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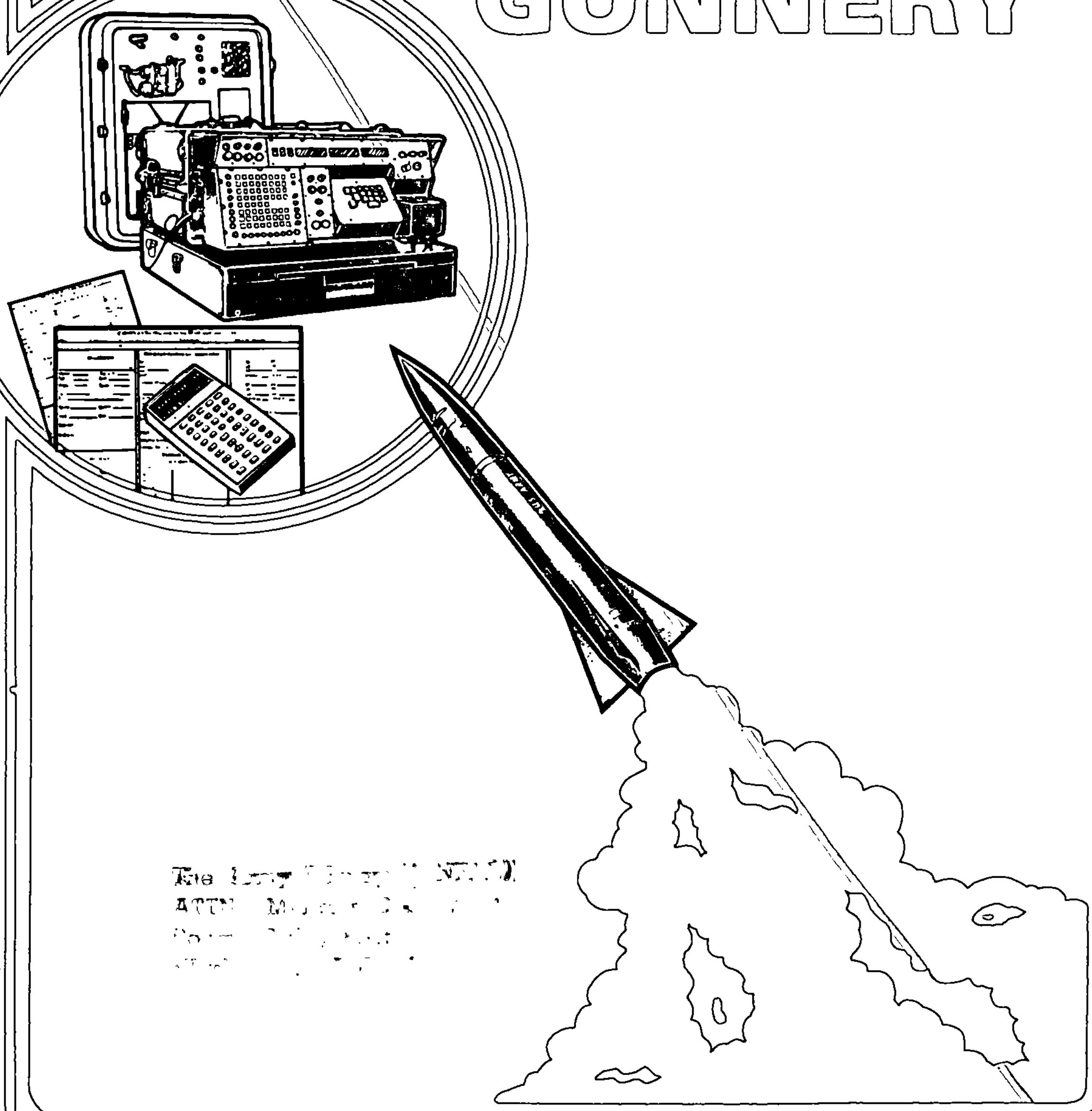
FIELD ARTILLERY LANCE MISSILE GUNNERY



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Field Manual
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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 on Lance missile gunnery.

