SM; +40;	ENTER
5	G-2 HORIZ ANGLE	SM; 2926.11;	ENTER
6	F-4 DECL	SM; +269.88;	ENTER
7	F-5 AZ BY ALT	SM; + (east)	

(4) *Solution.* The teletypewriter will print out the following solution:

OBE 625900.00 OBN 351000.00 OBS 1 OBZ 40 HORIZ ANGLE 2926.11 CORR ALT ANGLE 382.14 DECL 269.88 EAST TRUE AZ 5009.06 GRID CONV -13.16 GRID AZ 4995.91

g. **Geographic-to-UTM and UTM-to-geographic conversion.** The Lance program will convert geographic coordinates to UTM grid zones for any location in the universal transverse mercator projection. The entry procedures for geographic coordinates require the separation of the degrees, minutes, and seconds by decimal points.

h. **Example problem, geographic-to-UTM.**

(1) *Situation.* Geographic coordinates of a survey control point were obtained from a survey record.

(2) *Requirement.* The battalion survey officer has requested that the UTM coordinates be computed from the following data:

(a) North latitude: 34° 39′ 47.002″

(b) West longitude: 98° 24′ 42.100″

(c) International spheroid: (flag) 2

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	F-1 LAT	SM; +34.39.47.002;	ENTER
2	F-2 LONG	SM; -98.24.42.100;	ENTER
3	H-4 OBS SPHER	SM; 2;	ENTER
4	F-6 GEO TO UTM	SM	

(4) *Solution.* The teletypewriter will print out the following:

OBS 2 LAT 34.39.47.002 LONG -98.24.42.009 OBE 553905.70 OBN 3835895.88 OBS 2 OBZ 14

i. **Example problem, UTM-to-geographic.**

(1) *Situation.* The battalion S3 desires to know the geographic coordinates of UTM grid intersection 500000.00 3400000.00, zone 14 Northern Hemisphere, on his Clarke 1866 map (spheroid flag 1).

(2) *Requirement.* Convert the UTM grid to geographic coordinates.

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	H-1 OBS EAST	SM; 500000.0;	ENTER
2	H-2 OBS NORTH	SM; 3400000.0;	ENTER
3	H-4 OBS SPHER	SM; 1;	ENTER
4	H-5 OBS ZONE	SM; +14;	ENTER
5	F-7 UTM TO GEO	SM	

(4) *Solution.* The teletypewriter will print out the following:

OBE 500000.00 OBN 3400000.00 OBS 1 OBZ 14
LAT 30.44.04.344 LONG -98.59.59.999

3-29. Example Fire Mission Problems

a. **Entering target data on the target list.** The Lance program will accept and store 64 targets. The data stored in memory are entered using matrix functions A-1 through A-7. Target data are recalled using matrix function A-8 or by using matrix function C-7 to cause the FADAC to print the target list. Target data must be entered on the target list before the data can be used in a fire mission.

b. **Example problem, entering target data.**

(1) *Situation.* The following target list has been received from higher headquarters. All data are based on International mapping spheroid data (flag 2).

Target File Number	Target Number	Grid	Altitude	Zone
1	XZ 2100	298486 5438053	512	33P
2	XZ 2110	331162 5425810	337	33P
3	XZ 2170	698197 5426302	300	32P

(2) *Requirement.* Enter the target list into memory.

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	A-1 TGT EAST	SM; 298486;	ENTER
2	A-2 TGT NORTH	SM; 5438053;	ENTER
3	A-3 TGT ALT	SM; +512;	ENTER
4	A-4 TGT SPHER	SM; 2;	ENTER
5	A-5 TGT ZONE	SM; +33;	ENTER
6	A-7 TGT RECORD	SM; 1; ENTER;	ENTER
7	Repeat steps 1 through 6 using each set of target data.		

c. **Entering firing point data on the firing point list.** The Lance program will accept and store 48 firing points. The data that are stored in memory are entered using matrix functions B-1 through B-7. Firing point data are recalled using matrix function B-8 or by using matrix function C-5 to cause the teletypewriter to print the firing point list. Firing point data must be entered on the firing point list before the data can be used in a fire mission.

d. **Example problem, entering firing point data.**

(1) *Situation.* The following firing point data were obtained from the survey officer. Survey control is based on International mapping spheroid data (flag 2).

Firing Point Number	Grid Zone	Easting	Northing	Altitude	Azimuth OL
12	33P	311181	5411533	388	2896.83
22	32P	710007	5406721	628	6291.05

(2) *Requirement.* Enter the firing point data on the firing point list.

(3) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	B-1 FP EAST	SM; 311181;	ENTER
2	B-2 FP NORTH	SM; 5411533;	ENTER
3	B-3 FP ALT	SM; +388	ENTER
4	B-4 FP SPHER	SM; 1;	ENTER
5	B-5 FP ZONE	SM; +33;	ENTER
6	B-6 AZ OL	SM; 2896.83;	ENTER
7	B-7 FP RECORD	SM; 12; ENTER;	ENTER
8	Repeat steps 1 through 7 using the data for firing point 22.		

e. **Deletion of targets or firing points from the lists.** The Lance program provides the capability to delete specific targets from the target list or specific firing points from the firing point list when they are no longer required. A separate matrix function is provided for each list, C-6 (FP DELETE) and C-8 (TGT DELETE). The FADAC procedures are detailed in Table 3-6.

f. **Example problem, fire mission using the nuclear warhead M234.**

(1) *Situation.*

(a) The following call for fire has been received in the FDC.

FIRE MISSION
A/3/2, ONE LAUNCHER
FIRING POINT NO: 12
TARGET NUMBER: XZ 2170 (File No. 3)
TARGET COORDINATES: 32P ND 98197 26302
TARGET ALTITUDE: 300 meters
WARHEAD: M234A
HEIGHT OF BURST: LOW AIR
TIME ON TARGET: 230415
TOT NOT LATER THAN: 230430

(b) The fire direction officer issued the fire order.

(2) *FADAC procedures.*

Step	Activate Button or Matrix Location	Keyboard	
1	Mission buttons A-1	None	
2	E-8 CLEAR MISSION DATA	SM; 0	
3	E-1 TGT LIST ASSOC	SM; 3; ENTER;	ENTER
4	E-2 FP LIST ASSOC	SM; 12; ENTER;	ENTER
5	E-3 WHD TYPE	SM; 1;	ENTER
6	E-4 HOB OPTION	SM; 1;	ENTER
7	E-5 TOT	SM; 0415;	ENTER
8	COMPUTE		

Displayed solution: Part 1.

Battery	*Orienting Angle*
A	*4178.31*

ENTER

Displayed solution: Part 2.

Battery	*Sustainer cutoff*	*Range factor*	*Fuze setting*	*Quadrant elevation*
A	*3*	*3502*	*95.4*	*853.3*

ENTER

Displayed solution: Part 3.

	Battery		*Time to fire*
	A		*04.13.08*
9	D-1 RANGE	SM	

Displayed solution:

	Battery		*Range*
	A		*54735*
10	D-2 AZ FIRE	SM	

Displayed solution:

Battery	*Azimuth of fire*
A	*5118.52*

(3) *Processing continued.* A printout of the mission is obtained as illustrated in step 11 below.

Step	Activate Button or Matrix Location	Keyboard
11	E-7 PRINT MISSION	SM;

(4) *Solution continued.* The teletypewriter will print the following:

ORA	4178.31	ARM	
SCO	T	RF	3502
FS	95.4	QE	853.3
TOF	111.1	TTF	04.13.08
RG	54735	TOT	0415
WHD	1	OPT	L
AZF	5118.52	HOB	
FPE	311181	FPN	5411533
FPA	388	FPS	2
FPZ	33	AOL	2986.83
TGE	698197	TGN	5416302
TGA	300	TGS	2
TGZ	32		

g. Example problems using the high-explosive warhead (M251) or the practice nuclear warhead (M252).

(1) *Situation I.* Assume the call for fire in paragraph *f* above designates the high-explosive (HE) warhead (M251).

(2) *Processing an M251 warhead mission.* The procedures used to process an M251 warhead mission are the same as those used in processing the nuclear mission illustrated in paragraph *f* above except for the warhead flag entry in step 5 of the FADAC procedures. Flag 4 would be entered in this step to designate the M251 warhead. No HOB option (E-4) or HOB meters (D-4) is entered.

(3) *Displayed solution.*

Displayed solution: Part 1.

Battery	Orienting angle (corrected)	Arming time
A	4178.62	80

Displayed solution: Part 2.

Battery	Sustainer cutoff	Range factor	Fuze setting	Quadrant elevation
A	5	3670	107.9	853.3

Displayed solution: Part 3.

Battery	Time to fire
A	04.13.07

(4) *Situation II.* Assume the call for fire in paragraph *f* above designates the practice nuclear warhead M252.

(5) *Processing an M252 warhead mission.* The procedures used to process an M252 warhead mission are identical to those for the M234 mission except the entry of matrix function E-4 is always IMPACT (flag 0).

(6) *Displayed solution.*

Displayed solution: Part 1.

Battery	Orienting angle (corrected)
A	4178.31

Displayed solution: Part 2.

Battery	Sustainer cutoff	Range factor	Time of flight	Quadrant elevation
A	3	3502	95.4	853.3

Displayed solution: Part 3.

Battery	Time to fire
A	04.13.08

Section VIII. Operator Maintenance

3-30. Preventive Maintenance

Most troubles are the direct result of poor preventive maintenance or failure of personnel to understand and follow correct preventive maintenance procedures. Such malpractices detract from the proficiency of an FDC and contribute to hardware failures. Many troubles and hardware failures can be prevented if simple maintenance rules are observed.

a. **Generator maintenance.**

(1) Emplace the generator on level ground.

(2) Keep it well ventilated and protected from the weather.

(3) Keep the fuel strainer clean and replace it when necessary.

(4) Maintain the correct oil level in the crankcase.

(5) Insure that the generator is producing 120/208-volt, 400-hertz (+5 percent) output and that no unauthorized equipment is operated from this power source.

(6) Ground the generator with the equipment provided.

(7) Alternate generator sets every 8 hours or more frequently, if possible.

b. **FADAC maintenance.**

(1) Check the buttons, switches, keys, and cable connectors for dirt, rust, corrosion, looseness, bends, or breaks and have faulty items cleaned, repaired, or replaced.

(2) Turn off the FADAC before shutting off the generator.

(3) Clean the air filters daily.

(4) Cover the FADAC when it is not in use.

(5) Protect it from weather, especially rain and the direct rays of the hot sun.

(6) Each time the FADAC is put into operation, run program tests to check the memory.

(7) If the FADAC gets wet, dry it thoroughly before putting on the covers.

3-31. Common Troubles and Corrective Actions

Many of the common troubles that are experienced in the field can be corrected by the operator. The operator should use Figure 3-7 as a guide to diagnose and attempt to correct troubles before notifying maintenance personnel.

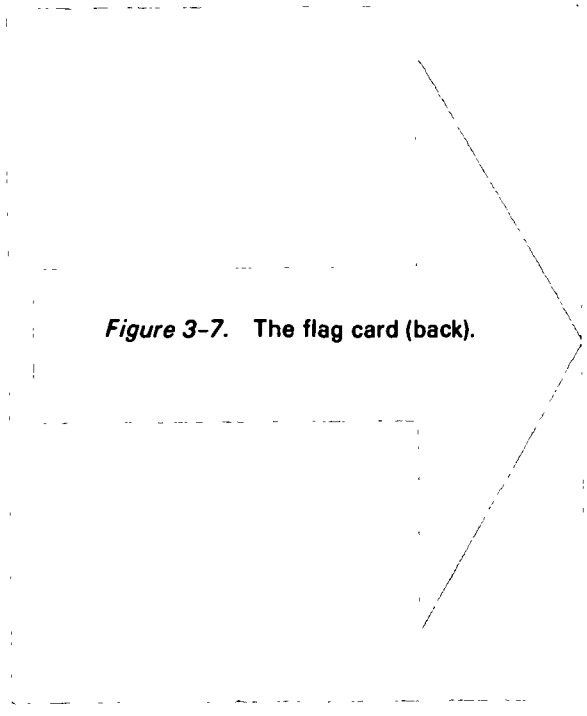
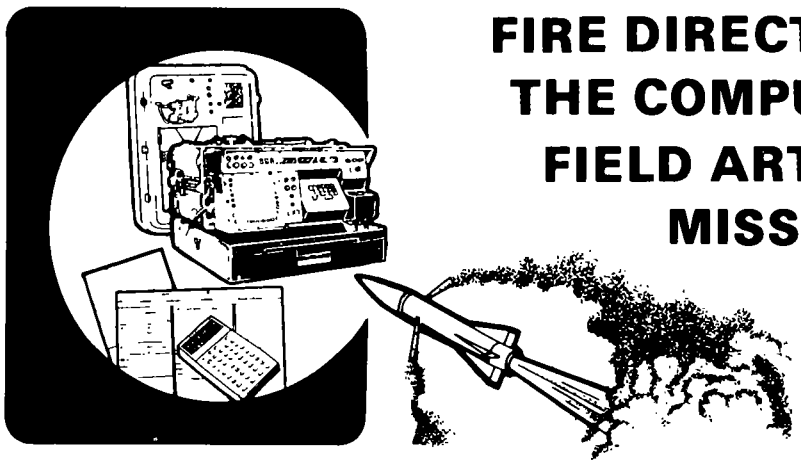


Figure 3-7. The flag card (back).

FADAC—TROUBLESHOOTING GUIDE—FADAC

	TROUBLE INDICATION	CORRECTIVE ACTIONS
1	NO POWER	Insure thet the FADAC circuit breeker is in the ON position. Insure thet the generator circuit breeker is in the ON position. Adjust the generetor output for 120/208 volts. Turn the generetor off, then check the power ceble connections. Tighten if necessery. Insure thet the 4-wire hookup on the generetor ceble end brecket adepter is correct. See TM 5-6115-271-14.
2	NO DISPLAY FOR PROGRAM TEST 1	Insure that a battery selector button has been pressed
3	UNINTELLIGIBLE OUTPUT ON DISPLAY PANEL	Run Program Test 1
4	FAILS PROGRAM TEST 1	Reprogram computer.
5	FAILS PROGRAM TEST 2	Clear the indiceted channel of memory by following the instructions in the eppropriate FM.
6	AUTOMATIC ENTRY INTO THE WRONG MODE OR FAILURE TO CHANGE MODES AS THE RESULT OF A LEGAL OPERATOR ACTION	Press the RESET button. If the failure recurs, turn the FADAC off, weit 30 seconds, then restert. If the feilure recurs, repeat the above ection egain, then run Progrem Test 1 Repeated failure indicates a need for hardware repair or e requirement for reprogremming
7	POWER READY LIGHT BLINKS	Insure that the MARGINAL TEST switch is in the OFF position. Remove reer cover unless cold weether operation requires thet the rear cover remein on Send to maintenence for repeir of blowers.
8	TEMPERATURE LIGHT BLINKS	The computer's internel tempereture is outside the limits for safe operetion. One or more of the following actions is indiceted. HOT WEATHER / COLD WEATHER 1. Remove from the direct rays of sun. / 1. Install the rear cover 2 Check the air filters to insure they are not blocked or dirty. / 2. Protect from wind 3 Shut the computer off for a cooling period.
9	TRANSIENT LIGHT BLINKS	Press the RESET button. If the RESET button feils to stop the blinking, turn the FADAC off. Reedjust the generator output for 120/208 volts and 400 hertz. Turn the FADAC on end run Program Test 1
10	PARITY LIGHT BLINKS	Press the RESET button. If the RESET button feils to stop the blinking, turn the FADAC off. Wait 30 seconds, then restart. Run Program Test 1 and 2
11	ERROR LIGHT BLINKS	Press the RESET button. Check all inputs relating to the problem solution. Correct erroneous date. Run Progrem Test 2.
12	NO SOLUTION LIGHT BLINKS	See appropriete FM

Note: *If the corrective actions fail to change the condition, notify maintenance personnel.*



FIRE DIRECTION WITH THE COMPUTER SET, FIELD ARTILLERY, MISSILE

CHAPTER 4

Section I. Organization and Equipment

The computer set, field artillery, missile, with the Lance program module (hereafter referred to as the calculator) is used to compute laying and firing data for the Lance missile, perform UTM zone-to-zone coordinate transformations, and compute unit march tables.

4-1. Fire Direction Personnel

a. The Lance battalion and firing battery FDCs provide personnel required for operating the calculator.

b. The fire direction computers are assigned the duties of calculator operator. The duties of the other personnel are essentially the same as described in Chapter 2.

4-2. Duties of the Calculator Operator

The calculator operators maintain and use the calculator. Their duties include the following:

a. Insure a proper power source is used.

b. Perform required maintenance in accordance with TM 9-1220-242-12 & P, *Operator and Organizational Maintenance Manual (including repair parts list) Computer, Field Artillery, General and Missile.*

c. Insure proper procedures are used when computing data.

d. Insure the calculator is properly protected and/or secured when not in use.

4-3. Description of the Calculator

a. The calculator consists of three major components: the calculator, a rechargeable battery, and a program module (Fig 4-1).

b. The calculator is a solid state device with a nonvolatile program memory and a volatile data memory. It is used to solve the gunnery problem for the Lance missile.

c. When the calculator is equipped with the Lance program module, it will compute and display target azimuth, range, elevation, sustainer cutoff, range factor, fuze setting, arm time, and time to fire or time of flight. When the calculator is used with the PC-100 print/security cradle (hereafter referred to as the printer), a printout of these firing data may be obtained. The calculator will also perform UTM zone-to-zone coordinate transformations and compute unit march tables (a printer is required for the latter).

Note: *When checking data obtained by the TI-59 calculator against a FADAC readout, large differences will be encountered depending upon the program in FADAC (training or actual).*

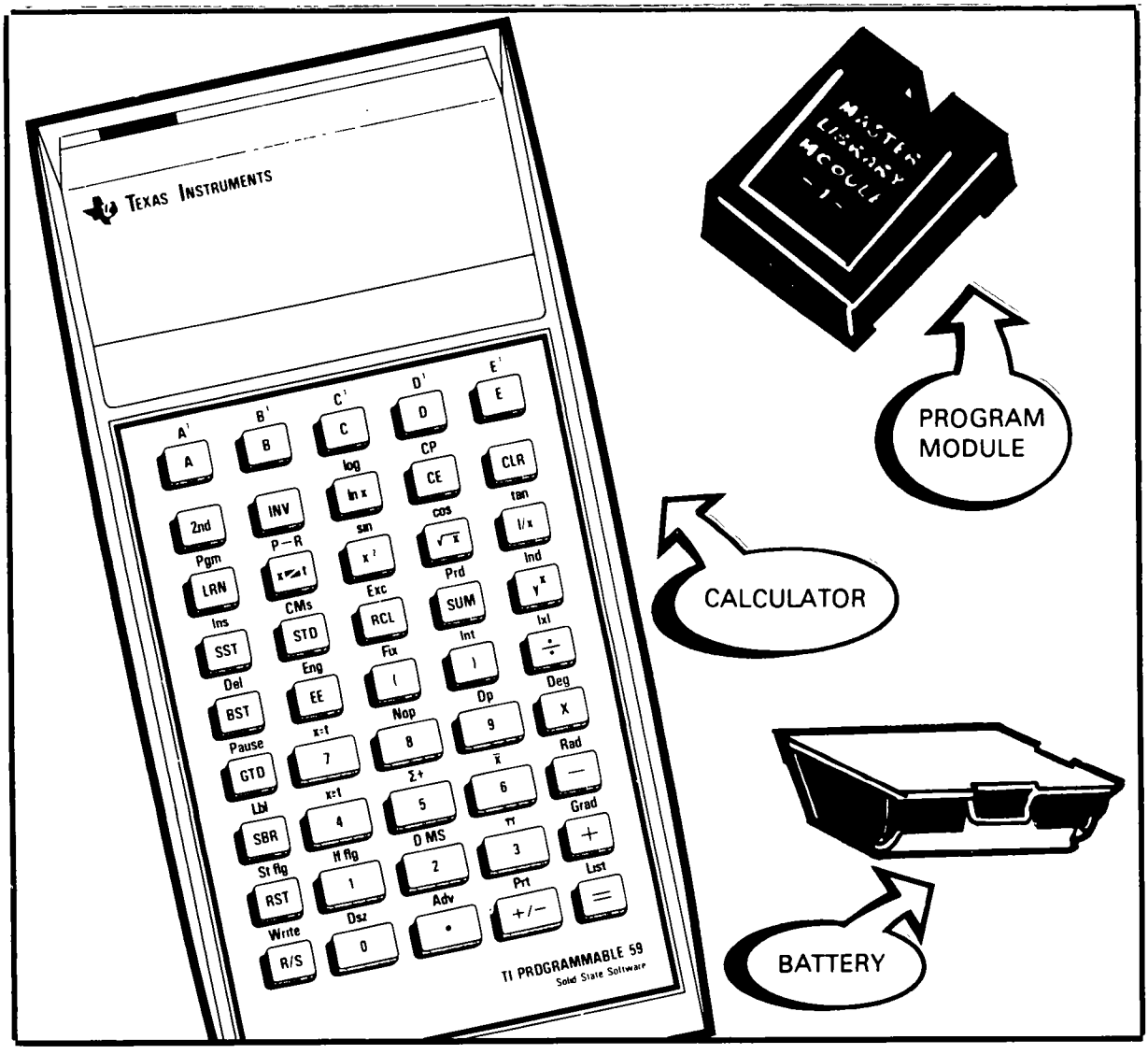


Figure 4-1. Calculator components.