Scope

This manual includes all aspects of the Lance gunnery problem and applies to units organized under the 06-595H series table of organization and equipment. The material concerns both nuclear and nonnuclear warfare and agrees with applicable international standardization agreements. The manual includes fundamentals of ballistics and fire direction, including both manual and computer (FADAC) 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, US Army Field Artillery School, ATTN: ATSF-TD-TM, Fort Sill, Oklahoma 73503.

Summary

The primary means of determining firing data for Lance missions is to use the field artillery digital automatic computer (FADAC) and the associated Lance program tape as discussed in chapter 3. The secondary means is the manual method, which is used only when the FADAC is not available. The manual solution requires approximately 15-20 minutes, while the FADAC requires only 2-3 minutes. The computer program provides for the solution to survey problems in addition to the computation of fire missions. Either the FADAC or manual method of determining data provides accurate fire commands for the delivery of designated munitions on selected targets.

Note.
Hand-held calculators should be used to the maximum extent 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.

CHAPTER 1

Ballistics

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

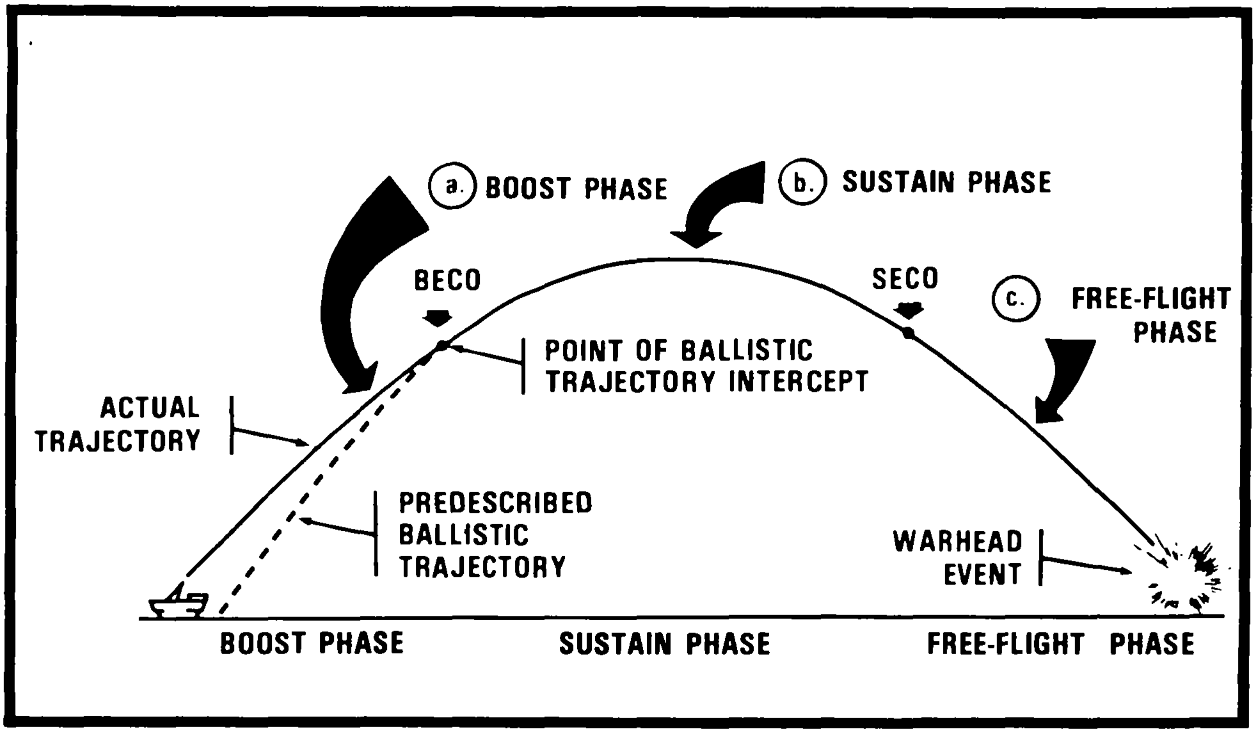


Figure 1-1. Lance trajectory.

meteorological conditions. The free-flight phase ends with the warhead event.