4-4. Associated Equipment

a. Associated equipment included in the set is shown in Figure 4-2.

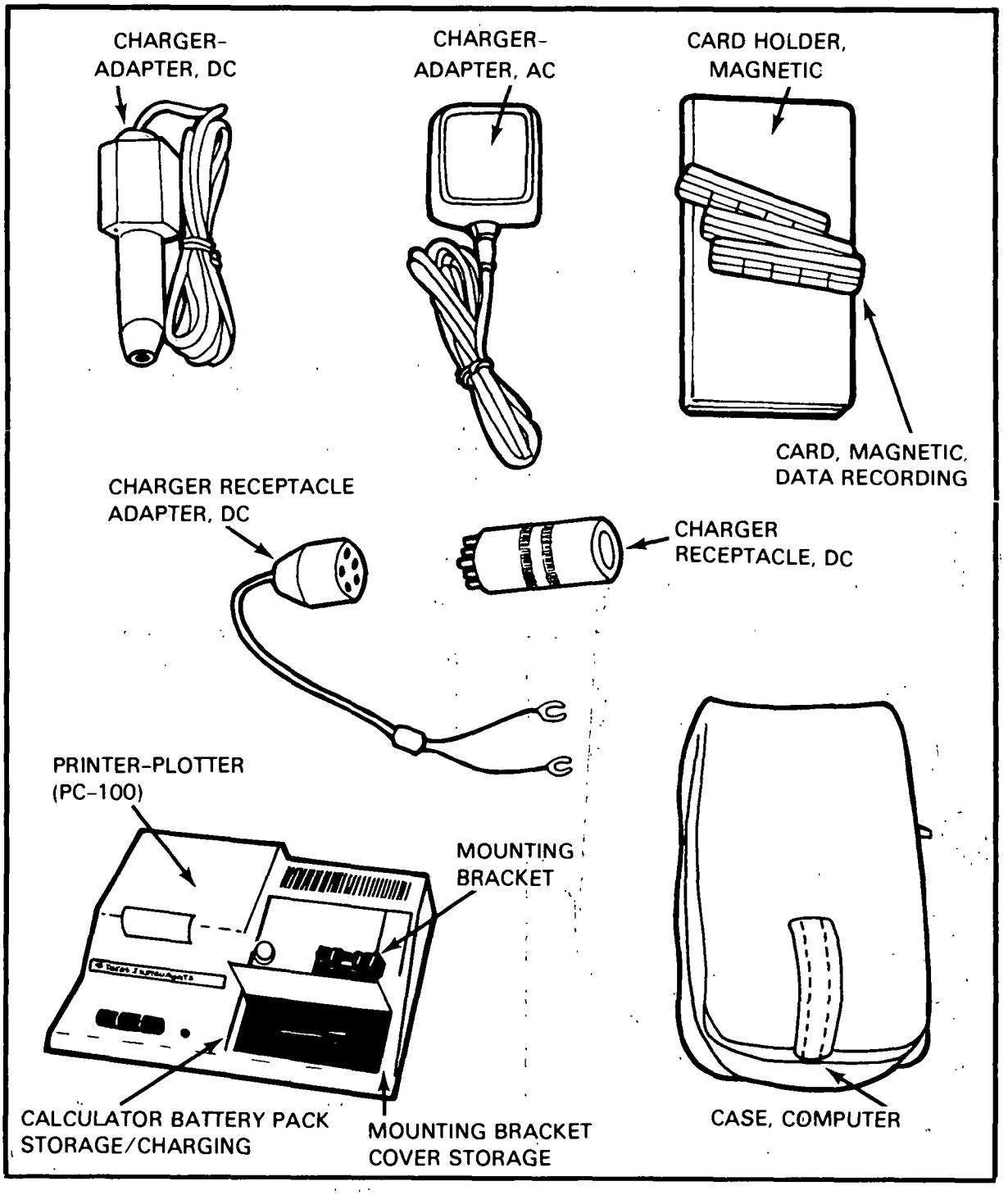


Figure 4-2. Calculator associated equipment.

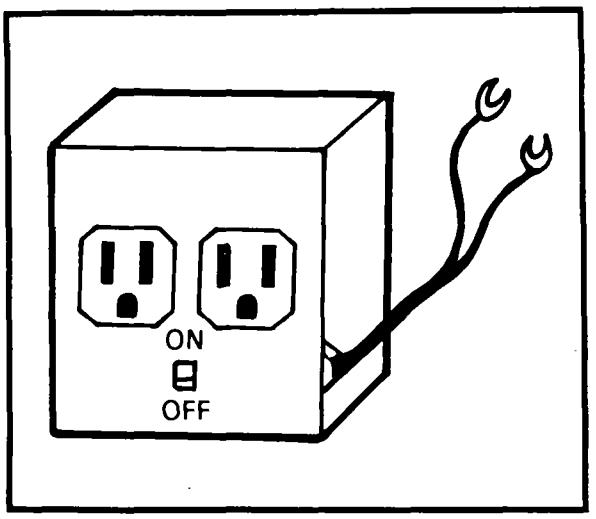


Figure 4-3. Inverter/vibrator.

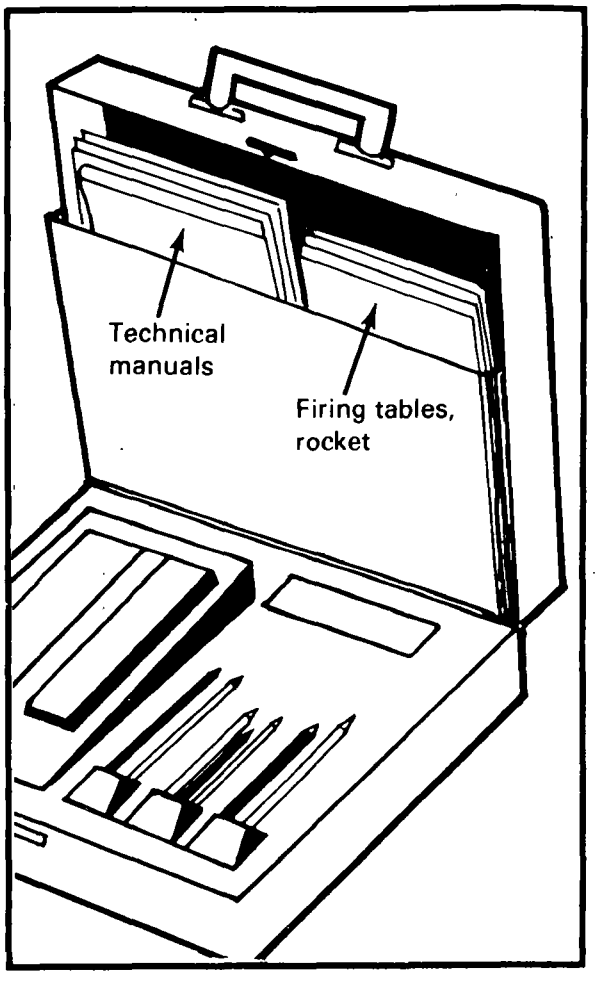


Figure 4-4. Briefcase.

b. Auxiliary equipment consists of an inverter/vibrator (NSN 6130-00-889-1207) used to convert 24-volt DC vehicular power to 110-volt AC power for the printer (Fig 4-3).

c. Miscellaneous equipment consists of a standard GSA briefcase. The case may be used for transporting and storing the components of the computer set and publications for operation, maintenance, and computation of fire missions (Fig 4-4).

4-5. Lance Program Module

The Lance program module contains 14 programs. Four of them may be called directly by the operator, and the remainder are subprograms used by the main gunnery program. The four programs the operator may call are:

PROGRAM NO.	PROGRAM
01	Program module test
02	Lance gunnery
04	March tables
09	Store firing point list

4-6. Loading a Program

To load a program, turn the calculator on then press (2nd PGM* NN (NN represents the program number). (See paragraphs 4-11, 4-12, 4-15*d*, and 4-20*a*.)

Note: *The asterisk following PGM indicates the label "PGM" is found on the backboard above the key.*

4-7. Preparation for Operation

a. Refer to TM 9-1220-242-12 & P, Chapter 2.

b. Connect the calculator to a suitable power source.

c. Turn on the calculator using the switch at the top. If the printer is being used, turn the printer power on using the switch on the right side.

d. Program the calculator as described in paragraph 4-6.

4-8. March Order Actions

a. Turn power switch(es) off.

b. Disconnect from power source.

c. Store the calculator.

> **Note:** *Turning the power off will result in a loss of any data stored in the calculator.*

Section II. Operator Controls and Tests

4-9. Calculator Keyboard

The various programs control most of the function keys required to compute data. Therefore, the operator must be concerned with only a few of the keys on the keyboard (*a* through *f* below) in addition to those discussed in paragraph 4-6. See Figure 4-5.

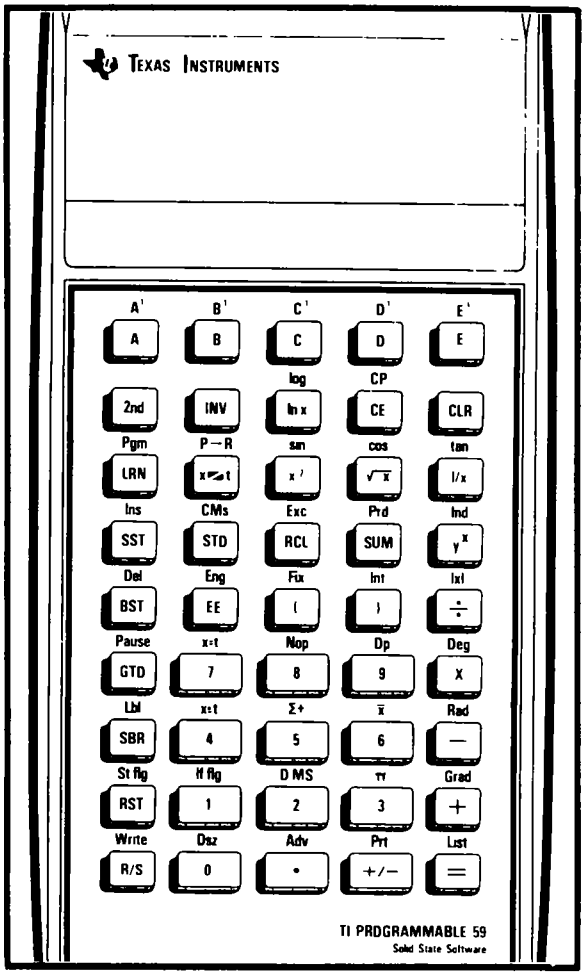


Figure 4-5. Calculator keyboard.

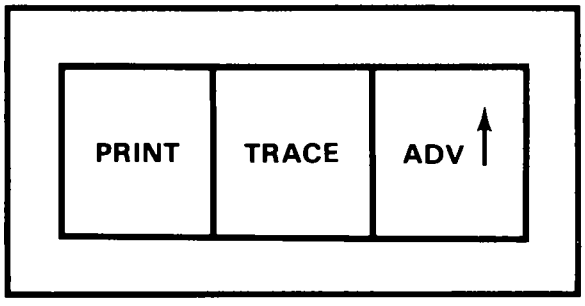


Figure 4-6. Printer keys.

a. 0 through 9	Enters numbers.
b. •	Places a decimal point (•) in a number.
c. +/−	Pressed after a number is entered. Changes the number to negative.
d. R/S	Used as an enter key.
e. CE	Used to clear the display of an erroneous entry before entering with R/S or an operation (+, −, , ×) key.
f. A through E and A'* through E'*	Pressed as prescribed on a computer's record. Initiates a portion of the program.

4-10. Printer Keys

The PRINT and TRACE keys on the printer are not used in the Lance application. The ADV key may be used to advance the paper in the printer when required (Fig 4-6).

4-11. Program Module Test

a. This test indicates whether the correct module is in the calculator.

b. The test is performed as follows:

(1) Turn on the calculator.

(2) Call program 01 by pressing 2nd PGM* 01 .

(3) Initiate the test by pressing E .

c. The calculator displays 1.000000559 if the Lance program module is in the calculator. Any other display indicates another program module is in the calculator or an operator/calculator error has occurred. Check the power source and perform steps *b*(1) through (3) again. If this fails, turn the power off and visually check the program module by opening the sliding door on the back of the calculator.

Section III. Storing/Printing the Firing Point List

The Lance program module provides a means of storing and using up to 13 firing points. Once stored, they are available for printing (if the printer is used), for recording on magnetic cards, or for use in fire mission computations.

4-12. Programing the Calculator

The calculator must be programed before it will accept the firing point list. Program it by pressing 2nd PGM* 09 . (Before program 09 can be used, the program module test must be run when the calculator is turned on.)

4-13. Entering the Firing Point/ Firing Point List

a. Select the Store Firing Point cue card (Fig 4-7), and place it in the calculator to define the functions of the lettered keys.

LANCE				
STORE FIRING POINT				PGM 09
FP #				
EASTING	NORTHING	ALTITUDE	AZ OL	LATITUDE

Figure 4-7. Cue card (store firing point).

b. Enter the firing point number to be stored (13 for this example).

c. Using the data for firing point 13 shown in Figure 4-8, enter the firing point by pressing:

(1) 13 2nd A'*

(2) 534439 R/S

Note: *Data entry is in the sequence shown on the cue card (Fig 4-7).*

(3) 3832017 R/S

(4) 432 R/S

(5) 4462.57 R/S

(6) 35 R/S

Note: *Latitudes in the Southern Hemisphere are entered as negative numbers.*

FP NO.	EASTING	NORTHING	ALT	AZ OF OL	LAT
1	501027	3795789	366	1101.36	34° N
2	460992	3822696	418	3625.37	35° N
3	422913	3780960	1469	4736.23	34° N
4	530954	3852050	442	4725.31	35° N
5	415703	3816038	503	0639.01	34° N
6	429809	3759294	488	1043.26	34° N
7	521270	3819783	384	0015.36	35° N
8	553201	3781342	483	1342.02	34° N
9	530021	3788242	951	3243.51	34° N
10	555423	3830010	980	2424.33	35° N
11	576204	3846249	636	1437.25	35° N
12	570934	3793414	153	1247.61	34° N
13	534439	3832017	432	4462.57	35° N

Figure 4-8. Firing point list.

d. Use the same steps to enter the remaining firing points. They may be entered in any sequence.

e. To correct an entry or replace a firing point on the list with a new one, enter the new/corrected data as described in *c* above.

f. Call the Lance gunnery program after entering the firing point list (press 2nd PGM* 02).

4-14. Printing the Firing Point List

a. The Lance gunnery program must be used to print the firing point list. Place the Lance Gunnery cue card in the calculator to define the lettered keys.

b. Print the firing point list by pressing 2nd D'* . If the firing point list in Figure 4-8 has been entered, the printout will appear as shown in Figure 4-9.

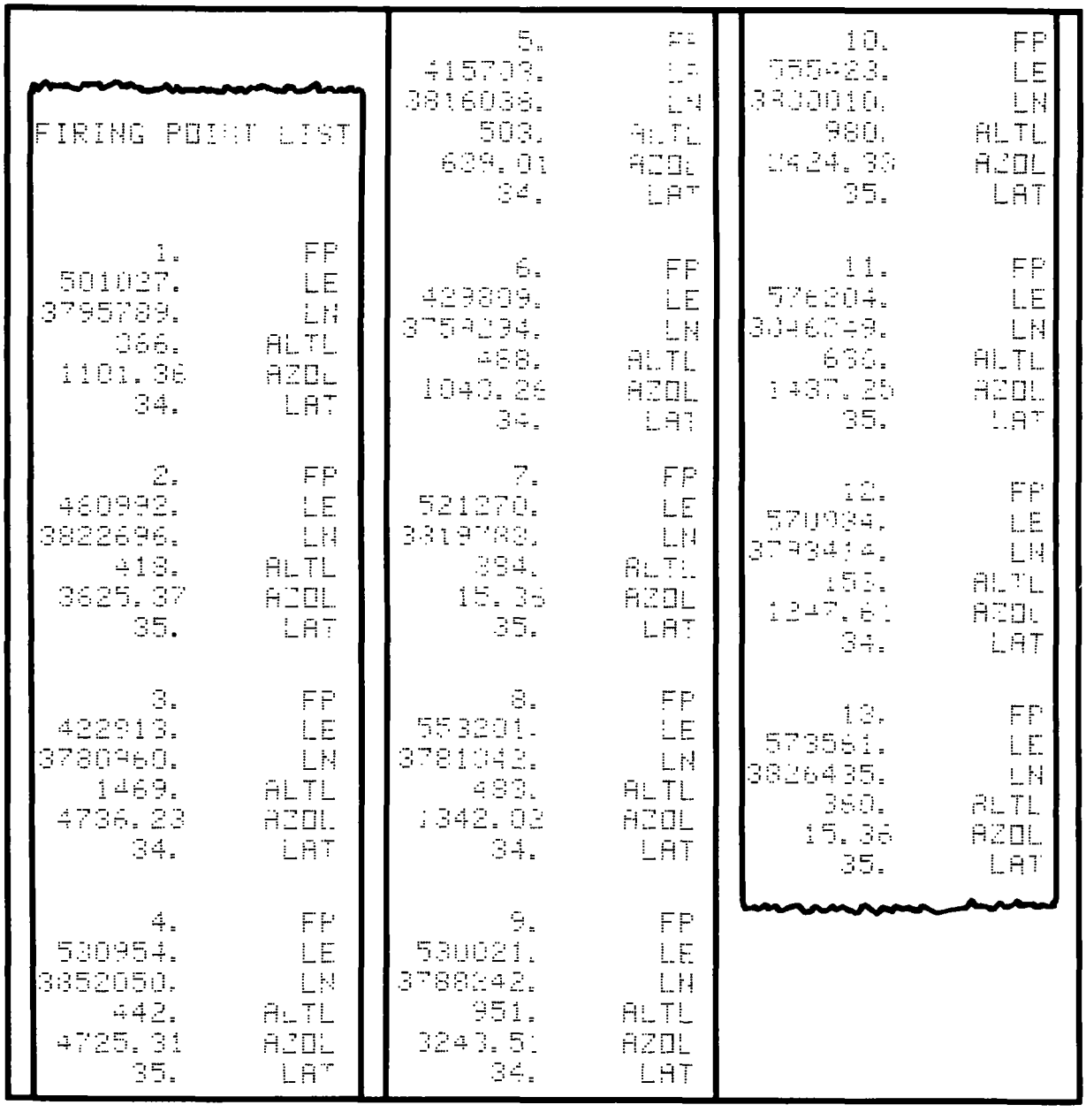


Figure 4-9. Printout of firing point list.

4-15. Recording on Magnetic Cards

a. The firing point list, once entered, may be recorded on magnetic cards. This procedure prevents loss of the data when the calculator is turned off and allows additional firing points to be stored.

b. To record the firing point list, press 1 2nd Write* and pass a magnetic card through the read/write slot from right to left. Then press 2 2nd Write* , rotate the card 180°, and pass it through the read/write slot again.

c. This method can be used to store an unlimited number of firing points on magnetic cards (13 points each).

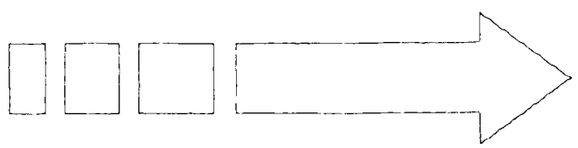
> **Note:** *Extreme care must be taken to insure the correct firing point data are in the calculator when a mission is computed.*

d. To reenter a firing point list from magnetic cards, call the gunnery program 2nd PGM* 02 and press A . Pass the magnetic card through the read/write slot. Press CLR , rotate the card 180°, and pass it through the read/write slot again.

e. For additional information on reading/writing magnetic cards, refer to the owner's manual and the operator's maintenance manual.

Section IV. The Computer's Record

The Computer Set, Field Artillery, Missile Sheet (Lance), DA Form 4603-1-R, (Fig 4-10 (1) and 4-10(2)), hereafter called the computer's record, is used for all fire mission computations with the calculator. It is designed to guide the operator through the mission and to provide a suitable record of fire mission data.



COMPUTER SET, FIELD ARTILLERY, MISSILE— COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form, see FM 6-40-4, the proponent agency is TRAOOC

1. UNIT	2. DATE AND TIME FIRED	3. MISSILE SERIAL NUMBER	4. TARGET NUMBER

CALL FOR FIRE

5. FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8. FIRING POINT NUMBER

9. TARGET NUMBER	10. TARGET GRID	11 ALTITUDE TARGET M	12. WARHEAD

13. HEIGHT OF BURST	14. TIME ON TARGET	15. TIME ON TARGET NO LATER THAN	16 REMARKS

FIRE ORDER

17. UNIT TO FIRE	18. LAUNCHER NUMBER	19. FIRING POINT NUMBER	20. TARGET NUMBER

WARNING ORDER

21. LAUNCHER NUMBER	22. FIRING POINT NUMBER	23. TARGET NUMBER	24. WARHEAD	25. HEIGHT OF BURST	26 TIME ON TARGET	27. TARGET AZIMUTH

FIRING POINT # [E'] IF POINT IS STORED OR

28. LAUNCHER EASTING	R/S	29. LAUNCHER NORTHING	R/S	30. ALTITUDE LAUNCHER	R/S	31. AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE N +/− S	R/S
33. TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36. HEIGHT OF BURST	R/S	37. TIME ON TARGET	R/S

38	IF ZONE TO ZONE				IF M251	B
	IF SOUTHERN HEMISPHERE	B'	E	NOW COMPLETE BACK		

39. PRESS C	40. TARGET AZIMUTH	41 RANGE	42. ELEVATION (Circle one) 853.3 960 0	43. SUSTAINER CUTOFF (See flag card on back)

44. EXPRESS DISPLAY (1000M)	R/S	45. EXPRESS DISPLAY (500M)	R/S	46 EXPRESS DISPLAY (500M)	R/S
(ENTRY RANGE TO TARGET)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)		(ENTRY ALTITUDE OF LAUNCHER)	
FOR M251 ONLY (ADD A-1) COLUMN 2 → COLUMN 6	R/S	47. EXPRESS DISPLAY (1000M)	R/S	48 EXPRESS DISPLAY (500M)	R/S
		(ENTRY RANGE TO BURST)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)	

49. (A-1 OR B-1) COLUMN 2 → COLUMN 16	R/S	RECORD FIRE COMMANDS
		PRESS D FOR PRINTOUT IF PC-100 IS USED

50. RANGE FACTOR	51. FUZE SETTING	52 ORIENTING ANGLE

53. TIME TO FIRE OR TIME OF FLIGHT	54. ARM TIME (For M251 only)

DA FORM 4603-1-R APR 82

Figure 4-10. (1) Computer Set, Field Artillery, Missile—Computer's Record and Data Correction Sheet (LANCE) (Front)

55. TARGET ZONE	56. LAUNCHER ZONE	57. SPHEROID
58. EXPRESS DISPLAY (100,000) R/S	59. EXPRESS DISPLAY (100,000) R/S	

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS.
IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS.

60. N_o R/S	61. E_o R/S	62. a_1 R/S
63. a_2 R/S	64 b_1 R/S	65. b_2 R/S
66. RECORD EASTING B	67. RECORD NORTHING B	

FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
10	N	44-59	20	OFF	4-5	44-51
11	P	60-85	21	A	6-7	52-75
12	R	86-117	22	B	8-9	76-93
13	T	118-159	23	C	10-11	94-117
14	V	160-191	24	E	12-13	118-141
15	W	192-233	25	E	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	18-19	174-185
18	V	298-309	28	F	20-21	186-197
19	Z	310-337	29	H	22-24	198-243

REMARKS

REVERSE OF DA FORM 4603-1-R

Figure 4-10(2). Computer's record (Reverse Side)

SYMBOL	MEANING
A OR R/S	Press the key on the calculator that has this label.
IF M251 | B	Press the key on the calculator that has this label only if the stated condition is met. In this case, press B if computing an M251 mission.
28 LAUNCHER EASTING | R/S	Enter the indicated data (in this case, launcher easting) in this block and in the calculator.
44 EXPRESS DISPLAY (1000M) (ENTRY RANGE TO TARGET) | R/S	Express the number displayed on the calculator to the accuracy indicated in the symbol, and enter the expressed number here and in the calculator.
FOR M251 ONLY (ADD A-1) COLUMN 2 → COLUMN 6 | R/S	Enter the values from columns 2 through 6 of the appropriate firing table in the calculator, and press R/S after each.
42 ELEVATION (Circle one) 8533 9600	Record the calculator display (in this case, elevation) in this block.

Figure 4-10(3). Symbols on the computer's record.

Section V. Computing Firing Data—M234/M252

The call for fire and fire order are completed as described in paragraphs 2-3 and 2-4. The warning order is completed as stated in paragraph 2-5 except that the target azimuth is computed and need not be measured on the map. Firing tables are still used in the computations; however, only Table C data are required.

4-16. Computing Firing Data for M234/M252 Warheads

a. When a call for fire is received, record it on the computer's record (Fig 4-11).

b. When the fire order is issued, record it on the computer's record (Fig 4-12).

c. Complete the warning order except for target azimuth and record it on the computer's record (Fig 4-13).

d. Transfer the firing point (launcher) data from the firing point list to the computer's record (Fig 4-14).

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	1-333	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ7	14SNP4698927581	35Ø M	M252

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
G	Ø916ØØ		

Figure 4-11. Call for fire.

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
A	2	13	XZ2ØØ7

Figure 4-12. Fire order.

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	13	XZ2ØØ7	M252	G	Ø916ØØ	

Figure 4-13. Warning order.

FIRING POINT LIST

FP	GRID	ALT	AZ OL	LAT
1	501027 3795789	366	2202.36	34° N
12	570934 3793414	153	1247.61	34° N
13	534439 3832017	432	4462.57	35° N

28 LAUNCHER EASTING	R/S	29 LAUNCHER NORTHING	R/S	30 ALTITUDE LAUNCHER	R/S	31 AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE (N)	R/S
534439		3832017		432		4462.57		35 +/- S	

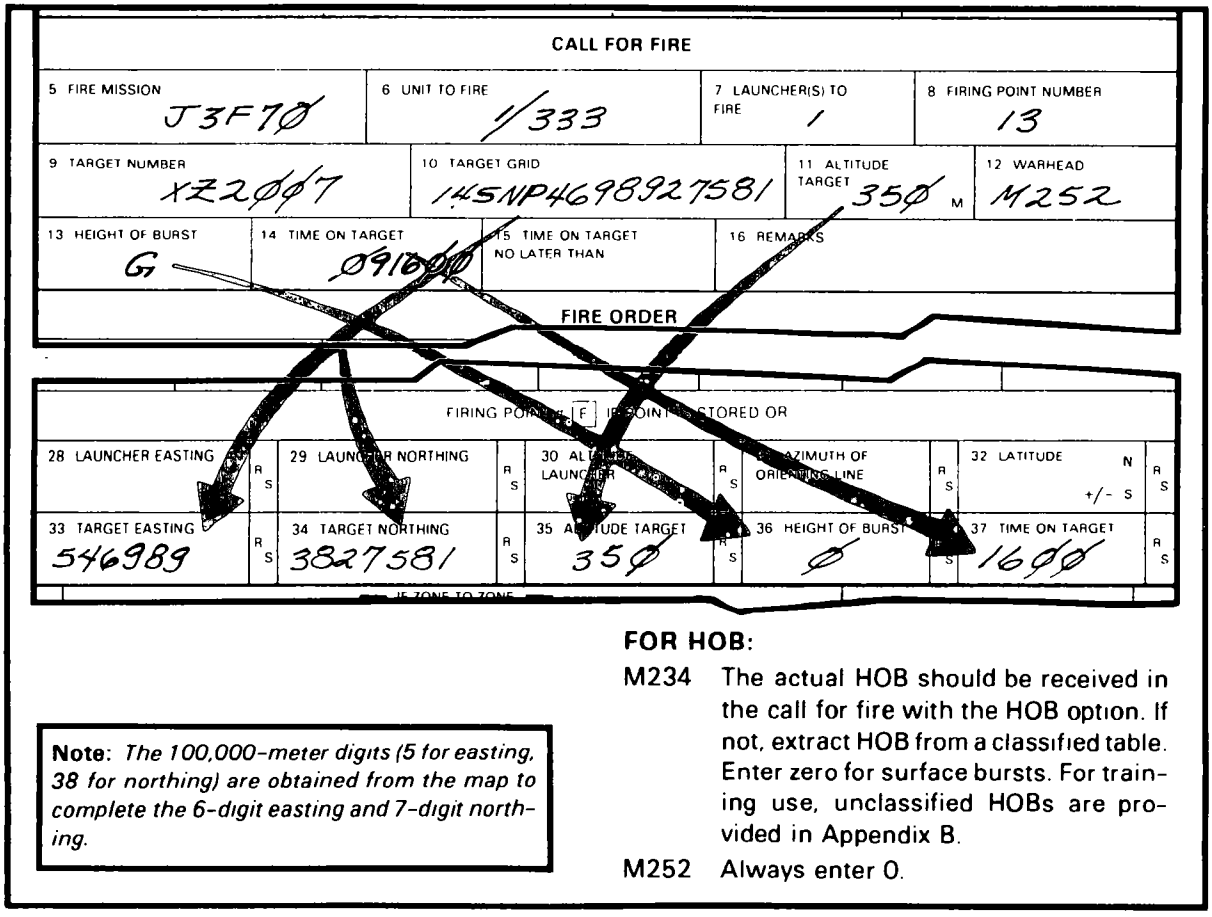
Figure 4-14. Transfer launcher data.

e. Transfer the target data from the call for fire/fire order to the target data line on the computer's record (Fig 4-15). A 0 must be used for HOB surface burst and for TOT if none is given.

f. Press A on the keyboard to clear mission data.

g. If the firing point is stored, enter the firing point number and press 2nd E'* (RCL FP). If the FP is not stored, enter launcher easting (LE), launcher northing (LN), altitude of launcher (ALTL), az OL, and latitude (LAT). Press R/S after each entry (Fig 4-16).

Note: *If firing from a point in the Southern Hemisphere, enter the latitude as a negative value by pressing +/- before R/S.*



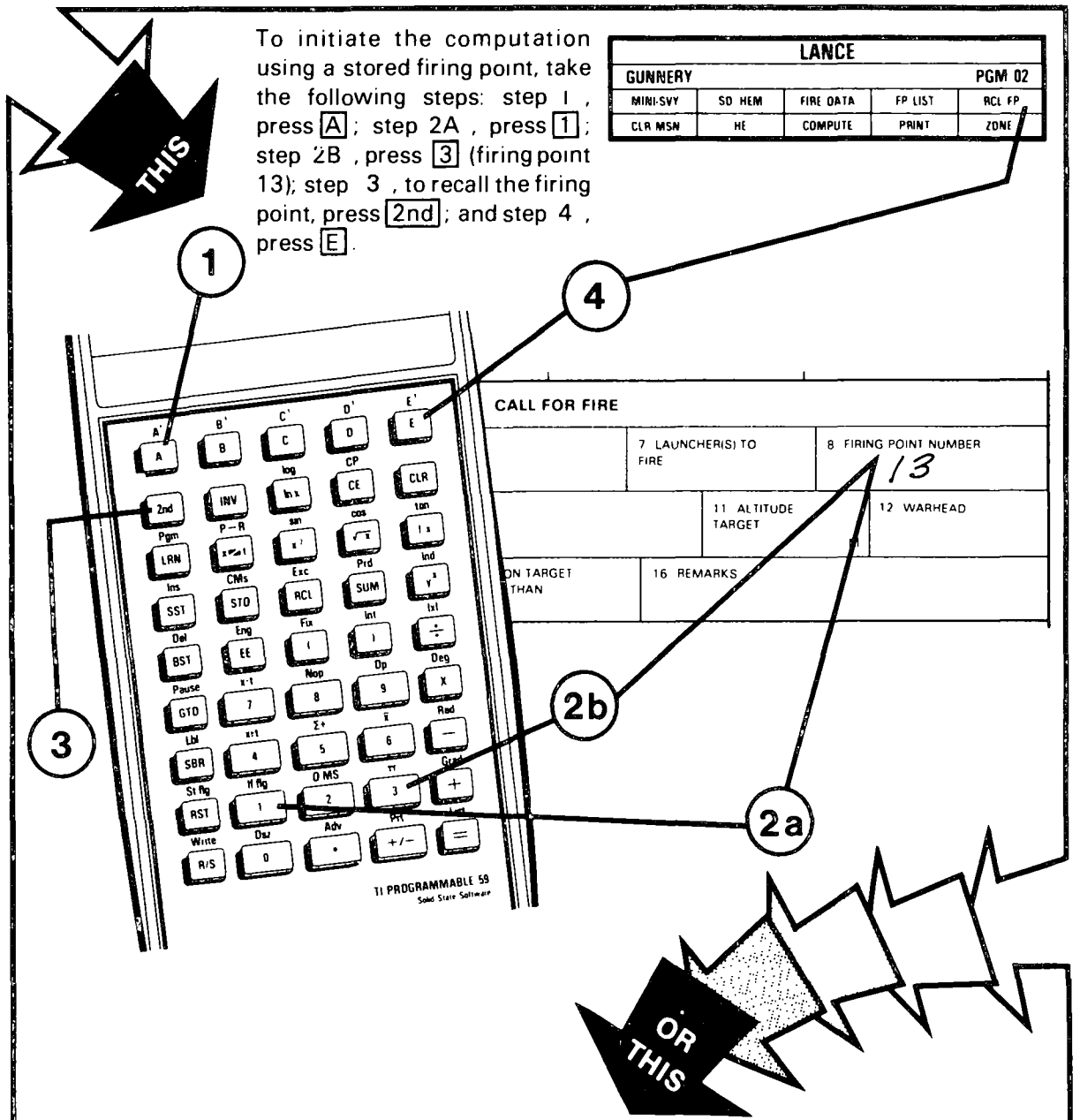
Note: *The 100,000-meter digits (5 for easting, 38 for northing) are obtained from the map to complete the 6-digit easting and 7-digit northing.*

FOR HOB:

M234 The actual HOB should be received in the call for fire with the HOB option. If not, extract HOB from a classified table. Enter zero for surface bursts. For training use, unclassified HOBs are provided in Appendix B.

M252 Always enter 0.

Figure 4-15. Transfer target data.



If the firing point is not stored, initiate computations by pressing [A]. Then enter data in blocks 28 through 32, pressing [R/S] after each entry.

FIRING POINT # [E] IF POINT IS STORED OR									
28 LAUNCHER EASTING 534439	R/S	29 LAUNCHER NORTHING 3832017	R/S	30 ALTITUDE LAUNCHER 432	R/S	31 AZIMUTH OF ORIENTING LINE 4462.57	R/S	32 LATITUDE 35 (N) +/- S	R/S
33 TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36 HEIGHT OF BURST	R/S	37 TIME ON TARGET	R/S

Figure 4-16. Enter launcher data.

h. Enter target easting (TE), target northing (TN), altitude of target (ALTT), height of burst (HOB), and time on target (TOT). Press R/S after each entry (Fig 4-17).

i. Initiate computation.

(1) A zone-to-zone coordinate transformation is not required for this mission. Therefore, do not use the first two blocks of the next line (Fig 4-18).

(2) This is not an M251 mission. Therefore, do not use the third block.

(3) Press C . The calculator enters the compute mode; then target azimuth, range, and elevation and an SCO flag are flashed on the display for approximately 5 seconds each.

> **Note:** *If the target is out of range, a flag of -1 (below minimum) or 99 (beyond maximum) will be displayed here. Pressing RCL 13 will cause the range to be displayed.*

(4) Record target azimuth and range as they appear, and circle the elevation and SCO flag (in the FLAGS block), blocks 39-43.

(5) Transfer the SCO (letter) corresponding to the SCO flag to the FIRE COMMAND block. (See figure 4-20).

33 TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36 HEIGHT OF BURST	R/S	+/- S 37 TIME ON TARGET	R/S
546989		3827581		350		Ø		1600	

38	IF ZONE TO ZONE				IF M251	B
	IF SOUTHERN HEMISPHERE	B'	E	NOW COMPLETE BACK		

Figure 4-17. Enter target data.

38	IF SOUTHERN HEMISPHERE	8'	E	NOW COMPLETE BACK	IF M251	B

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)		43 SUSTAINER CUTOFF (See flag card on back)
C	1946	13316	(8533)	9600	P

44 EXPRESS DISPLAY (1000M)	45 EXPRESS DISPLAY (500M)	46 EXPRESS DISPLAY (500M)

FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
10	N	44-59	20	OFF	4-5	44-51
(11)	P	60-85	21	A	6-7	52-75
12	R	86-117	22	B	8-9	76-93
13	T	118-159	23	C	10-11	94-117
14	V	160-191	24	E	12-13	118-141
15	W	192-233	25	E	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	18-19	174-185
18	V	298-309	28	F	20-21	186-197
19	Z	310-337	29	H	22-24	198-243

Figure 4-18. Initiate computation.

j. Determine and enter FTR entry values.

(1) The calculator will stop with range displayed. Express the displayed value to the nearest 1,000 and enter it in the space provided (Fig 4-19). Enter the expressed data on the keyboard, and store it in the calculator by pressing R/S.

(2) The calculator displays height relative to launcher. Express the displayed value to the nearest 500, and enter it in the space provided (Fig 4-19). Enter the expressed data on the keyboard, and store it in the calculator by pressing R/S.

(3) The calculator stops with launcher altitude displayed. Express the displayed value to the nearest 500, and enter it in the space provided (Fig 4-19). Enter the expressed data on the keyboard, and store it in the calculator by pressing R/S.

(4) The calculator stops with 0 displayed.

k. Enter the firing table.

(1) Using the page numbers from the flag table on the form (Fig 4-20) adjacent to the SCO and the three FTR entry values determined above, enter Table C of FTR LANCE A-1.

(2) Enter all the data from columns 2 through 16. Press R/S following each entry.

C		853 3	960 0	(See flag card on back)
44 EXPRESS DISPLAY (1000M) 13000	R/S	45 EXPRESS DISPLAY (500M) 0	R/S	46 EXPRESS DISPLAY (500M) 500	R/S
(ENTRY RANGE TO TARGET)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)		(ENTRY ALTITUDE OF LAUNCHER)	
FOR M251 ONLY (ADD A-1)		47 EXPRESS DISPLAY (1000M)		48 EXPRESS DISPLAY (500M)	
COLUMN COLUMN	R		R		R

Figure 4-19. FTR entry values.

6 RECORD EASTING B			67 RECORD NORTHING B		
FLAGS					
NUCLEAR			**HIGH EXPLOSIVE**		
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (8-1)
~~10~~	N	44-59	20	OFF	4-5	44-51
11	P	60-85	21	A	6-7	52-75
~~12~~	R	86-117	22	B	8-9	76-93
13	T	118-159	23	C	10-11	94-117
14	V	160-191	24	E	12-13	118-141
15	W	192-233	25	E	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	18-19	174-185
18	V	298-309	28	F	20-21	186-197
19	Z	310-337	29	H	22-24	198-243
EMARKS						

Figure 4-20. Flag table.

l. Record the fire commands.

(1) When the value in column 16 is entered on the keyboard and R/S is pressed, range factor (RF), fuze setting (FZ), orienting angle (ORA), and time to fire (TTF) are displayed for 5 seconds each. If zero (0) was entered for the time on target (TOT), then time of flight (TOF) will be displayed in the place of time to fire.

(2) Record these data in the FIRE COMMAND blocks 50-54, of the computer's record (Fig 4-21).

(3) The calculator stops with zero (0) in the display.

m. If required, press 2nd C'* (FIRE DATA) to cause the fire commands to be displayed again in the sequence shown on the computer's record.

n. A complete computer's record is shown in Figure 4-22.