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.

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-Automet) system in a hermetically sealed unit. The directional control system guides the missile during the boost phase to maintain the desired attitude and thereby establish the initial portion of the desired trajectory to the target. The automatic meteorological compensation 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. Prior to 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 automatic meteorological compensation 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 automatic meteorological compensation 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.

CHAPTER 2

Fire Direction, General

Section I. Fire Direction Organization

The fire direction centers (FDC) 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
- 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

Duties pertaining to fire direction are identical for personnel of battery and battalion fire direction centers. 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 battalion personnel at battalion FDC and by their counterparts at battery level:

a. *S3*. The S3 is the officer responsible for the overall supervision and operation of the fire direction center. 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 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, range, sustainer cutoff (SCO) setting, elevation, range factor, fuze setting, orienting angle, time to fire, and arm time.

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

g. Recorders. The recorders must be trained in procedures for encoding and decoding classified fire missions and fire commands, techniques of plotting locations, and determining azimuth on a map. 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. The radiotelephone operators must be trained in FDC communication procedures. Specific duties of the radiotelephone operators are to—

(1) Operate communication equipment; e.g., radio, telephone, switchboard, in the fire direction center.

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

(3) Receive and transmit target and firing point 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 the performance of 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—the exercise of 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 within range.

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.

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 position number	FIRING POSITION 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	------------------------------------

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 (M251)—HOB is omitted from the call for fire; it is extracted from FTR LANCE ADD—A-1 and corrected in the second trajectory calculation.

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

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 position number	FIRING POSITION 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 position(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 position number	FIRING POSITION 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 cut-off/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 is applicable 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 includes 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:

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	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.

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, sustainer cutoff setting and elevation must be determined from the firing tables. No corrections are made for nonstandard materiel or meteorological conditions, since these corrections are automatically 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 and begin with the computation of the bearing angle and the resultant launcher-target azimuth, the range to target, and the height of burst with respect to the launcher. When these data have been determined, the sustainer cutoff setting and elevation are obtained from the firing tables. For the M251 a corrected range to burst (RB) 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 conjunction with Az of 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 CFRD except when an impact (0) height of burst (HOB) is required; it is then unclassified.

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 fire direction center 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.

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

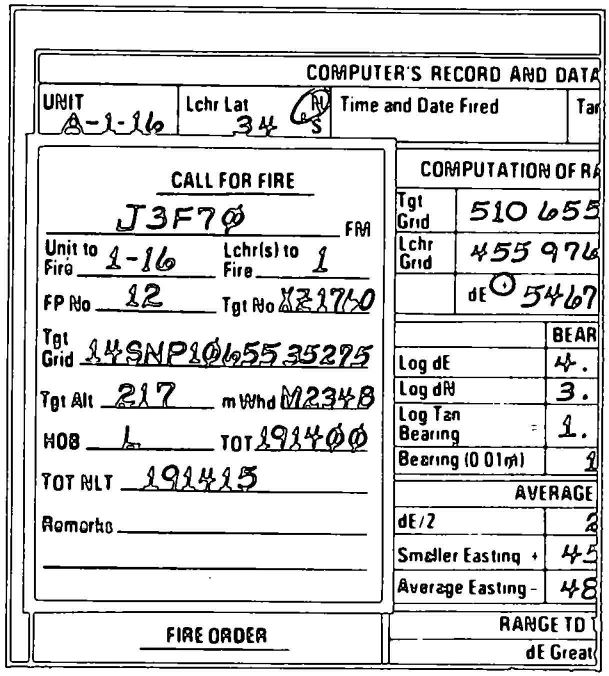


Figure 2-1. Call for fire.