33 TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36 HEIGHT OF BURST	R/S	37 TIME ON TARGET	R/S
38 IF ZONE TO ZONE: IF SOUTHERN HEMISPHERE		8'	E	NOW COMPLETE BACK		IF M251		B	
39 PRESS C	40 TARGET AZIMUTH	41 RANGE		42 ELEVATION (Circle one) 853 3 960 0		43 SUSTAINER CUTOFF (See flag card on back)			
44 EXPRESS DISPLAY (1000M) (ENTRY RANGE TO TARGET)	R/S	45 EXPRESS DISPLAY (500M) (ENTRY HEIGHT RELATIVE TO LAUNCHER)	R/S	46 EXPRESS DISPLAY (500M) (ENTRY ALTITUDE OF LAUNCHER)	R/S				
FOR M251 ONLY (ADD A-1) COLUMN 2 → COLUMN 6	R/S	47 EXPRESS DISPLAY (10000) SAMPLE (ENTRY RANGE TO BURST)	R/S	48 EXPRESS DISPLAY (500M) (ENTRY HEIGHT RELATIVE TO LAUNCHER)	R/S				
49 (A-1 OR 8-1) COLUMN 2 → COLUMN 16	R/S	RECORD FIRE COMMANDS PRESS 0 FOR PRINTOUT IF PC-100 IS USED							
50 RANGE FACTOR 1826		51 FUZE SETTING 42		52 ORIENTING ANGLE 2517.45					
53 TIME TO FIRE OR TIME OF FLIGHT 1559:04		54 ARM TIME (For M251 only)							

DA FORM 4603-1-R APR 82

Figure 4-21. Fire commands.

COMPUTER SET, FIELD ARTILLERY, MISSILE— COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form, see FM 6-40-4, the proponent agency is TRADOC

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
A 1/333			XZ2007

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F70	1/333	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2007	14SNP4698927581	350 M	M252

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
G/O	091600		

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
A	2	13	XZ2007

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	13	XZ2007	M252	G/O	091600	1946

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R/S	29 LAUNCHER NORTHING	R/S	30 ALTITUDE LAUNCHER	R/S	31 AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE (N)	R/S
534439		3832017		432		4462.57		35 +/- S	
33 TARGET EASTING	**R/S**	**34 TARGET NORTHING**	**R/S**	**35 ALTITUDE TARGET**	**R/S**	**36 HEIGHT OF BURST**	**R/S**	**37 TIME ON TARGET**	**R/S**
546989		3827581		350		0		1600	

38	IF ZONE TO ZONE: IF SOUTHERN HEMISPHERE	B'	E	NOW COMPLETE BACK	IF M251	B

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF (See flag card on back)
C	1946	13316	(853 3) 96D D	P

44 EXPRESS DISPLAY (1000M)	R/S	45 EXPRESS OISPLAY (500M)	R/S	46 EXPRESS DISPLAY (500M)	R/S
13000		0		500	
(ENTRY RANGE TO TARGET)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)		(ENTRY ALTITUOE OF LAUNCHER)	

FOR M251 ONLY (ADD A-1)

COLUMN 2 → COLUMN 6	R/S	47 EXPRESS DISPLAY (1000M)	R/S	48 EXPRESS DISPLAY (500M)	R/S
		(ENTRY RANGE TO BURST)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)	

49 (A-1 OR B-1) COLUMN 2 → COLUMN 16	R/S	RECORD FIRE COMMANDS
		PRESS D FOR PRINTOUT IF PC-100 IS USED

50 RANGE FACTOR	51 FUZE SETTING	52 ORIENTING ANGLE
1826	42	2517.45

53 TIME TO FIRE OR TIME OF FLIGHT	54 ARM TIME (For M251 only)
1559:04	

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55 TARGET ZONE	56 LAUNCHER ZONE	57 SPHEROID

58 EXPRESS DISPLAY (100,000)	R/S	59 EXPRESS DISPLAY (100,000)	R/S

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS
IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS

60 N_o	R/S	61 E_o	R/S	62 a_1	R/S
63 a_2	**R/S**	**64 b_1**	**R/S**	**65 b_2**	**R/S**

66 RECORD EASTING 8	67 RECORD NORTHING 8

FLAGS

NUCLEAR

FLAG	SUSTAINER CUTOFF	TABLE C (A-1)
10	N	44-59
11	P	60 85
12	R	86 117
13	T	118 159
14	V	160 191
15	W	192-233
16	Y	234-255
17	X	256-297
18	V	298-309
19	Z	310-337

HIGH EXPLOSIVE

FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
20	OFF	4-5	44-51
21	A	6-7	52-75
22	8	8-9	76-93
23	C	10-11	94-117
24	E	12-13	118-141
25	E	14-15	142-149
26	F	16-17	150-173
27	G	18-19	174-185
28	F	20-21	186-197
29	H	22-24	198-243

REMARKS

SAMPLE

REVERSE OF DA FORM 4603-1-R

Figure 4-22. Completed computer's record.

o. If a printer is connected to the calculator, obtain a printout of fire mission data by pressing D (Fig 4-23).

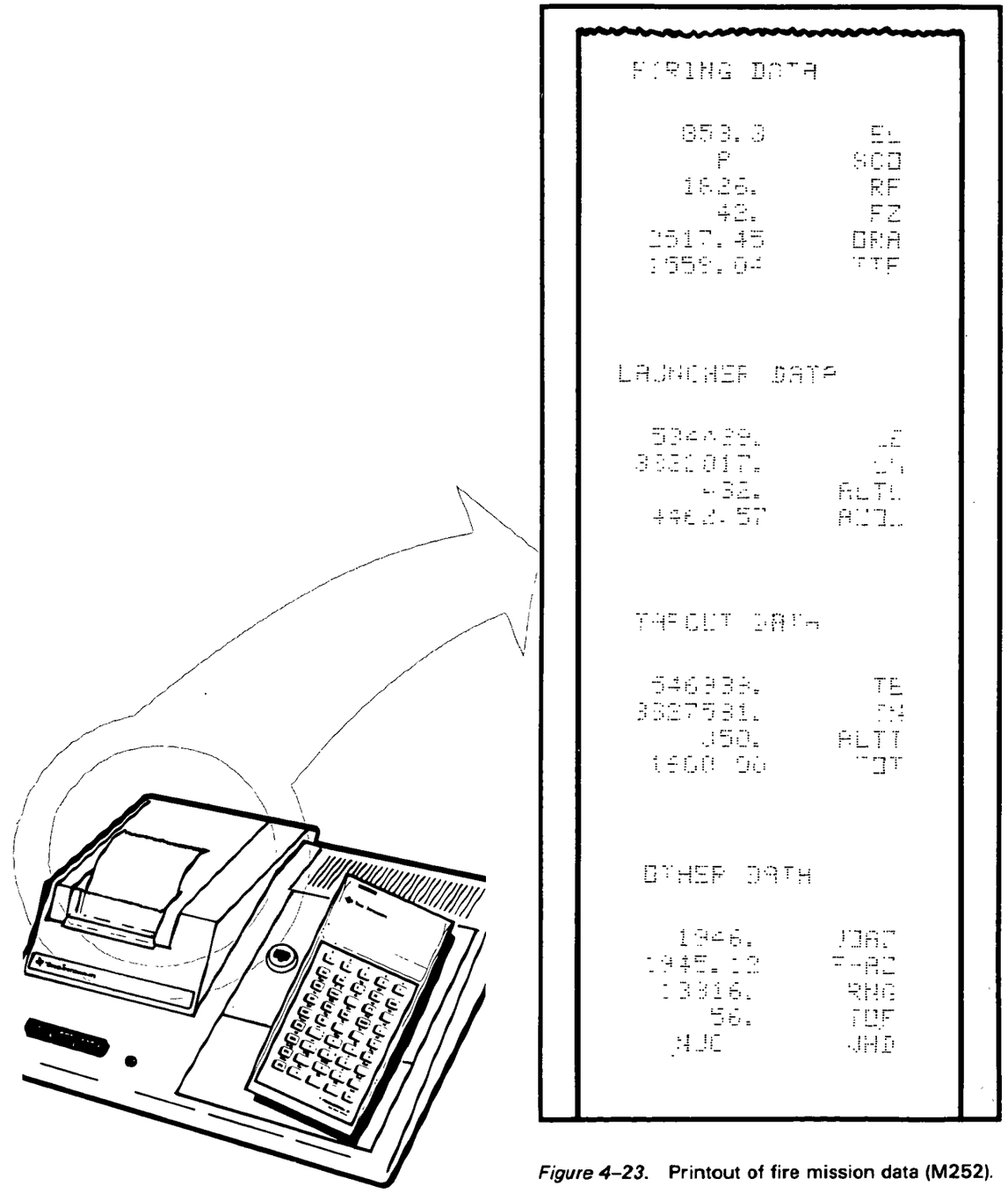


Figure 4–23. Printout of fire mission data (M252).

4-17. Computing Firing Data for M251 Warheads

a. When a call for fire and fire order are received, record them on the computer's record (Fig 4-24).

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	3-79	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ8	14SNP3Ø9973Ø9Ø5	372 M	M251

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
	16ØØ		

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
B-3-79	1	4	XZ2ØØ8

Figure 4-24. Call for fire and fire order.

b. Complete the warning order except for target azimuth (Fig 4-25).

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
1	4	XZ2ØØ8	M251		16ØØ	

FIRING POINT # [E] IF POINT IS STORED OR

Figure 4-25. Warning order.

c. Transfer the firing point (launcher) data from the firing point list to the computer's record, blocks 28-32 (Fig 4-26).

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R/S	29 LAUNCHER NORTHING	R/S	30 ALTITUDE LAUNCHER	R/S	31 AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE (N) +/- S	R/S
573561		3826435		360		15.36		35	

33 TARGET EASTING	R	34 TARGET NORTHING	R	35 ALTITUDE TARGET	R	36 HEIGHT OF BURST	R	37 TIME ON TARGET	R

Figure 4-26. Transfer firing point data.

d. Transfer the target data from the call for fire to the target data line of the computer's record (Fig 4-27).

Note: *A 0 is always used for height of burst for the M251.*

e. Clear mission data by pressing A (CLR MSN).

f. If the firing point is stored, enter the firing point number and press 2nd E'* (RCL FP). If FP is not stored, enter the launcher easting, northing, altitude, az of OL, and latitude. Press R/S after each entry.

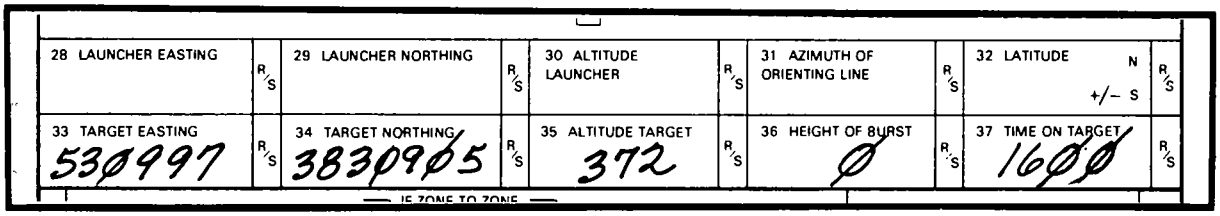


Figure 4-27. Transfer target data.

g. Enter target easting, northing, altitude, height of burst, and time on target. Press R/S after each entry.

h. No zone-to-zone transformation is required. Therefore, do not use that portion of block 38 on the computer's record (Fig 4-28).

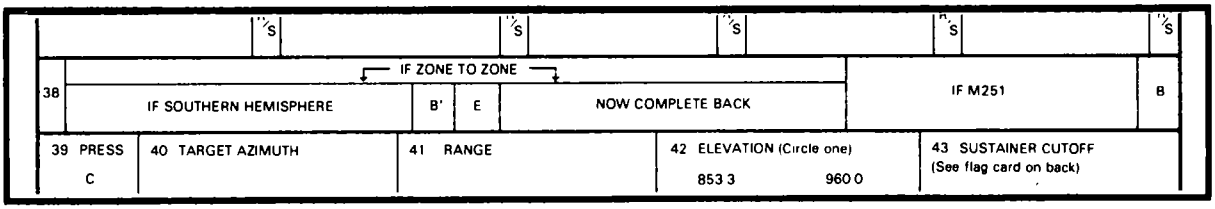


Figure 4-28. Decision blocks.

i. Press B to set the program for M251.

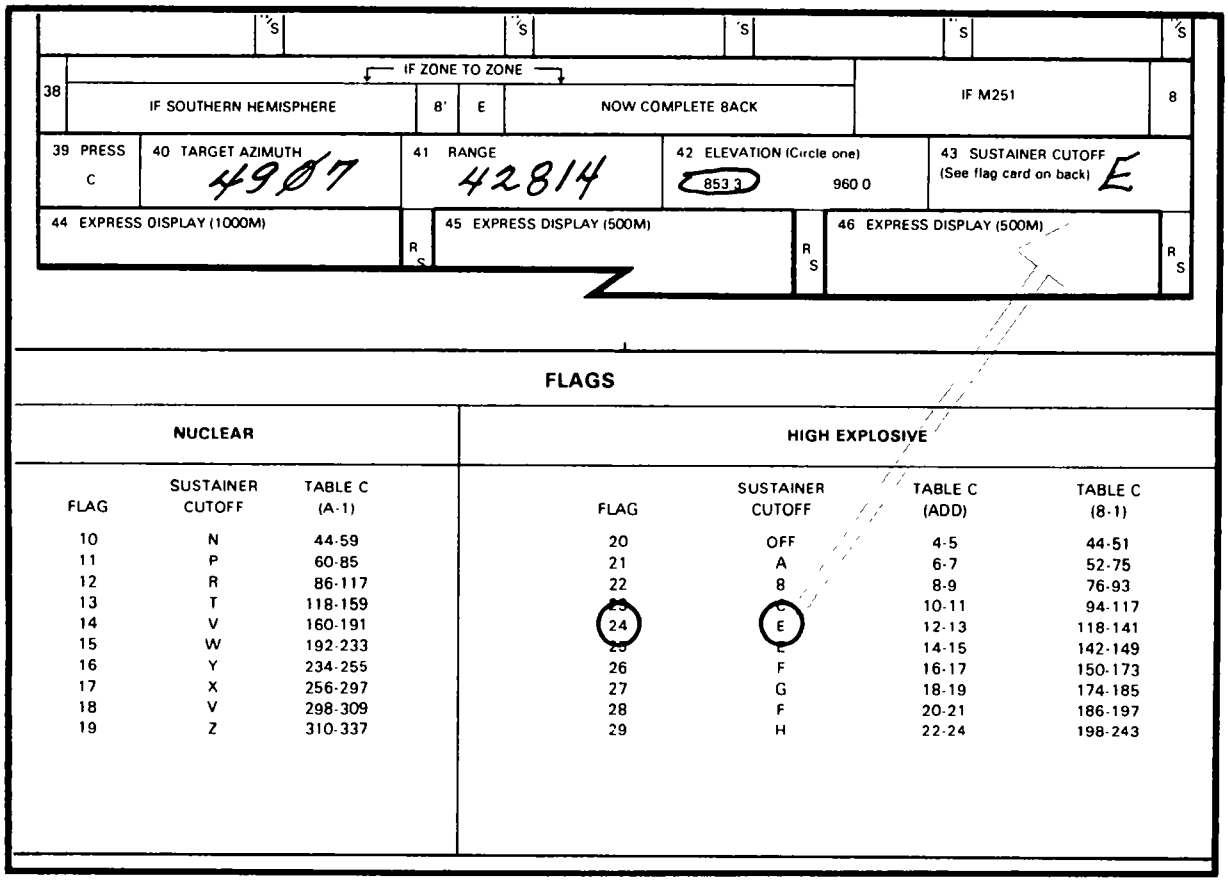
j. Initiate computation.

(1) Press C.

Note: *If the target is out of range, a flag of -1 (below minimum) or 99 (beyond maximum) will be displayed here. Pressing RCL 13 will cause the range to be displayed.*

(2) Record target azimuth and range as they appear, and circle the elevation and SCO flag.

(3) Transfer the SCO (letter) corresponding to the SCO flag to the FIRE COMMAND block (Fig 4-29).



FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (8-1)
10	N	44-59	20	OFF	4-5	44-51
11	P	60-85	21	A	6-7	52-75
12	R	86-117	22	B	8-9	76-93
13	T	118-159	[illegible]	C	10-11	94-117
14	V	160-191	24	E	12-13	118-141
15	W	192-233	[illegible]	[illegible]	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	18-19	174-185
18	V	298-309	28	F	20-21	186-197
19	Z	310-337	29	H	22-24	198-243

Figure 4-29. Initial fire commands.

k. Determine and enter FTR entry values.

(1) The calculator will stop with range displayed. Express the displayed value to the nearest 1,000, and enter it in the space provided (Fig 4-30). Enter the expressed value on the keyboard and press R/S.

(2) The calculator displays height relative to launcher. Express the displayed value to the nearest 500, and enter it in the space provided (Fig 4-30). Enter the expressed value on the keyboard and press R/S.

(3) The calculator displays launcher altitude. Express the displayed value to the nearest 500, and enter it in the space provided (Fig 4-30). Enter the expressed value on the keyboard and press R/S.

(4) The calculator stops with zero (0) displayed.

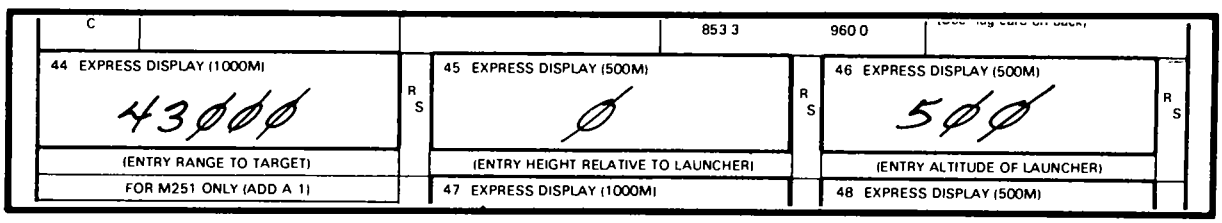


Figure 4-30. FTR entry values.

l. Enter the firing table addendum.

(1) Using the page numbers from the flag table on the form (Fig 4-31) corresponding to the circled SCO flag and the three FTR entry values just determined, enter FTR LANCE ADD-A-1, Table C.

(2) Enter the data from columns 2 through 6. Press R/S after each entry.

a_2	R/S	64 b_1	R/S	65 b_2
RECORD EASTING B		67 RECORD NORTHING B		

FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
10	N	44-59	20	OFF	4-5	44-51
11	P	60-B5	21	A	6-7	52-75
12	R	B6-117	22	B	B-9	76-93
13	T	11B-159	[illegible]	C	10-11	94-117
14	V	160-191	24	E	12-13	11B-141
15	W	192-233	[illegible]	E	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	1B-19	174-1B5
18	V	298-309	28	F	20-21	1B6-197
19	Z	310-337	29	H	22-24	19B-243

MARKS

Figure 4-31. Flag table.

m. Determine and enter corrected FTR entry values.

(1) The calculator stops with range to burst displayed. Express the displayed value to the nearest 1,000, and enter it in the space provided (Fig 4-32). Enter the expressed data on the keyboard, and store it in the calculator by pressing R/S.

(2) The calculator displays corrected height relative to launcher. Express the displayed value to the nearest 500, and enter

it in the space provided (Fig 4-32). Enter the expressed value on the keyboard and press R/S.

(3) The calculator displays zero (0).

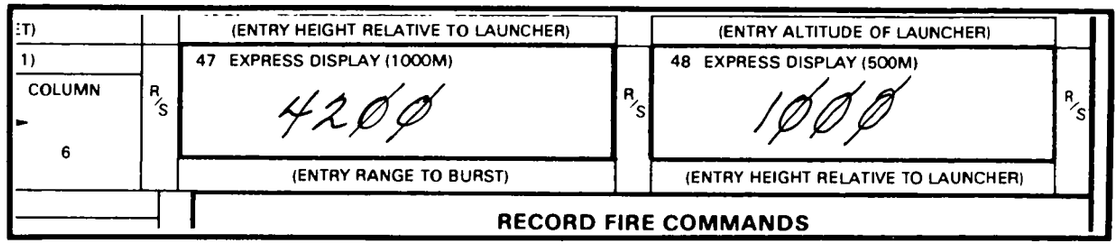


Figure 4-32. FTR entry values.

n. Enter FTR LANCE B-1.