b. The following data are known:

Survey grid of firing position number 12: 455976-3832923

Altitude of firing position number 12: 254 meters

Latitude of firing position number 12: 34° 15′ 00″ N

Azimuth of orienting line: 0015.36 mils

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

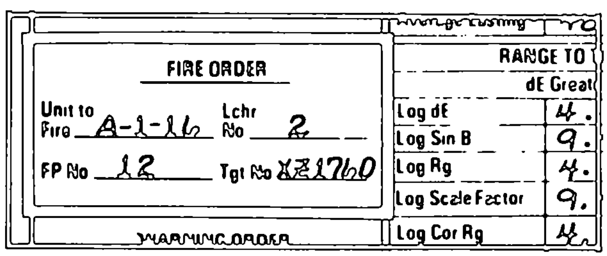


Figure 2-2. Fire order.

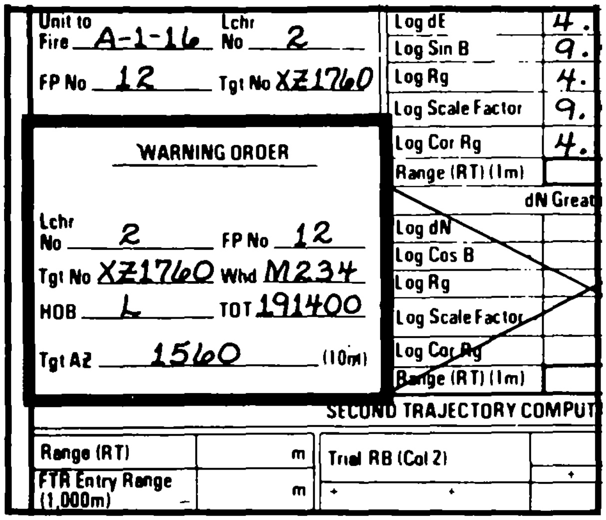

Unit to Fire A-1-16 Lchr No 2
FP No 12 Tgt No XZ1760
WARNING ORDER
Lchr No 2 FP No 12
Tgt No XZ1760 Whd M234
HOB L TOT 191400
Tgt AZ 1560 (10m)
Log dE 4.
Log Sin B 9.
Log Rg 4.
Log Scale Factor 9.
Log Cor Rg 4.
Range (RT) (1m)
dN Great
Log dN
Log Cos B
Log Rg
Log Scale Factor
Log Cor Rg
Range (RT) (1m)
SECOND TRAJECTORY COMPUT
Range (RT) m
FTR Entry Range (1,000m) m
Trial RB (Col 2)

Figure 2-3. Warning order.

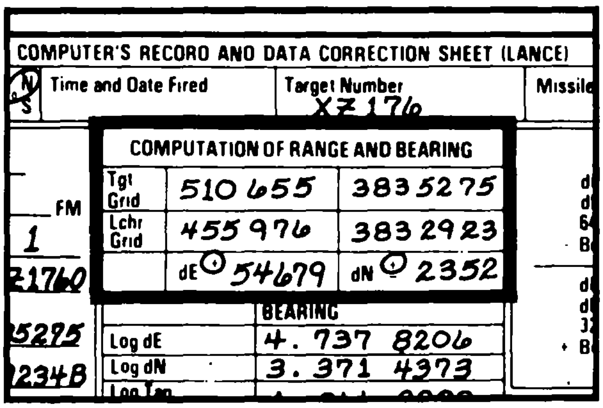

COMPUTER'S RECORD AND DATA CORRECTION SHEET (LANCE)
Time and Date Fired
Target Number XZ176
Missile
COMPUTATION OF RANGE AND BEARING
Tgt Grid 510655 3835275
Lchr Grid 455976 3832923
dE + 54679 dN + 2352
BEARING
Log dE 4.737 8206
Log dN 3.371 4373

Figure 2-4. Computation of dE and dN.

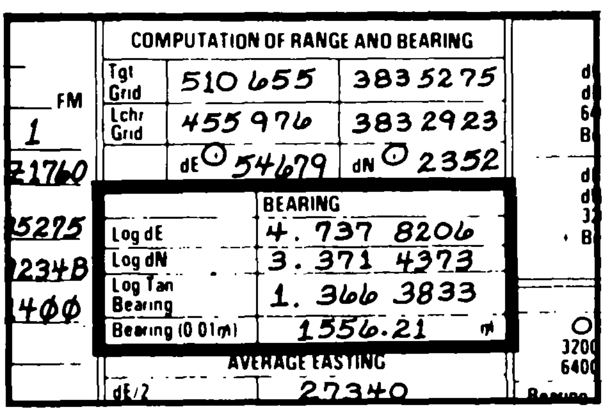
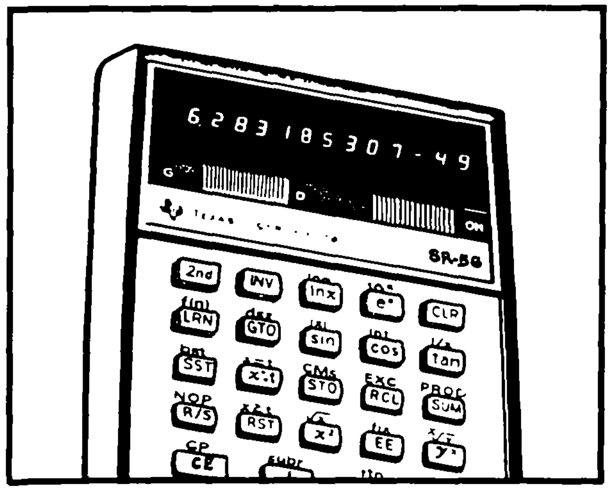

COMPUTATION OF RANGE AND BEARING
Tgt Grid 510655 3835275
Lchr Grid 455976 3832923
dE + 54679 dN + 2352
BEARING
Log dE 4.737 8206
Log dN 3.371 4373
Log Tan Bearing 1.366 3833
Bearing (0.01m) 1556.21 m
AVERAGE EASTING
dE/2 27340

Figure 2-5. Computation of bearing.

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 position were plotted on a map, and the azimuth from the firing position 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 the determination of the missile and warhead presettings is to convert the military grid of the target to UTM by consulting 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 resulting bearing angle (to the nearest hundredth mil) on the computer's record (fig 2-5).

g. The next step is to 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).

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 target easting (455976) is the smaller value; therefore, add the target 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).

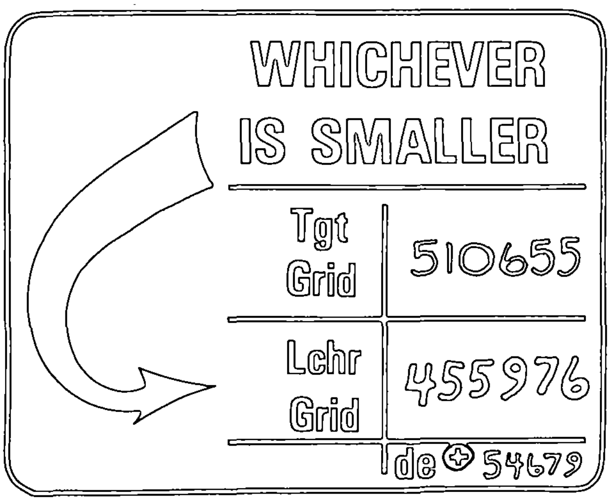


Figure 2-7 ① . Determining the smaller easting.