(1) Using the page numbers from the flag table on the form adjacent to the SCO flag and the FTR entry values from paragraphs *m*(1), *m*(2), and *k*(3) above, enter FTR LANCE B-1, Table C.

(2) Enter the data from columns 2 through 16. Press R/S after each entry.

o. Record the fire commands.

(1) When the value in column 16 is entered and R/S is pressed, range factor, fuze setting, orienting angle, time to fire, and arm time are displayed for 5 seconds each. If zero (0) was entered for the time on target, then time of flight will be displayed in place of time to fire.

(2) Record these data in the FIRE COMMAND block of the computer's record (Fig 4-33).

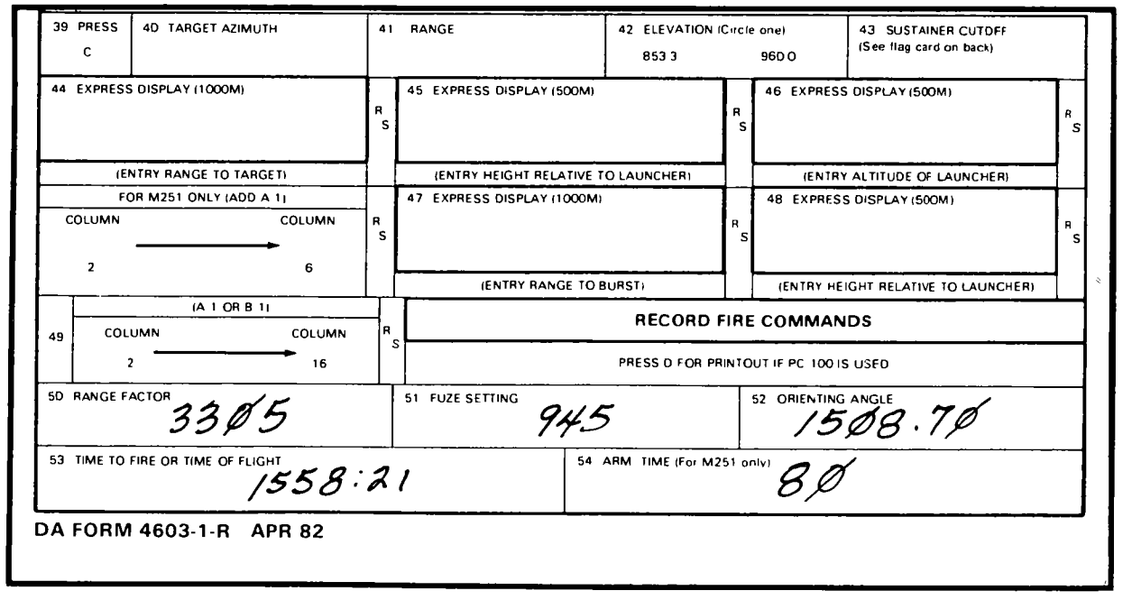


Figure 4-33. Fire commands.

COMPUTER SET, FIELD ARTILLERY, MISSILE— COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form, see FM 6-40-4 the proponent agency is TRADOC

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
B 3/79			XZ2ØØ8

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	3/79	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ8	14SNP3Ø9973Ø9Ø5	372 M	M251

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
	16ØØ		

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
B 3/79	1	13	XZ2ØØ8

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
1	13	XZ2ØØ8	M251		16ØØ	

FIRING POINT # 'E' IF POINT IS STORED OR

28 LAUNCHER EASTING	29 LAUNCHER NORTHING	30 ALTITUDE LAUNCHER	31 AZIMUTH OF ORIENTING LINE	32 LATITUDE (N) +/- S
573561	3826435	36Ø	15.36	35

33 TARGET EASTING	34 TARGET NORTHING	35 ALTITUDE TARGET	36 HEIGHT OF BURST	37 TIME ON TARGET
53Ø997	383Ø9Ø5	372	Ø	16ØØ

38 IF ZONE TO ZONE — IF SOUTHERN HEMISPHERE — B' — E — NOW COMPLETE BACK — IF M251 — B

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF (See flag card on back)
C	49Ø7	42814	B533 9600	E

44 EXPRESS DISPLAY (1000M)	45 EXPRESS DISPLAY (500M)	46 EXPRESS DISPLAY (500M)
43ØØØ	Ø	5ØØ
(ENTRY RANGE TO TARGET)	(ENTRY HEIGHT RELATIVE TO LAUNCHER)	(ENTRY ALTITUDE OF LAUNCHER)
FOR M251 ONLY (ADD A-1)	47 EXPRESS DISPLAY (1000M)	48 EXPRESS DISPLAY (500M)
COLUMN 2 → COLUMN 6	42ØØØ	1ØØØ
	(ENTRY RANGE TO BURST)	(ENTRY HEIGHT RELATIVE TO LAUNCHER)

49 (A 1 OR B 1) COLUMN 2 → COLUMN 16

RECORD FIRE COMMANDS

PRESS D FOR PRINTOUT IF PC 100 IS USED

50 RANGE FACTOR	51 FUZE SETTING	52 ORIENTING ANGLE
3305	94.5	1508.70

53 TIME TO FIRE OR TIME OF FLIGHT	54 ARM TIME (For M251 only)
1558.21	8Ø

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55 TARGET ZONE	56 LAUNCHER ZONE	57 SPHEROID

58 EXPRESS DISPLAY (100,000)	59 EXPRESS DISPLAY (100 000)

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS
IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS

60 N_o	61 E_o	62 a_1

63 a_2	64 b_1	65 b_2

66 RECORD EASTING B	67 RECORD NORTHING B

FLAGS

NUCLEAR

FLAG	SUSTAINER CUTOFF	TABLE C (A-1)
10	N	44-59
11	P	60-85
12	R	86-117
13	T	118-159
14	V	160-191
15	W	192-233
16	Y	234-255
17	X	256-297
18	V	298-309
19	Z	31D-337

HIGH EXPLOSIVE

FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
20	OFF	4-5	44-51
21	A	6-7	52-75
22	B	8-9	76-93
[illegible]	C	10-11	94-117
(24)	E	12-13	118-141
[illegible]	E	14-15	142-149
26	F	16-17	150-173
	G	18-19	174-185
	F	20-21	186-197
	H	22-24	198-243

SAMPLE

REMARKS

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Figure 4-34. Completed computer's record (M251).

p. If required, press 2nd C'* (FIRE DATA). This will cause the fire commands to be displayed again in the sequence they appear in the FIRE COMMAND block of the computer's record.

q. A complete computer's record is shown in Figure 4-34.

r. If a printer is used, a printout of firing data can be obtained by pressing D (PRINT) (Fig 4-35).

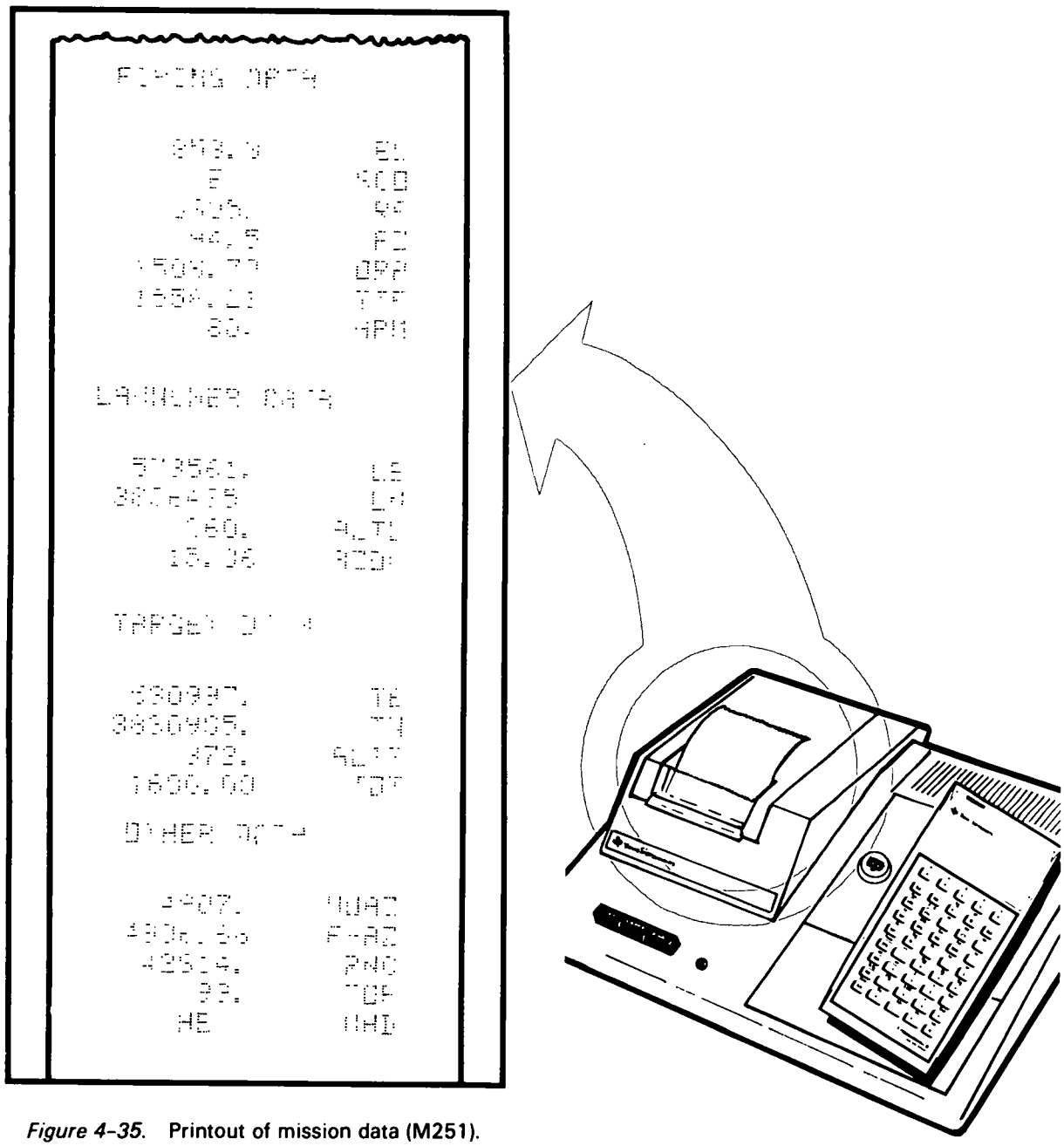

Figure 4-35. Printout of mission data (M251).

4-18. Mission With Zone-to-Zone Coordinate Transformations Required

a. Perform actions in paragraph 4-16*h* for M234/M252 or paragraph 4-17*g* for M251 (Fig 4-36).

b. Initiate zone-to-zone computations (Fig 4-37).

(1) If in the Southern Hemisphere, press 2nd B'* (SO HEM).

(2) Press E (ZONE).

(3) Turn to back of form.

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER XZ2763
CALL FOR FIRE			
5 FIRE MISSION J3F7Ø	6 UNIT TO FIRE 1-12	7 LAUNCHER(S) TO FIRE 1	8 FIRING POINT NUMBER 25
9 TARGET NUMBER XZ2763	10 TARGET GRID 334TQ8276328665	11 ALTITUDE TARGET 4Ø2 M	12 WARHEAD M234
13 HEIGHT OF BURST H/84Ø	14 TIME ON TARGET 271500	15 TIME ON TARGET NO LATER THAN 271515	16 REMARKS
FIRE ORDER			
17 UNIT TO FIRE B-1-12	18 LAUNCHER NUMBER 2	19 FIRING POINT NUMBER 25	20 TARGET NUMBER XZ2763
WARNING ORDER			

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	25	XZ2763	M234	H	271500	

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R S	29 LAUNCHER NORTHING	R S	30 ALTITUDE LAUNCHER	R S	31 AZIMUTH OF ORIENTING LINE	R S	32 LATITUDE (N) +/- S	R S
708352		5425216		375		2306.78		49	
33 TARGET EASTING	**R S**	**34 TARGET NORTHING**	**R S**	**35 ALTITUDE TARGET**	**R S**	**36 HEIGHT OF BURST**	**R S**	**37 TIME ON TARGET**	**R S**
282763		5428665		402		840		1500	

38 IF ZONE TO ZONE — IF M251 a

Figure 4-36. Partial computer's record.

S	S	S	S	S
3B	IF ZONE TO ZONE			IF M251 B
	IF SOUTHERN HEMISPHERE	B' E	NOW COMPLETE BACK	
39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF

Figure 4-37. Initiate zone-to-zone computations.

c. Determine TM 5-241-2 entry values.

(1) Express the displayed value to the nearest 100,000, and enter it on the form (Fig 4-38). Enter the expressed value on the keyboard and press R/S. This is the "e" value.

(2) Express the displayed value to the nearest 100,000, and enter it on the form (Fig 4-38). Enter the expressed value on the keyboard and press R/S. This is the "n" value.

(3) Record the target zone, launcher zone, and spheroid in the blocks provided on the computer's record (Fig 4-38).

d. Determine TM 5-241-2 entry.

(1) Enter the index with the spheroid to determine a page number to enter the tables.

(2) Beginning at this page, search for a block of data headed by the "n" value determined in *c*(2) above.

(3) Refer to the map and determine if the launcher is east or west of the target.

55 TARGET ZONE	56 LAUNCHER ZONE	57 SPHEROID
33 U	32 U	INTERNATIONAL

58 EXPRESS DISPLAY (100 000)	R S	59 EXPRESS DISPLAY (100,000)	R S
300,000		5400,000	

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS
IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS

60 N_o	R S	61 E_o	R S	62 a_1	R S
63 a_2	R S	64 b_1	R S	65 b_2	R S

66 RECORD EASTING B	67 RECORD NORTHING B

FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A 1)	FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B 1)
10	N	44 59	20	OFF	4-5	44 51
11	P	60 85	21	A	6-7	52 75
12	R	86 117	22	B	8-9	76 93
13	T	118 159	23	C	10-11	94-117
14	V	160 191	24	E	12 13	118-141
15	W	192 233	25	E	14 15	142-149
16	Y	234 255	26	F	16 17	150-173
17	X	256 297	27	G	18 19	174-185

Figure 4-38. TM 5-241-2 entry values.

(4) Use the statements on the computer's record (Fig 4-39) to determine how to enter the data blocks.

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS

IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS

Figure 4-39. TM 5-241-2 entry.

(5) Enter the data from columns N_0 through b_2 on the keyboard, press [+/-] after each negative value. Press R/S after each entry (Fig 4-40).

(6) Record the easting and northing as they are flashed on the display (Fig 4-40).

(7) If the printer is used, a printout will be automatically printed (Fig 4-41). The printout should be left in the printer until the mission is completed and firing data are printed.

(8) Return to the front of the computer's record and resume with the next block.

e. Perform actions in paragraphs 4-16*i*(3) through 4-16*l* for M234/M252 or paragraphs 4-17*i* through 4-17*o* for M251 to complete the mission (Figs 4-42(1) and (2)).

n = 5 400 000

55.	e	N_0		E_0		a_1		a_2		b_1		b_2		c_1	
	300 000	+5 401 626	759	∓241 304	495	+ 99 712	574	±7 866	499	-06	585	±53	785	+0	021
58.	400 000	+5 409 500	170	∓341 070	834	+ 99 820	084	±7 880	035	-07	570	±53	727	+0	017
	500 000	+5 417 388	723	∓440 944	628	+ 99 927	489	±7 896	784	-08	563	±53	680	+0	014
	600 000	+5 425 294	404	∓540 925	785	+100 034	814	±7 914	910	-09	564	±53	646	+0	010
	700 000	+5 433 219	214	∓641 014	236	+100 142	080	±7 935	048	-10	575	±53	622	+0	006

R/S

60 N_0 +5401162.759 R/S | 61 E_0 +2413044.495 R/S | 62 a_1 +99714.574 R/S

63 a_2 −7866.499 R/S | 64 b_1 −6.585 R/S | 65 b_2 −53.785 R/S

66 RECORD EASTING B 721860 | 67 RECORD NORTHING B 5428848

Figure 4-40. Data entry and recording.

ZONE-TO-ZONE
TRANSFORMATION

FROM ZONE-A
COORDINATES

382763. E
5428665. N

TO ZONE-B
COORDINATES

721860. E
5428848. N

Figure 4-41. Zone-to-zone printout.

COMPUTER SET, FIELD ARTILLERY, MISSILE— COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form, see FM 6-40-4, the proponent agency is TRADOC

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
B-1-12			XZ 2763

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	1-12	1	25

9. TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ 2763	33UTQ8276328665	402 M	M234

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
H/84Ø	271500	271515	

FIRE ORDER

17. UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
B-1-12	2	25	XZ2763

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	25	XZ2763	M234	84Ø	271500	

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R/S	29 LAUNCHER NORTHING	R/S	30 ALTITUDE LAUNCHER	R/S	31 AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE (N) +/- S	R/S
7Ø8352		5425216		375		2306.78		49	

33 TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36 HEIGHT OF BURST	R/S	37. TIME ON TARGET	R/S
282763		5428665		402		84Ø		15ØØ	

38	IF ZONE TO ZONE: IF SOUTHERN HEMISPHERE	B'	E	NOW COMPLETE BACK	IF M251	B

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF (See flag cord on back)
C	1332	13985	(B53 3) 960 0	P

44 EXPRESS DISPLAY (1000M)	R/S	45 EXPRESS DISPLAY (500M)	R/S	46 EXPRESS DISPLAY (500M)	R/S
14ØØØ		1ØØØ		5ØØ	
(ENTRY RANGE TO TARGET)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)		(ENTRY ALTITUDE OF LAUNCHER)	

FOR M251 ONLY (ADD A-1) COLUMN 2 → COLUMN 6	R/S	47. EXPRESS DISPLAY (1000M)	R/S	48 EXPRESS DISPLAY (500M)	R/S
		(ENTRY RANGE TO BURST)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)	

49 (A-1 OR B-1) COLUMN 2 → COLUMN 16	R/S	RECORD FIRE COMMANDS
		PRESS D FOR PRINTOUT IF PC-100 IS USED

50 RANGE FACTOR	51 FUZE SETTING	52 ORIENTING ANGLE
1932	41	975.96

53 TIME TO FIRE OR TIME OF FLIGHT	54 ARM TIME (For M251 only)
1459:Ø5	

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Figure 4-42 (1). **Completed zone-to-zone mission (front).**

55 TARGET ZONE	56 LAUNCHER ZONE	57 SPHEROID
33U	32U	INTERNATIONAL

58 EXPRESS DISPLAY (100,000)	R/S	59 EXPRESS DISPLAY (100,000)	R/S
300,000		5400,000	

IF LAUNCHER IS EAST OF TARGET USE (e) VALUE ON RIGHT SIDE OF TABLE AND UPPER OF SIGNS
IF LAUNCHER IS WEST OF TARGET USE (e) VALUE ON LEFT SIDE OF TABLE AND LOWER OF SIGNS

60 N_o	R/S	61 E_o	R/S	62 a_1	R/S
5401626		2413044495		99712574	
63 a_2	**R/S**	**64 b_1**	**R/S**	**65 b_2**	**R/S**
-7866499		-06585		-53785	

66 RECORD EASTING B	67 RECORD NORTHING B
721860	5428848

FLAGS

NUCLEAR

FLAG	SUSTAINER CUTOFF	TABLE C (A-1)
10	N	44-59
11	P	60-85
12	R	86-117
13	T	118-159
14	V	160-191
15	W	192-233
16	Y	234-255
17	X	256-297
18	V	298-309
19	Z	310-337

HIGH EXPLOSIVE

FLAG	SUSTAINER CUTOFF	TABLE C (ADD)	TABLE C (B-1)
20	OFF	4-5	44-51
21	A	6-7	52-75
22	B	8-9	76-93
23	C	1D-11	94-117
24	E	12-13	118-141
25	E	14-15	142-149
26	F	16-17	150-173
27	G	18-19	174-185
28	F	2D-21	186-197
29	H	22-24	198-243

REMARKS

REVERSE OF DA FORM 4603-1-R APR 82

Figure 4-42 (2). Completed zone-to-zone mission (back).

4-19. Missions Requiring Survey (Floating Firing Points)

a. Perform actions in paragraphs 4-16*a* through 4-16*i*(3) for M234/M252 or paragraphs 4-17*a* through 4-17*j*(1) for M251 (Fig 4-43).

> **Note:** *The coordinates of the orienting station are used as the launcher location.*

b. DO NOT record any of the data displayed when C is pressed.