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

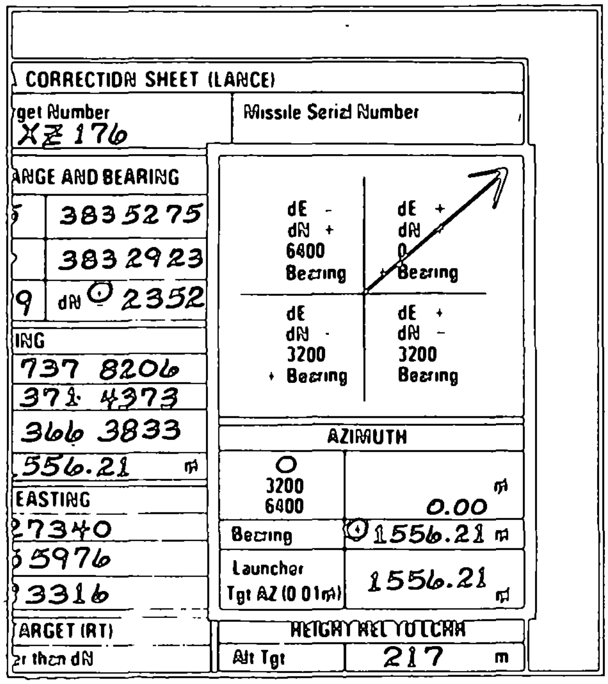


Figure 2-6. Computation of launcher-target azimuth.

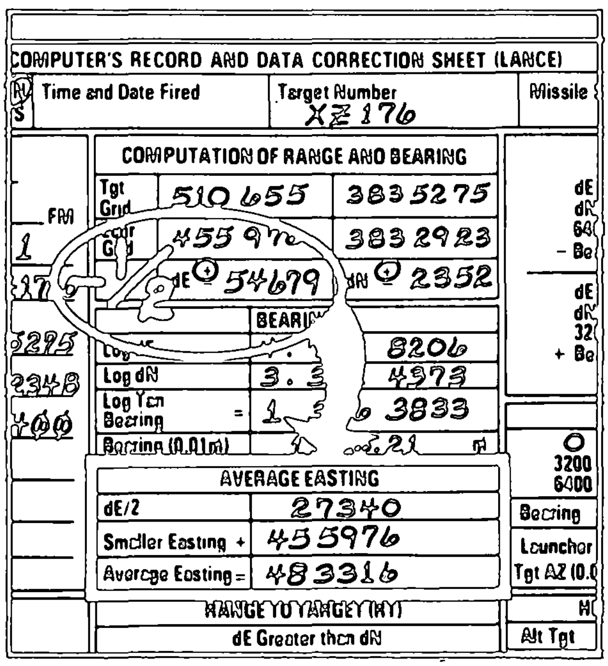


Figure 2-7 ② . Computation of average easting.

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)	54751 m
dN Greater than dE	
Log dN	
Log Cos B	
Log Rg	
Log Scale Factor	
Log Cor Rg	
Range (RT) (1m)	m
SECOND TRAJECTORY COMPUTATIONS	
Trial RB (Col 2)	m
Trial HBL (Col 6)	

Figure 2-8. Computation of range to target.

455976		Launcher - Tgt AZ (0.01m)	1556.21 m
483316			
TO TARGET (RT)		**HEIGHT REL TO LCHR**	
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
9.999 8284		Height Rel to Lchr (HL)(1m)	⊕ 195 m
4.738 3937			
54751	m		
Greater than dE			

Figure 2-9. Determining height relative to launcher.

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).

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 Whd

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).

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 △ Range/100	⊖ 2.49	② △ HL/100	⊕ 1.95	③ △ ALTL/100	⊖ 2.46

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

① Δ Range/100	± 2.49	② Δ HL/100	⊕ 1.95	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)	⑤ Cos L SIN Az	⊕ 0.83	⑦ Cos L Cos Az	⊕ 0.03
TRIAL RANGE FACTOR (Col 2)	[illegible] (+ / −)		TRIAL TIME PARAMETER (Col 6)	[illegible] sec (+ / −)	

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

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 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).

d. With range (RT) and launcher altitude, enter part 2 of table B and extract the appropriate elevation and sustainer cutoff 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 and 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 time parameter (Corrected TP), and Firing Azimuth (0.01㎖) (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 ∴ HL 100	1.95	③ ∴ 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)	5 Cos L SIN Az	0.83	⑦ Cos L Cos Az	0.03