COMPUTER SET, FIELD ARTILLERY, MISSILE—
COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form, see FM 6-40-4; the proponent agency is TRADOC

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
			XZ2ØØ7

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	1-333	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ7	14SNP4698927581	35Ø M	M252

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
G	ØØ16ØØ		

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
A-1-333	2	13	XZ2ØØ7

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	13	XZ2ØØ7	M252	G	ØØ16ØØ	4844

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R/S	29 LAUNCHER NORTHING	R/S	30 ALTITUDE LAUNCHER	R/S	31 AZIMUTH OF ORIENTING LINE	R/S	32 LATITUDE (N) +/- S	R/S
573561		3826435		36Ø		15.36		35	

33 TARGET EASTING	R/S	34 TARGET NORTHING	R/S	35 ALTITUDE TARGET	R/S	36 HEIGHT OF BURST	R/S	37 TIME ON TARGET	R/S
546989		3827581		35Ø		Ø		16ØØ	

38 IF ZONE TO ZONE					
IF SOUTHERN HEMISPHERE	B'	E	NOW COMPLETE BACK	IF M251	B

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF (See flag cerd on back)
C			8533 9600	

Figure 4-43. Starting data.

c. Refer to the memory map (Fig 4-44) and find the azimuth of the orienting line stored in 05 and the azimuth in mils stored in 14.

d. Compute an orienting angle for the firing platoon to use for surveying the firing point.

(1) Press CLR.

(2) Subtract the azimuth of fire from the az of the OL, adding 6,400 if necessary, to find the orienting angle. This is done by pressing RCL 05 - RCL 14 = (+ 6400 = IF RESULT IS NEGATIVE) 2nd Fix* 2.

(3) Transmit this orienting angle to the firing platoon for their use in surveying the firing point.

Note: *This is not the orienting angle to be used for laying the missile.*

(4) Record this orienting angle in the margin of the form (Fig 4-45).

(5) Press the PRINT key on the printer to record this orienting angle on the printout.

e. Compute the firing point coordinates.

(1) Press clear key, then enter the distance the firing point is displaced from the orienting station on the keyboard (in this case, 40 meters) and press 2nd A'* (MINI-SVY).

(2) Record the firing point easting and northing as they are displayed (Fig 4-46). These data are automatically printed if the printer is being used.

Note: *These coordinates are automatically transferred to the mission working area and replace the coordinates of the orienting station.*

ANNEX A

MEMORY MAP

00	853.3	25	ADD-A-1 Col 5	50	TTF	75	FP-6
01	960	26	ADD-A-1 Col 6	51	ARM	76	FP-6
02	LE	27	RANGE (RB)	52	FIRING AZ	77	FP-6
03	LN	28	CosL Sin Az	53	CORR TP	78	FP-7
04	ALTL	29	CosL Cos Az	54	TOF	79	FP-7
05	AZOL	30	Cos 2L	55	BT	80	FP-7
06	LAT (GRADS)	31	Sin L	56		81	FP-8
07	TE	32	A-1 or B-1 Col 2	57		82	FP-8
08	TN	33	A-1 or B-1 Col 3	58		83	FP-8
09	ALTT	34	A-1 or B-1 Col 4	59		84	FP-9
10	HOB	35	A-1 or B-1 Col 5	60	FP-1	85	FP-9
11	TOT	36	A-1 or B-1 Col 6	61	FP-1	86	FP-9
12	AZ (GRADS)	37	A-1 or B-1 Col 7	62	FP-1	87	FP-10
13	RANGE (RT)	38	A-1 or B-1 Col 8	63	FP-2	88	FP-10
14	Az (Mils)	39	A-1 or B-1 Col 9	64	FP-2	89	FP-10
15	RT/100	40	A-1 or B-1 Col 10	65	FP-2	90	FP-11
16	HL/100	41	A-1 or B-1 Col 11	66	FP-3	91	FP-11
17	ALTL/100	42	A-1 or B-1 Col 12	67	FP-3	92	FP-11
18	ALTL/100	43	A-1 or B-1 Col 13	68	FP-3	93	FP-12
19	WORK AREA	44	A-1 or B-1 Col 14	69	FP-4	94	FP-12
20	ELEVATION	45	A-1 or B-1 Col 15	70	FP-4	95	FP-12
21	SCO FLAG	46	A-1 or B-1 Col 16	71	FP-4	96	FP-13
22	ADD-A-1 Col 2	47	RF	72	FP-5	97	FP-13
23	ADD-A-1 Col 3	48	FZ	73	FP-5	98	FP-13
24	ADD-A-1 Col 4	49	ORA	74	FP-5	99	.49999999

Figure 4-44. Memory map.

COMPUTER SET, FIELD ARTILLERY, MISSILE—
COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)

For use of this form see FM 6 40 4 the proponent agency is TRADOC

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
A-1-333			XZ2ØØ7

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	1-333	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ7	14SNP4698927581	35Ø M	M252

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
G/Ø	Ø916ØØ		40METER FLOAT

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
A-1-333	2	13	XZ2ØØ7

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	13	XZ2ØØ7	M252	Ø	Ø916ØØ	

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R S	29 LAUNCHER NORTHING	R S	30 ALTITUDE LAUNCHER	R S	31 AZIMUTH OF ORIENTING LINE	R S	32 LATITUDE N +/- S	R S
573561		3826438		36Ø		15.36		35	
33 TARGET EASTING		34 TARGET NORTHING		35 ALTITUDE TARGET		36 HEIGHT OF BURST		37 TIME ON TARGET	

Figure 4-45. Record orienting angle.

For use of this form see FM 6 40 4 the proponent agency is TRADOC ORA FOR SUY 1576.46

1 UNIT	2 DATE AND TIME FIRED	3 MISSILE SERIAL NUMBER	4 TARGET NUMBER
A-1-333			XZ2ØØ7

CALL FOR FIRE

5 FIRE MISSION	6 UNIT TO FIRE	7 LAUNCHER(S) TO FIRE	8 FIRING POINT NUMBER
J3F7Ø	1-333	1	13

9 TARGET NUMBER	10 TARGET GRID	11 ALTITUDE TARGET	12 WARHEAD
XZ2ØØ7	14SNP4698927581	35Ø M	M252

13 HEIGHT OF BURST	14 TIME ON TARGET	15 TIME ON TARGET NO LATER THAN	16 REMARKS
G/Ø	Ø916ØØ		4Ø METER FLOAT

FIRE ORDER

17 UNIT TO FIRE	18 LAUNCHER NUMBER	19 FIRING POINT NUMBER	20 TARGET NUMBER
A-1-333	2	13	XZ2ØØ7

WARNING ORDER

21 LAUNCHER NUMBER	22 FIRING POINT NUMBER	23 TARGET NUMBER	24 WARHEAD	25 HEIGHT OF BURST	26 TIME ON TARGET	27 TARGET AZIMUTH
2	13	XZ2ØØ7	M252	Ø	Ø916ØØ	

FIRING POINT # [E] IF POINT IS STORED OR

28 LAUNCHER EASTING	R S	29 LAUNCHER NORTHING	R S	30 ALTITUDE LAUNCHER	R S	31 AZIMUTH OF ORIENTING LINE	R S	32 LATITUDE (N) +/- S	R S
573561		3826438		36Ø		15.36		35	
33 TARGET EASTING	R S	34 TARGET NORTHING	R S	35 ALTITUDE TARGET	R S	36 HEIGHT OF BURST	R S	37 TIME ON TARGET	R S
573521		3826437							

Figure 4-46. Record the firing point coordinates.

39 PRESS	40 TARGET AZIMUTH	41 RANGE	42 ELEVATION (Circle one)	43 SUSTAINER CUTOFF (See flag card on back)
C		26566	(8533) 9600	R

44 EXPRESS DISPLAY (1000M)	R/S	45 EXPRESS DISPLAY (500M)	R/S	46 EXPRESS DISPLAY (500M)	R/S
27000		0		500	
(ENTRY RANGE TO TARGET)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)		(ENTRY ALTITUDE OF LAUNCHER)	
FOR M251 ONLY (A0D A-1)		47 EXPRESS DISPLAY (1000M)	R/S	48 EXPRESS DISPLAY (500M)	R/S
COLUMN 2 → COLUMN 6	R/S	(ENTRY RANGE TO BURST)		(ENTRY HEIGHT RELATIVE TO LAUNCHER)	

49 (A-1 OR B-1) COLUMN 2 → COLUMN 16	R/S	RECORD FIRE COMMANDS
		PRESS D FOR PRINTOUT IF PC-100 IS USED

50 RANGE FACTOR	51 FUZE SETTING	52 ORIENTING ANGLE
2597	64	1571.85

53 TIME TO FIRE OR TIME OF FLIGHT	54 ARM TIME (For M251 only)
1558:41	

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FLAGS

NUCLEAR			HIGH EXPLOSIVE			
FLAG	SUSTAINER CUTOFF	TABLE C (A-1)	FLAG	SUSTAINER CUTOFF	TABLE C (A00)	TABLE C (8-1)
10	N	44-59	20	OFF	4-5	44-51
11	P	60-85	21	A	6-7	52-75
12	R	86-117	22	B	8-9	76-93
13	T	118-159	23	C	10-11	94-117
14	V	160-191	24	E	12-13	118-141
15	W	192-233	25	E	14-15	142-149
16	Y	234-255	26	F	16-17	150-173
17	X	256-297	27	G	18-19	174-185
18	V	298-309	28	F	20-21	186-197
19	Z	310-337	29	H	22-24	198-243

Figure 4-47. Completed mission (floating firing point).

f. Initiate computation by pressing C.

g. Record target azimuth, range, elevation, and SCO flag as they are displayed.

h. Complete the mission by performing the actions in paragraphs 4-16*i*(3) through 4-16*l* for M234/M252 or paragraphs 4-17*i* through 4-17*o* for M251 (Fig 4-47).

4-20. March Tables

March tables for unit movement can be computed and printed by using the computer set, FA, missile. The printer *must* be used for this operation.

Note: *Using this program will erase any firing points that are stored.*

a. **Programing.**

(1) Call the march table program by pressing 2nd PGM* 04.

(2) Insert the march table cue card (Fig 4-48).

(3) Press 2nd D'* (CLR) to clear the working area.

LANCE				
MARCH TABLE				PGM 04
KMH	TOTAL	CHANGE	CLEAR	KM
MPH	VEH	INTERVAL	SP TIME	MI

Figure 4-48. March table cue card.

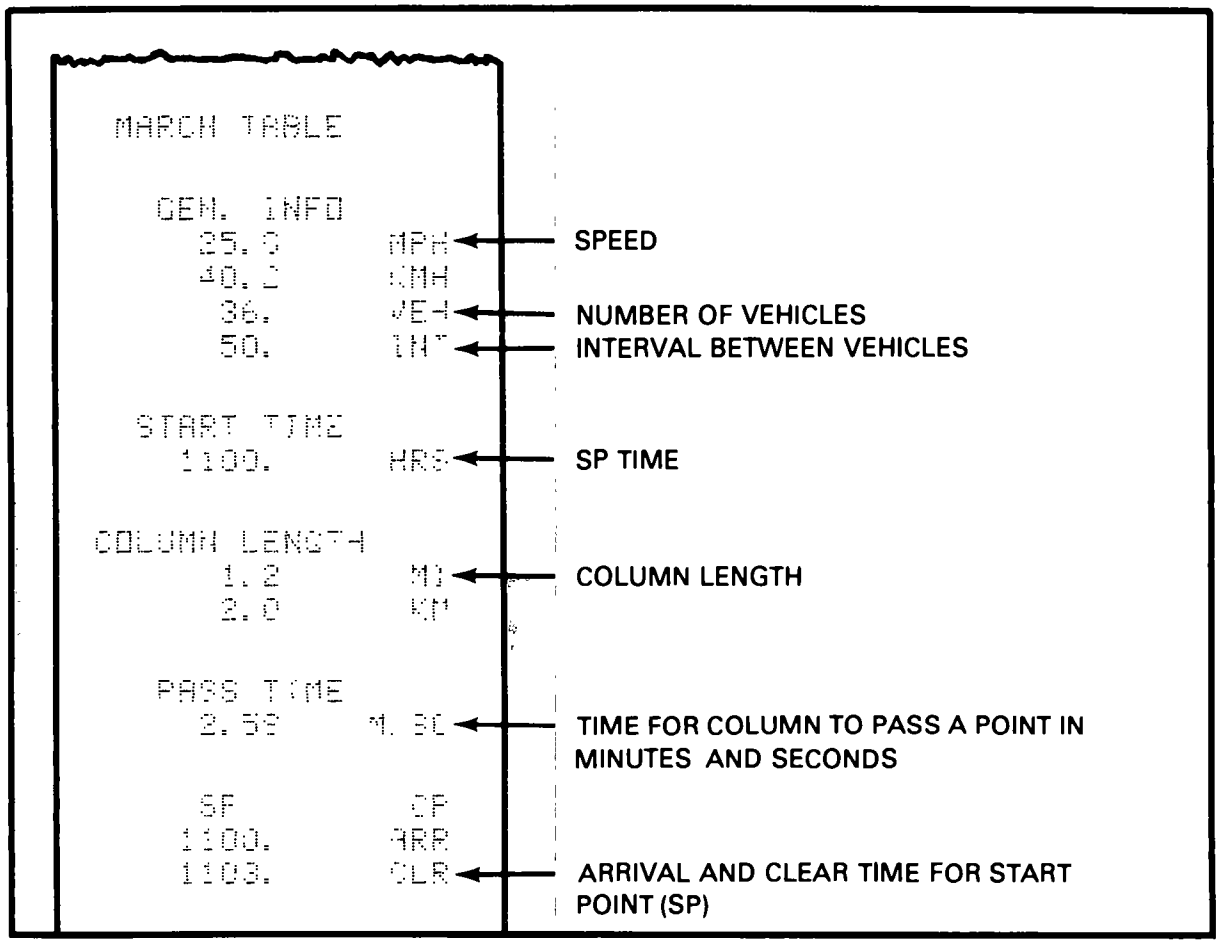


Figure 4-49. March table, general information.

b. **Computing.**

(1) Enter speed and press A (MPH) or 2nd A'* (KMH).

(2) Enter the number of vehicles in the column and press B (VEH).

(3) Enter the interval between vehicles and press C (INT).

(4) Enter the start point time and press D (SP TI).

(5) The printer will produce a printout (Fig 4-49).

(6) Enter distance to the first checkpoint and press E (MI) or 2nd E'* (KM). The printer will print the information in Figure 4-50.

(7) Enter additional checkpoints as in (6) above.

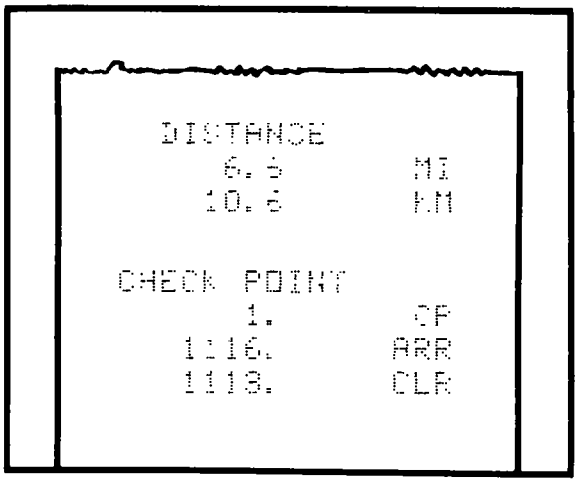


Figure 4-50. March table, checkpoint data.

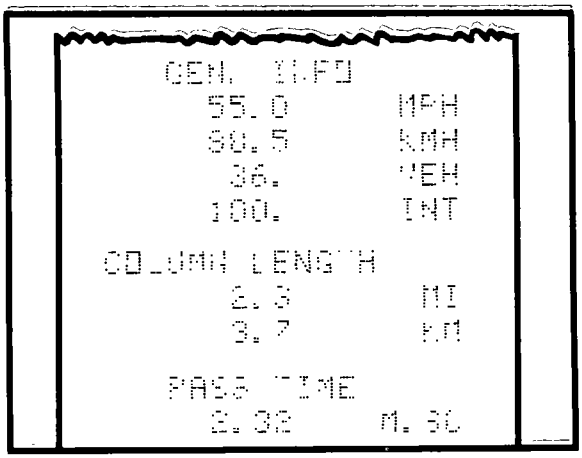


Figure 4-51. Revised general information.

(8) When changes in speed and/or interval are required (as when leaving a secondary road and entering a major highway):

(a) Enter the new speed and press A (MPH) or 2nd A'* (KMH).

(b) Enter the new interval and press C.

(c) Press 2nd C'* to print the revised general information (Fig 4-51).

(9) Enter additional checkpoints as in (6) above.

(10) Print total (after the last checkpoint has been computed) by pressing 2nd B'* (TOTAL) (Fig 4-52).

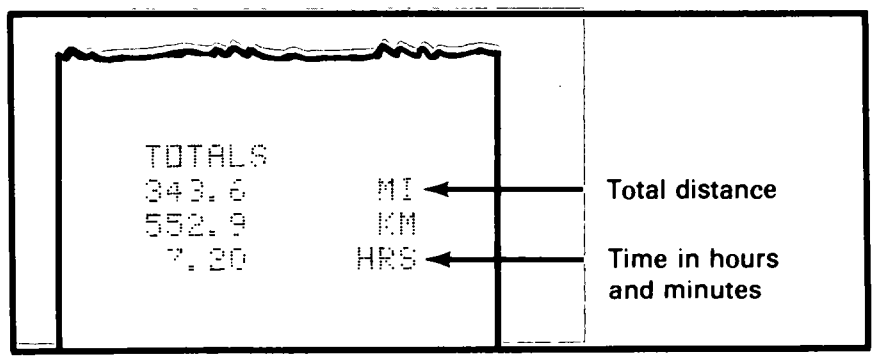


Figure 4-52. March table, totals.

4-21. Troubleshooting

a. **Fire missions.**

(1) If an error is made in entering data and the R/S key has not been pressed, press CE and enter the correct data.

(2) If an error is made in entering data and the R/S key has been pressed:

(a) Press A (CLR MSN) and start again,

or

(b) Determine from the memory map where the data are stored (Fig 4-44), and enter the correct data followed by STO (store) nn, where nn is the memory location.

(3) If an error is made after pressing C (COMPUTE), it is normally quicker to press CLR and C and begin again at C on the computer's record.

b. **Storing firing points.** Reenter with the correct data.

c. **March tables.** Press 2nd D'* and start over from the beginning.

d. **Other errors or problems.**

(1) Refer to TM 9-1220-242-12&P, Table 5-1.

(2) Refer to the Texas Instruments owner's manual.

REFERENCES

APPENDIX A

A-1. Publication Indexes

Department of the Army pamphlets of the 310-series should be consulted frequently for latest changes to or revisions of references listed in this appendix and for information on new publications relating to material covered in this manual.

A-2. Army Regulations

220-15	Journals and Journal Files
310-3	Preparation, Coordination, and Approval of Department of the Army Publications
310-25	Dictionary of United States Army Terms
310-50	Authorized Abbreviations and Brevity Codes (Microfiche only)
340-2	Maintenance and Disposition of Records in TOE Units of the Active Army and the Army Reserve
385-62	Firing Guided Missiles and Heavy Rockets for Training, Target Practice, and Combat
385-63	Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat
611-201	Enlisted Career Management Fields and Military Occupational Specialties

A-3. Army Training and Evaluation Program

6-595	Lance, The Field Artillery Battalion

A-4. Department of the Army Pamphlets

108-1	Index of Army Motion Pictures and Related Audio-Visual Aids
310-series	Military Publications Indexes

A-5. Field Manuals

5-25	Explosives and Demolitions
6-2	Field Artillery Survey
6-15J-CM	Commander's Manual: 15J, Lance Operations/Fire Direction Specialist
6-15J 1/2	Soldier's Manual: Lance Operations/Fire Direction Specialist Skill Level 1/2
6-15J 3	Soldier's Manual: Lance Operations/Fire Direction Specialist Skill Level 3
6-15J 4	Soldier's Manual: Lance Operations/Fire Direction Specialist Skill Level 4
6-20	Fire Support in Combined Arms Operations (How To Fight)
6-40	Field Artillery Cannon Gunnery
6-42	Field Artillery Battalion, Lance
6-141-1	Field Artillery Target Analysis and Weapon Employment: Nonnuclear
(C)6-141-2	Field Artillery Target Analysis and Weapon Employment: Nonnuclear (U)
21-6	How to Prepare and Conduct Military Training
21-26	Map Reading
21-30	Military Symbols
32-6	SIGSEC Techniques
101-31-1	Staff Officer's Field Manual: Nuclear Weapons Employment, Doctrine and Procedures
(SRD)101-31-2	Staff Officer's Field Manual: Nuclear Weapons Employment Effects Data (U)
101-31-3	Staff Officer's Field Manual: Nuclear Weapons Employment Effects Data

A-6. Training Circulars

21-5-7	Training Management in Battalions

A-7. Firing Tables

(C)FTR LANCE-A-1	Firing Tables for Lance Warhead Section, Atomic: M234 and Warhead Section, M252 (U)
(C)FTR LANCE-B-1	Firing Tables for Lance Warhead Section, High Explosive: M251 and Warhead Section, Practice: M198 (U)

(C)FTR LANCE ADD-A-1	Firing Table Addendum to FTR Lance B-1 for Warhead Section, Guided Missile, HE, M251 (U)

Note: *These publications are classified CONFIDENTIAL and must be obtained through classified publications channels.*

A-8. Technical Manuals

5-241-2	Universal Transverse Mercator Grid: Zone to Zone Transformation Tables
5-6115-271-14	Operator/Crew, Organizational, Intermediate (Field), Direct and General Support and Depot Maintenance Manual: Generator Set, Gasoline Engine Driven, Skid Mounted, Tubular Frame, 3KW, 3 Phase, AC 120/208 and 120/240 V, 28V DC (Less Engine)
6-231	Seven Place Logarithmic Tables
9-1115-485-12	Operator and Organizational Maintenance (Prelaunch Procedures): M234, M234F1 and M234F2 Atomic Warhead Section; M240 Training Atomic Warhead Section
9-1220-221-10/1	Operator's Manual for Computer, Gun Direction, M18 Cannon/ Lance (FADAC)
9-1220-221-20&P	Organizational Maintenance Manual: Computer, Gun Direction M18 (FADAC)
*9-1220-242-12&P	Operator and Organizational Maintenance Manual (Including Repair Parts List), Computer, Field Artillery, General and Missile
9-1290-326-34	Operator's and Organizational Maintenance Manual: Reproducer, Signal Data AN/GSQ-64
9-1336-486-12	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists): Warhead Section, Guided Missile: Practice: (Modified) and XM198E1
9-1336-488-12&P	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists): Warhead Section, Guided Missile, Practice: Lightweight, M252
9-1336-489-12&P	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools Lists): Warhead Section, Guided Missile, High Explosives: M251 and Warhead Section; Guided Missile: Training M201
9-1425-485-10-1	System Description for Lance Guided Missile System
9-1425-485-10-2	Operator's Manual: Lance Guided Missile System
9-1425-485-20	Organizational Maintenance Manual for Lance Guided Missile System

*This publication is not available through regular publication channels. Copies may be obtained from Commander, US Army Armament and Materiel Readiness Command, ATTN: DRSAR-MAS, Rock Island, IL 61299

9-2300-257-20P	Organizational Maintenance Repair Parts and Special Tool List for Carrier, Command Post, Light, Tracked, M577A1 and M577A2
9-2300-257-34P	Direct Support and General Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Carrier, Command Post, Light, Tracked, M577A1 and M577A2
9-4931-204-12&P	Operator's and Organizational Maintenance Manual: Reproducer, Signal Data, AN/GSQ 64, and Test Set Computer Logic Unit AN/GSM-70
11-5820-401-12	Operator's and Organizational Maintenance Manual: Radio Sets AN/VRC-Series

A-9. Allied Communications Publications (ACP)

134(A)	Telephone Switchboard Operating Procedures

A-10. DA Forms

1594	Daily Staff Journal or Duty Officer's Log
3613	Record Survey Control Point
4603	Computer's Record and Data Correction Sheet (Lance)
4603-1-R	Computer Set, Field Artillery Missile—Computer's Record and Data Correction Sheet (LANCE)
5090-R	Alfa Report (SITREP)
5091-R	Bravo Report (Equipment Status)
5092-R	Charlie Report (Firing Point List
5093-R	Delta Report (Fire Mission/Mission Status)
5094-R	Echo Report (Ammunition Status)
5095-R	Foxtrot Report (Fire Mission Summary)

APPENDIX B

M234 WARHEAD DATA

HEIGHT OF BURST (HOB)

Type Warhead	HOB Selector Position	Actual HOB*
M234	Contact (G)	0
M234	Air Low (L)	232
M234 -	Air Low/Contact Backup (LG)	232
M234	Air High (H)	840
M234	Air High/Contact Backup (HG)	840

*The data presented are for training purposes only and are not valid for any other purposes. For actual HOB, refer to (SRD) FM 101-31-2, *Staff Officer's Field Manual: Nuclear Weapons Employment Effects Data* (U).

LANCE FIRE DIRECTION APPENDIX TO AN OPERATIONS ANNEX TO A BATTALION TACTICAL SOP

APPENDIX C

C-1. Normal Conditions

The material included in this appendix is intended for immediate application and use by all US Lance battalions in line with the Army's standardization efforts. Minor variations may be made when necessary to comply with higher headquarters or supported units' tactical SOPs.

C-2. Unusual Conditions

During periods of personnel shortages or when a lack of trained personnel makes compliance with this appendix impractical, units must vary these procedures or their organizations to maintain an operational capability. Because of the criticality of fire direction, these sections should be maintained at full strength and kept at a high level of training.

C-3. Organization

a. **Personnel.** Personnel will be organized in two shifts as follows to facilitate 24-hour operations. Modifications may be made based on actual personnel strengths.

	SHIFT 1	*SHIFT 2*
Battalion FDC:	FDO	Chief Cmptr
	Asst Chief Cmptr	Cmptr
	Cmptr	Cmptr
	Recorder	Driver
Battery FDC:	FDO	Chief Cmptr
	Asst Chief Cmptr	Cmptr
	Cmptr	Recorder
	Recorder	Driver

* *b.* **Command post carrier (M577).** The command post carrier (M577) and extension will be set up in accordance with the plan at Figure C-1.

(1) Personnel generally work in the positions indicated in Figure C-1.

(2) The equipment and materials shown in the extension are carried in the M577.

c. **The 1¼-ton truck and ¾-ton trailer.** The truck and trailer are loaded in accordance with the plan at Figure C-2.

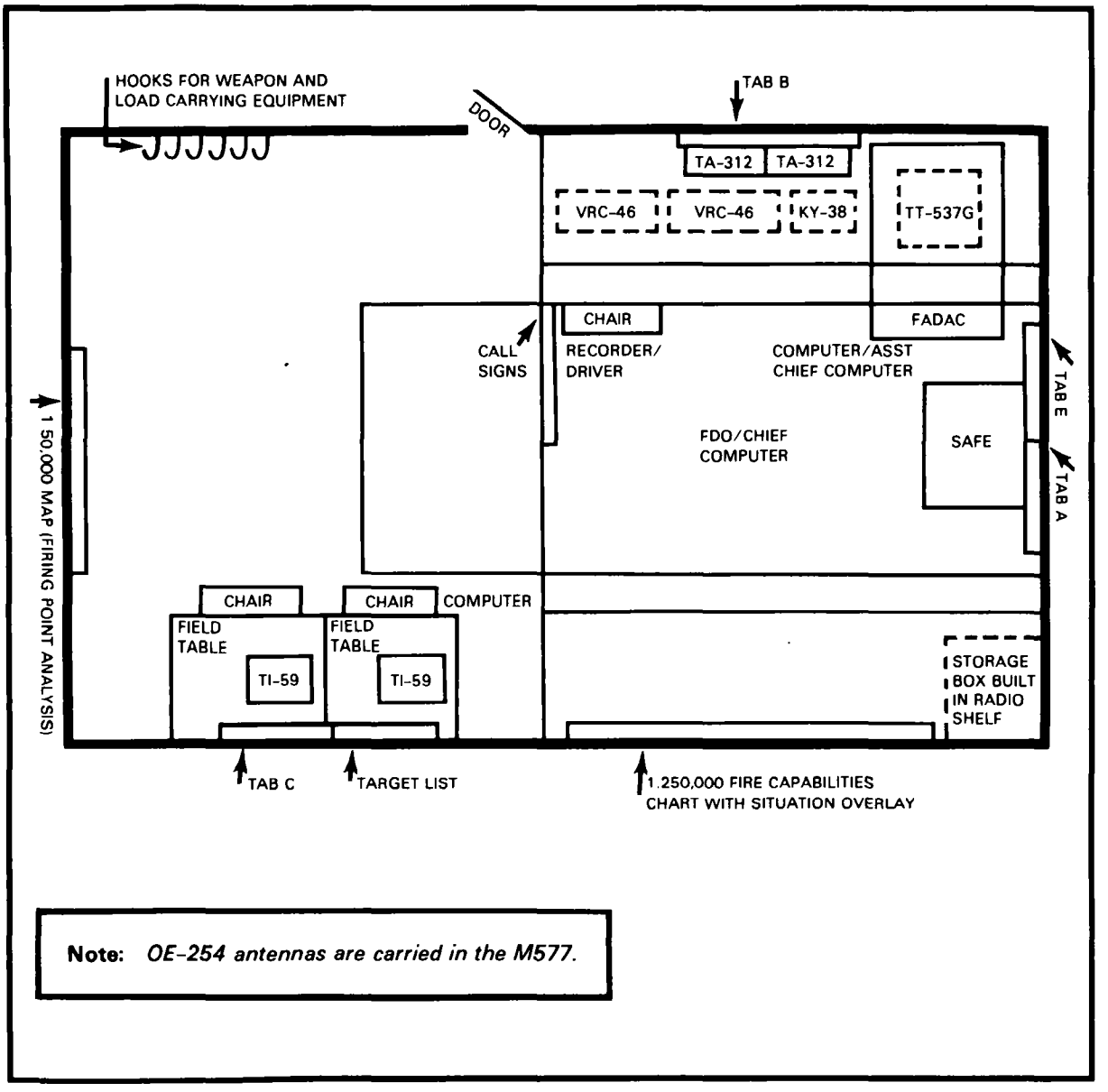
d. **Camouflage nets.** Nets are carried on top of vehicles/trailers.

e. **Charts/maps.** The following charts and maps will be maintained in each FDC as shown in Figure C-1.

(1) The fire capabilities chart is a 1:250,000 map that contains, as a minimum, the following:

(a) Unit locations.

(b) Firing points.



Note: *OE-254 antennas are carried in the M577.*

Figure C-1. Operational layout for M577A1 and extension.

(c) Range arcs for nuclear and nonnuclear warheads for each firing battery position.

(d) Targets.

(e) Control measures from supported unit OPLAN/OPORD.

(f) Boundaries.

(2) Situation overlay, which is a roll-up overlay for the fire capabilities chart, will show the following as a minimum. (This overlay is not required at battalion FDC, as these data are maintained on a situation map in the operations track.)

(a) Adjacent friendly units.

(b) Enemy units.

(c) Contaminated areas.

(d) Front line trace.

(3) Firing point list.

(4) Target list.

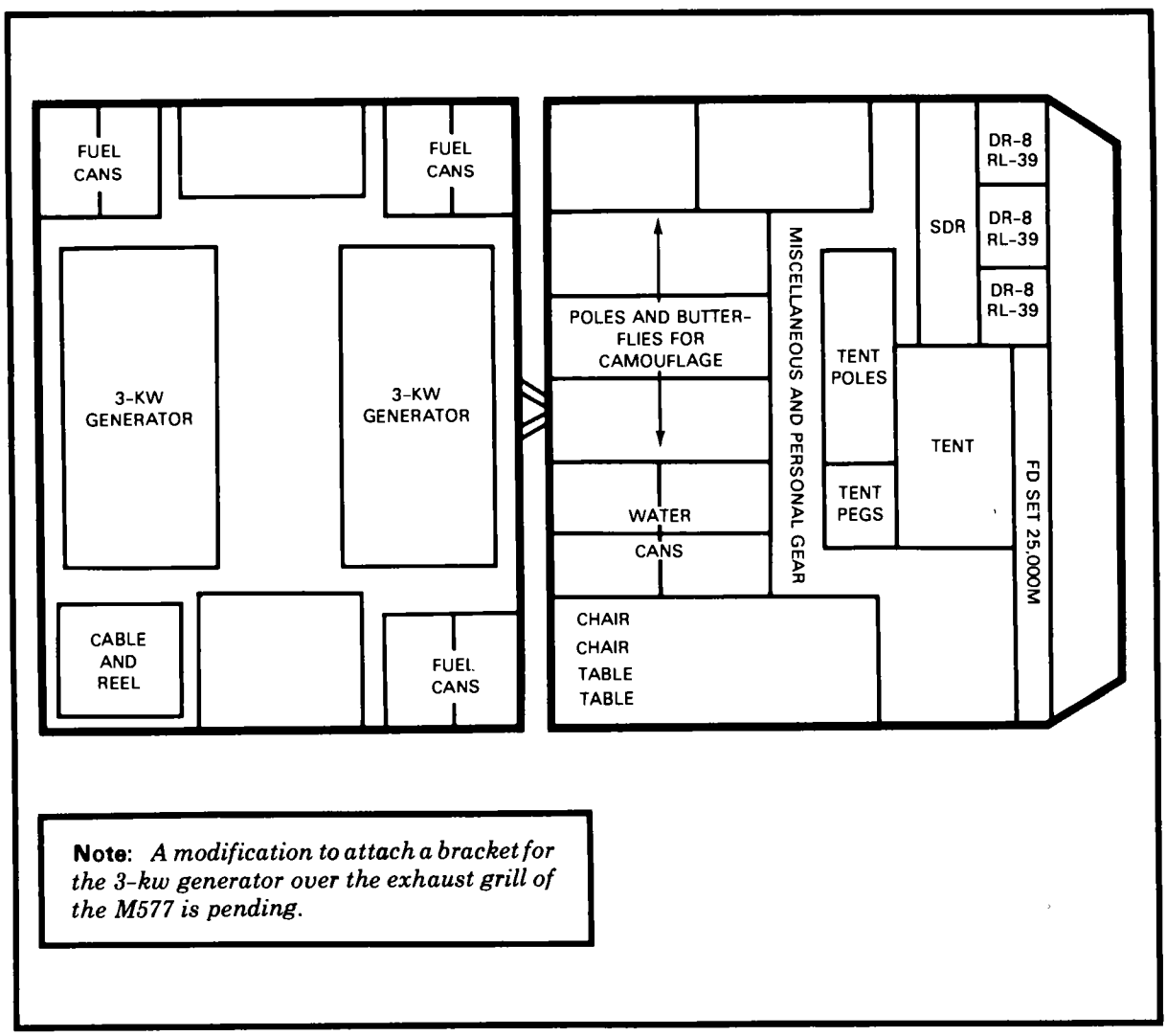
(5) Mission status chart.

(6) Ammunition status chart.

(7) Equipment status chart.

(8) Call sign chart.

Note: *The charts in (3) through (8) above are acetate/plexiglass-covered charts.*



Note: *A modification to attach a bracket for the 3-kw generator over the exhaust grill of the M577 is pending.*

Figure C-2. Loading plan for 1¼-ton truck and ¾-ton trailer.

C-4. Tactical Fire Direction

a. **Battalion FDC/alternate.**

(1) *Fire mission receipt.* The fire mission(s) is(are) received by operations or an alternate FDC from the supported unit FSE or FA brigade by one of the following means:

(a) Multichannel sole-user circuit (secure) to operations only.

(b) AM/RATT.

(c) AM/voice to operations only.

(d) FM (secure) from FA brigade only.

> Note: *If mission is received by operations, operations personnel will perform (2)(a), (b), and (c) below and give the data to battalion FDC.*

(2) *Processing.*

(a) Record the mission(s).

(b) Plot the target(s) on the fire capabilities chart and verify data if the target location appears to violate control measures.

(c) Select the battery to fire.

(d) Transmit call for fire and fire order to the selected battery FDC by:

1. FM secure.
2. AM/RATT secure.
3. FM unsecure (encrypted).
4. Messenger.

(e) Receive reports of firing from the selected battery.

(f) Transmit reports of firing to higher headquarters as required by their SOP.

(3) *Backup.* A backup firing unit will be assigned *only* when directed by the supported unit FSE.

b. **Battery FDC.**

(1) The fire mission will be received from battalion FDC/alternate by:

(a) FM secure.

(b) AM/RATT secure.

(c) FM unsecure (encrypted).

(d) Multichannel common-user circuit secure.

(e) Messenger.

(2) If the battery has a separate mission, the battery FDC will perform the actions listed in *a* above.

C-5. Technical Fire Direction

a. **General.**

(1) Under normal conditions, battalion FDC performs *no* technical fire direction. Technical fire direction, including data checks, will be performed by the battery firing the mission.

(2) Battalion FDC will compute technical firing data when:

(a) The battery FDC is moving.

(b) The battery FDC has less than two TI-59s operational and their FADAC is nonoperational.

(c) The battery FDC has insufficient personnel to function.

(d) The battery FDC has been destroyed.

b. **Computing firing data.** Computing will be accomplished by one of the following methods (listed in order of priority):

1. FADAC.
2. TI-59.
3. Battalion FDC.
4. Another battery FDC.
5. Manual computation.

c. **Data checks.**

(1) Data checks will be performed internally by the FDC computing the firing data.

(2) *No data checks by another FDC are necessary.*

(3) Data checks are accomplished as follows (depending on the computational method used):

METHOD	CHECK	ACCURACY
(a) FADAC	1. TI-59.	Range: ±5 M. SCO: None. Elevation: None. Fuze setting: ±0.1 sec. Range factor: 1. Time to fire: 1 sec. Arm time: None. Orienting angle: ±0.25 mil.
	2. Supervisor watches all inputs and outputs.	All data entered correctly, correct procedures used, and resulting data recorded correctly.
(b) TI-59	Another operator computes using a separate TI-59 while the supervisor watches both to detect errors.	No deviation in firing data.
(c) Manual	Another individual uses manual procedures while the supervisor watches both to detect errors.	No deviation in firing data.

d. **Data transmission.**

(1) Data will be transmitted in two parts to the firing platoon:

(a) Warning order

(b) Fire commands.

> **Note:** *Fire commands will not be transmitted to a firing platoon for a nuclear fire mission unless proper release has been granted and authenticated.*

(2) Data will be transmitted as follows:

(a) Firing platoon leader/sergeant will pick up data if the platoon is still in the battery area.

(b) FM secure.

(c) FM unsecure (encrypted).

(d) Messenger.

e. **Mission status.**

(1) Battery FDC will record mission status provided by the platoon.

(2) Mission status will be transmitted to the controlling FDC.

C-6. Extensions

a. **Battery FDC.** As soon as it becomes apparent that a firing platoon will not be able to meet an assigned time on target, the battery FDC will request a TOT extension. The request will include the time estimated to complete the mission either with the assigned platoon or with another platoon (if available), whichever is most timely, and will indicate the reason for the delay.

b. **Battalion FDC.** On receipt of a request for TOT extension from a battery, battalion FDC will take the following actions:

(1) If a backup platoon has been assigned, battalion FDC will have them fire the mission and cancel the mission for the primary platoon.

(2) If no backup platoon is assigned, battalion FDC will:

(a) Determine if there is a platoon in another battery which can meet the TOT or which can fire faster than the time indicated in the request for extension.

1. If another platoon can meet the TOT, the mission will be assigned to that platoon and the original mission assignment will be canceled.

2. If another platoon cannot meet the TOT but can fire faster than the original platoon, it will be assigned the mission and the original mission assignment will be canceled.

(b) Request an extension of the TOT from higher headquarters using the time from paragraph *a* above and include an explanation for the request.

(c) Transmit the TOT extension to the appropriate battery FDC.

C-7. Cancellations

a. **Battalion FDC** will notify the appropriate battery FDC of cancellations by the fastest means available.

b. **Battery FDC** will notify the appropriate firing platoon of cancellations by the fastest means available.

> **Note:** *All FDCs must insure that mission cancellations are properly received and authenticated for any nuclear mission before the cancellation is implemented.*

C-8. Alternate Battalion FDC

* *a.* **Maintenance of data.** Each FDC in the battalion will maintain all data required to assume battalion control.

b. **Assumption of control.**

(1) *Order of precedence (based on looking toward the enemy):*

(a) Center battery.

(b) Left battery.

(c) Right battery.

(2) *Assuming control.* Control will be assumed:

(a) When designated by battalion FDC.

(b) When communications with battalion are lost by all batteries.

C-9. Reports

a. **Battalion FDC/alternate.**

(1) *SITREP.* Submitted IAW supported unit tactical SOP.

(2) *Equipment status.* Submitted IAW supported unit tactical SOP.

(3) *Fire mission report.* Submitted IAW supported unit tactical SOP.

(4) *Others.* Submitted IAW supported unit tactical SOP.

b. **Battery FDC (operating with a separate mission).** Submit reports described for battalion FDC.

* *c.* **Battery FDC (operating with the battalion).**

(1) *Alfa Report (SITREP) (Fig C-3).*

(a) PART I. Submitted to battalion FDC on occupation of a new position.

(b) PART II.

1. Submitted to battalion FDC on occupation or when information changes.

2. Column H.

a. Launcher section alone. Use 1 for M234, 2 for M251, or 0 for none.

b. Firing team (self-propelled launcher (SPL) and loader-transporter (LT) together). Use a three-digit number (such as 120). The first digit is for the SPL; the second and third digits are for the LT.

(2) *Bravo Report (Equipment Status) (Fig C-4).*

(a) Submitted to battalion FDC upon initial deployment and at 2200Z daily.

(b) Single lines are reported as the status changes.

(3) *Charlie Report (Firing Point List) (Fig C-5).*

(a) Submitted to battalion FDC as soon as it becomes available.

(b) Single lines may be transmitted as new firing points are surveyed.

(4) *Delta Report (Fire Mission/Mission Status) (Fig C-6).*

(a) PART I (Call for Fire). Used to transmit data from battalion to battery FDC.

(b) PART II (Warning Order). Used to transmit the warning order to a firing platoon.

(c) PART III (Fire Commands). Used to transmit fire commands to the fire platoon.

(d) PART IV.

1. The spare groups from the low level code which corresponds to the line number are used for this transmission when secure communications are not available.

2. Used by all elements to report any listed information.

(5) *Echo Report (Ammunition Status) (Fig C-7).* Submitted to battalion FDC:

(a) Upon initial deployment.

(b) Following resupply.

(c) At 2300Z daily.

(6) *Foxtrot Report (Fire Mission Summary) (Fig C-8).*

(a) Used for ready reference of fire mission status in each FDC.

(b) Submitted to battalion FDC on request.

SEE FIGURES C-3 THROUGH C-8, NEW DA FORMS

ALFA REPORT
[SITUATION REPORT]

For use of this form, see FM 6-40-4, the proponent agency is TRADOC

PART I
OF SITUATION REPORT

LINE NO	UNIT *a*	COMMAND POST LOCATION *b*	HELICOPTER PAD LOCATION *c*	REMARKS *d*
1	HEADQUARTERS			
2	A			
3	B			
4	C			
5	SERVICE			

PART II
OF SITUATION REPORT

LINE NO	UNIT *e*	LAUNCHER NUMBER *f*	FIRING POINT NUMBER *g*	WARHEAD (EMPTY, M234, M251) *h*	REMARKS *i*
6	A	FIRST LAUNCHER			
7		SECOND LAUNCHER			
8	B	FIRST LAUNCHER			
9		SECOND LAUNCHER			
10	C	FIRST LAUNCHER			
11		SECOND LAUNCHER			

DA FORM 5090-R APR 82

*Figure C-3. ALFA Report (Situation Report)

BRAVO REPORT
[EQUIPMENT STATUS]

For use of this form, see FM 6-40-4; the proponent agency is TRADOC.

LINE NO	ITEM *a*	HEADQUARTERS BATTERY		A BATTERY		B BATTERY		C BATTERY		SERVICE BATTERY	
		OPERATIONAL *b*	NON-OPERATIONAL *c*	OPERATIONAL *d*	NON-OPERATIONAL *e*	OPERATIONAL *f*	NON-OPERATIONAL *g*	OPERATIONAL *h*	NON-OPERATIONAL *i*	OPERATIONAL *j*	NON-OPERATIONAL *k*
1	SELF-PROPELLED LAUNCHER										
2	MOBILITY KIT										
3	LAUNCHER ZERO LENGTH										
4	LOADER-TRANSPORTER										
5	REMOTE THEODOLITE (T-2)										
6	TEST TARGET SET (TT)										
7	MONITOR-PROGRAMMER (MP)										
8	GUNNER'S SIGHT UNIT (GSU)										
9	FIRING DEVICE										
10	PERMISSIVE ACTION LINK DEVICE (T-1533)										
11	FADAC										
12	FADAC GENERATORS										
13	RADIO TELETYPEWRITER RIGS										
14	VEHICLES										
15	RADIOS										
16	SPEECH SECURITY EQUIPMENT										
17	M577										
18	REMARKS										

DA FORM 5091-R APR 82

✱ *Figure C-4.* **Bravo Report (Equipment Status).**

CHARLIE REPORT
[FIRING POINT LIST]

For use of this form, see FM 6-40-4; the proponent agency is TRADOC.

LINE NO	FIRING POINT NUMBER *a*	COORDINATES *b*	LAUNCHER ALTITUDE *c*	AZIMUTH OF ORIENTING LINE *d*	GRID ZONE DESIGNATION (OPTIONAL) *e*	LAUNCHER LATITUDE (OPTIONAL) *f*	REMARKS *g*
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

DA FORM 5092-R APR 82

✱ *Figure C-5.* Charlie Report (Firing Point List).

DELTA REPORT
[FIRE MISSION/MISSION STATUS]

For use of this form, see FM 6-40-4, the proponent agency is TRADOC

PART I
CALL FOR FIRE

1. FIRING POINT NUMBER	2 TARGET NUMBER	3 TARGET GRID	4 TARGET ALTITUDE

5. WARHEAD (Circle one)	6 HEIGHT OF BURST (Circle one)	7 TIME ON TARGET
M234A M234B M234C M251	G L L/G H H/G	

PART II
WARNING ORDER

8. LAUNCHER NUMBER	9. FIRING POINT NUMBER	10 TARGET NUMBER	11. WARHEAD (Circle one)
			M234A M234B M234C M251

12. HEIGHT OF BURST (Circle one)	13 TIME ON TARGET	14 TARGET AZIMUTH
G L L/G H H/G		(10 Mils)

PART III
FIRE COMMANDS

15 ELEVATION (Circle one)	16. SUSTAINER CUTOFF	17. RANGE FACTOR
853.3 960.0		

18 FUZE SETTING	19. ORIENTING ANGLE	20 TIME TO FIRE	21 ARM TIME

PART IV
MISSION STATUS

22. LINE NUMBERS CORRESPOND TO SPARE GROUP LISTINGS. CHECK BOX ☑ AS EACH PORTION OF MISSION IS COMPLETED.

1 FIRE MISSION, PREPARE TO COPY ☐	7 READY TO FIRE (CREW IN PIT) ☐	13 MISSION HOLD—MONITOR-PROGRAMMER—NO GO ☐
2 FIRE TEAM READY FOR MISSION ☐	8 FIRE ON COMMAND BY FIRE DIRECTION CENTER ☐	14 MISSION HOLD—REPLACING MONITOR-PROGRAMMER ☐
3 LAUNCHER IN HIDE AREA ☐	9 FIRE ON COMMAND BY FIRING POINT LEADER (AS SOON AS POSSIBLE) MISSION ONLY ☐	15 MISSION HOLD—CANNOT MAKE WARHEAD SETTING ☐
4 LAUNCHER OVER LAUNCH POINT ☐	10 SHOT _____ (TIME) ☐	16 MISSION HOLD—RANGE TO TARGET AND TEST TARGET SWITCHED ☐
5 MISSILE ELEVATED ☐	11 HANGFIRE/MISFIRE ☐	17 MISSION HOLD—LIMITED VISIBILITY ☐
6 MISSILE LAID ☐	12 MISSILE NOT LAID ☐	18 MISSILE CHECKOUT NO GO ☐

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*Figure C-6(1). Delta Report (Fire Mission/Mission Status) (Front Side)

PART IV
MISSION STATUS (CONTINUED)

19 REQUEST TIME ON TARGET EXTENSION ☐ _____ (MINUTES)	31 PROCEED TO FIRING POINT NUMBER ☐ NO _____	43 ADVANCE PARTY DEPARTING ☐
20 EXTENSION DENIED ☐	32 DEPART(ING) FIRING POINT ☐	44 BATTERY DEPARTING OLD POSITION ☐
21 TIME ON TARGET EXTENDED. NEW TIME TO FIRE ☐ _____ (TIME)	33 DEPARTING BATTERY AREA ☐	45 BATTERY IN NEW LOCATION ☐
22 COMMAND HOLD ☐	34 RETURN(ING) TO BATTERY AREA ☐	46 EMERGENCY DESTRUCTION EXECUTED ☐
23 CANCEL COMMAND HOLD ☐	35 CONVERT SELF-PROPELLED LAUNCHER TO LAUNCHER ZERO LENGTH ☐	47 COMMAND DISABLEMENT EXECUTED ☐
24 REQUEST PERMISSION TO FIRE ☐	36 CONVERT LAUNCHER ZERO LENGTH TO SELF-PROPELLED LAUNCHER ☐	48 REQUEST AMMUNITION RESUPPLY ☐
25 CANCEL MISSION ☐	37 CONVERSION STARTED ☐	49 REQUEST RATIONS ☐
26 RENDEZVOUS WITH LOADER-TRANSPORTER. TRANSLOAD MISSILE ☐	38 CONVERSION COMPLETE ☐	50 ASSUME BATTALION FIRE DIRECTION CENTER FUNCTIONS ☐
27 TRANSLOAD STARTED ☐	39 WHAT IS YOUR STATUS? ☐	51 GO TO RETRANS 1 ☐
28 TRANSLOAD COMPLETE ☐	40 MOVEMENT WARNING ORDER ☐	52 GO TO RETRANS 2 ☐
29 LOADER-TRANSPORTER AT FIRING POINT NUMBER ☐ NO _____	41 CONDUCT HASTY DISPLACEMENT ☐	53 CHANGE TO NEW FREQUENCIES ☐
30 LOADER-TRANSPORTER IN HIDE AREA ☐	42 MOVE TO NEW POSITION ☐	

REMARKS

REVERSE OF DA FORM 5093-R APR 82

Figure C-6(2). Delta Report (Reverse Side)

ECHO REPORT
[AMMUNITION STATUS]

For use of this form, see FM 6-40-4; the proponent agency is TRADOC.

LINE NO	STATUS *a*	M234 *b*	M251 *c*	MMA *d*	EXPENDED (Last 24 hours) *e*	REMARKS *f*
	A BATTERY					
1	MATED ON SELF-PROPELLED LAUNCHER/LAUNCHER ZERO LENGTH					
2	MATED ON LOADER-TRANSPORTER					
3	UNMATED ON LOADER-TRANSPORTER					
4	MATED IN CONTAINER					
5	UNMATED IN CONTAINER					
6	TOTAL					
	B BATTERY					
7	MATED ON SELF-PROPELLED LAUNCHER/LAUNCHER ZERO LENGTH					
8	MATED ON LOADER-TRANSPORTER					
9	UNMATED ON LOADER-TRANSPORTER					
10	MATED IN CONTAINER					
11	UNMATED IN CONTAINER					
12	TOTAL					
	C BATTERY					
13	MATED ON SELF-PROPELLED LAUNCHER/LAUNCHER ZERO LENGTH					
14	MATED ON LOADER-TRANSPORTER					
15	UNMATED ON LOADER-TRANSPORTER					
16	MATED IN CONTAINER					
17	UNMATED IN CONTAINER					
18	TOTAL					
	SERVICE BATTERY					
19	MATED ON LOADER-TRANSPORTER					
20	UNMATED IN CONTAINER					
21	TOTAL					
22	BATTALION TOTAL					

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Figure C-7. Echo Report (Ammunition Status).

FOXTROT REPORT
[FIRE MISSION SUMMARY]

For use of this form, see FM 6-40-4, the proponent agency is TRADOC

LINE NO	MISSION NUMBER *a*	LAUNCHER *b*	FIRING POINT NUMBER *c*	TARGET NUMBER *d*	TIME OF RECEIPT DATE-TIME GROUP *e*	TIME ON TARGET *f*	WARHEAD TYPE *g*	TIME SHOT *h*	SHOT TO LIAISON OFFICER *i*	REMARKS— *j*
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										

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✱ *Figure C-8.* Foxtrot Report (Fire Mission Summary).

* C-10. Records

a. Daily Staff Journal (DA Form 1594):

(1) Each FDC will maintain a staff journal starting with alert notification and continuing through operation or exercise termination. The journal will include (but is not limited to):

(a) Alert notification.

(b) Emergency action traffic.

(c) Fire missions (receipt and transmission).

(d) Receipt of plans/orders.

(e) Visits of higher commanders/staff officers.

(f) Transmission of plans/orders.

(g) Other important events.

(2) The journal will remain on file as a permanent record in accordance with AR 340-2, *Maintenance and Disposition of Records in TOE Units of the Active Army and Army Reserve.*

(3) Additional information can be found in AR 220-15, *Journals and Journal Files.*

b. Computer's records (DA Form 4603, Computer's Record and Data Corrections Sheet (Lance), or DA Form 4603-1-R):

(1) DA Form 4603 will be used to record fire mission data when FADAC or manual computation procedures are used.

(2) DA Form 4603-1-R will be used to record fire mission data when the computer set, FA, missile or general (TI-59) is used.

(3) Printouts will be obtained from FADAC or the computer set, FA, missile (whichever is used to compute the firing data) if time and equipment permit.

(4) For live firings, data correction sheets from primary and check methods of computation (para C-5*c*(3)) will be stapled with printouts and the Delta Report. These will be kept on file permanently to support journal entries (*a*(2) above).

c. Record-Survey Control Point (DA Form 3613) will be maintained in the FDC for each firing point surveyed. Copies of DA Form 3613 will be sent to the survey information center (SIC) at battalion as soon as possible after the survey is completed. These forms will be maintained as long as the unit remains in the general area of operations.

d. Other documents such as the Alfa, Bravo, Charlie, Echo, and Foxtrot reports, operation plans, and operation orders will be marked with the item numbers corresponding to the entries on the daily staff journal. They will be filed in order by the journal item number and date. They will have the same disposition as the staff journal they support.

C-11. Advance Party

a. **Personnel.** One person (designated by the chief computer) will participate in the advance party.

b. **Equipment.**

(1) OE-254 antenna—one or two, depending on equipment availability.

(2) Vehicle location marking stakes or signs.

(3) Flashlights.

c. **Duties.**

(1) Screen the area as directed by the BC/1SG.

(2) Mark vehicle locations as directed by BC/1SG.

(3) Erect OE-254 antenna(s) near the M577 with assistance from other advance party members.

(4) Reconnoiter the route from the position entrance to the vehicle locations.

(5) Guide the FDC vehicles to their positions.

C-12. March Order

a. **Preparation for movement.**

(1) Move equipment and materials from tent extension and store them in the M577.

(2) Remove and store camouflage nets.

(3) Install whip antennas.

(4) Move 1:50,000 map and storage hooks into M577.

(5) Store the tent extension.

(6) Disconnect OE-254 antennas and connect whips.

(7) Disassemble and store OE-254 antennas.

(8) Remove and store FADAC power cable.

(9) Remove and store ground rods and secure trailer canvas.

(10) Double-check the area for equipment and tools and police the area.

b. **Report.** Report to the OIC that the FDC is ready to move.

C-13. Movement

a. **Order of march.**

(1) Truck and trailer.

(2) Command post carrier M577.

> **Note:** *If the truck breaks down, the M577 will halt and transfer the trailer to the M577.*

b. **Air guards.** Each vehicle will have an air guard. The track commander provides this function for the M577.

* *c.* **Personnel.** Personnel will ride in the vehicles as prescribed by the FDO/chief computer. As a minimum, a complete operational shift will ride in the M577.

* *d.* **Communications.** Radio nets will be monitored during all movements.

C-14. Occupation

a. **Position entry.**

(1) Follow guide (advance party member).

(2) Stop truck and trailer in position.

> **Note:** *The trailer should be as far from the M577 as the position area and length of FADAC power cable will allow.*

(3) Stop M577 in position.

b. **Preparation for action.**

(1) Connect OE-254 antenna(s) to M577.

> **Note:** *Cable, special purpose, electrical, artillery communication kit (NSN 2590-00-757-2762, PN 10932555) (2 each) should be installed in the M577 to provide external OE-254 cable connections and eliminate the need for routing cables through the driver's or commander's hatch. See TM 9-2300-257-34P, Direct Support and General Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Carrier, Command Post, Light, Tracked, M577A1 and M577A2.*

(2) If OE-254 antenna(s) were not erected by the advance party, erect the antenna(s) and then perform action in (1) above.

(3) Concurrent with (1) and (2) above, roll up sides of ¾-ton trailer, install and connect ground rods, and lay and connect FADAC power cable.

> **Note:** *Lead-in kit, FADAC power supply (NSN 2590-00-502-5448, PN 11589324) should be installed in the M577 to provide an external FADAC power cable connector and eliminate the need for routing the power cable through a hatch. See TM 9-2300-257-20P, Organizational Maintenance Repair Parts and Special Tool List for Carrier, Command Post, Light, Tracked M577A1 and M577A2.*

(4) Check communications and transmit required reports (see paragraph C-9).

(5) Erect the tent extension (connect battalion FDC tent extension to operations tent extension).

(6) Move 1:50,000 map and storage hooks into tent extension.

(7) Remove whip antennas.

(8) Install camouflage nets (M577 first).

(9) Continue to improve the position as time and mission permit.

APPENDIX D

STANDARDIZED PROCEDURES

This field manual contains the following standardized procedures relevant to field artillery Lance missile gunnery operations. These procedures are denoted in text by an asterisk (*).

ABBREVIATIONS AND ACRONYMS

Section I. General

add	addendum
az	azimuth
az OL	azimuth of orienting line
BECO	boost engine cutoff
CFRD	CONFIDENTIAL FORMERLY RESTRICTED DATA
CLUT	computer logic unit test
CP	command post
DC-Automet	directional control and automatic meteorological compensation
dE	difference in easting
dN	difference in northing
FADAC	field artillery digital automatic computer/ M18 gun direction computer
FDC	fire direction center
FP	firing point
FSE	fire support element
FTR	firing table, rocket
G	ground
H	air high
HE	high explosive
HG	air high ground
HTL	height of target relative to launcher
L	low air
LE	launcher easting
LG	air low ground
LT	loader-transporter
LN	launcher northing
LZL	launcher zero length
MP	monitor-programmer
msl	missile
OL	orienting line
RB	range to burst
RT	range to target
SDR	signal data reproducer
SECO	sustainer engine cutoff
SM	sample matrix
SPL	self-propelled launcher
STO	store
TE	target easting
TGT	target

TN	target northing
TOE	tables of organization and equipment
TP	time parameter
TRIAL HB	trial height of burst
TRIAL RB	trial range to burst
TT	test target
UTM	universal transverse mercator (grid)

Section II. Abbreviations and Acronyms From Teletypewriter (TT-537/G)

AOL	azimuth of the orienting line
ARM	arm time
AZF	azimuth of fire
BACK AZ	back azimuth
CORR ALT ANGLE	corrected altitude angle
DECL	declination
FPA	firing point altitude
FPE	firing point easting
FPN	firing point northing
FPS	firing point spheroid
FPZ	firing point zone
FS	fuze setting
FWD AZ	forward azimuth
GRID AZ	grid azimuth
GRID CONV	grid convergence
HORIZ ANGLE	horizontal angle
HORIZ DIST	horizontal distance
LAT	latitude
LONG	longitude
OBA	observer's altitude
OBE	observer's easting
OBN	observer's northing
OBS	observer's spheroid
OBZ	observer's zone
OPT	height of burst option
ORA	orienting angle
QE	quadrant elevation
RF	range factor
rg	range
SCO	sustainer cutoff
TGA	target altitude
TGE	target easting
TGN	target northing
TGS	target spheroid
TGZ	target zone
TOF	time of flight
TOT	time on target
TRUE AZ	true azimuth
TTF	time to fire
VERT ANGLE	vertical angle
WHD	warhead

Section III. Abbreviations and Acronyms From Printer (PC-100) Printout

ALTL	altitude of launcher	**PGM**	program
AZF	azimuth of fire	**RF**	range factor
FS	fuze setting	**SCO**	sustainer cutoff
HL	height relative to launcher	**TOF**	time of flight
		TOT	time on target
HOB	height of burst	**TTF**	time to fire
ORA	orienting angle	**WHD**	warhead

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By Order of the Secretary of the Army:

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