TRIAL RANGE FACTOR (Col 2)	3775.15 (+)	(−)	TRIAL TIME PARAMETER (Col 6)	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 = 3768.75	8.815	15.214	116.43 + 0.26 = 116.69	0.951	0.689
		8.815		0.689	
		6.399		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		
Launcher Tgt Azimuth	1556.21 mil (+)	(−)
(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 (0.01mil) =	1557.05 mil	

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 (0.01mil)	0015.36 mil
6400 (if nec) +	6400.00 mil
Sum =	6415.36 mil
Firing Azimuth (0.01mil) −	1557.05 mil
Orienting Angle (0.1mil) =	4858.31 mil

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.

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

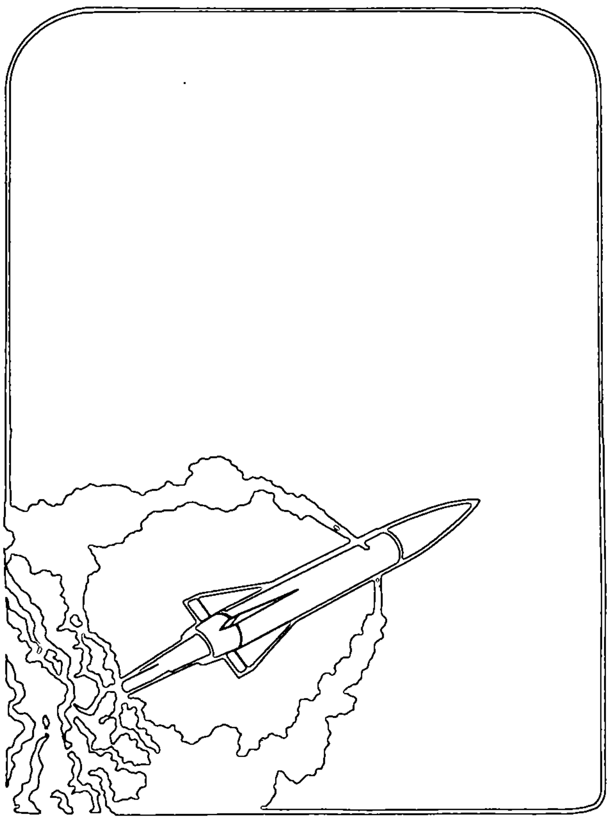
1557.05		4.631
		0.836
Firing Azimuth (0.01 ㎖)	=	1557.05 ㎖
ORIENTING ANGLE		
Az of OL (0.01 ㎖)		0015.36 ㎖
6400 (if nec)	+	6400.00 ㎖
Sum	=	6415.36 ㎖
Firing Azimuth (0.01 ㎖)	–	1557.05 ㎖
Orienting Angle (0.1 ㎖)	=	4858.31 ㎖

Figure 2-13. Computation of the orienting angle.

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).

Fuze Setting (NUC 1.0 sec)	=	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) 120.57	=	121 sec
Time on Target 191400		191359.60
Time of Flight (min & sec)	–	2:01
Time to Fire (1.0 sec)	=	191357:59
FIRE COMMANDS		
SCO/(ARM TIME HE ONLY)		T
Elevation		853.3

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



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

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.

i. The completed computer's record for the nuclear mission is shown in figure 2-16 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)		XZ 176	

CALL FOR FIRE

J3F7Ø FM

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

FP No 12 Tgt No XZ176Ø

Tgt Grid 145NP 1Ø655 35275

Tgt Alt 217 m Whd M234B

HOB L TOT 1914ØØ

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 82Ø6
Log dN	–	3.371 4373
Log Tan Bearing	=	1.366 3833
Bearing (0.01mil)		1556.21 mil

AVERAGE EASTING	
dE/2	2734Ø
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 mil
Bearing	+ 1556.21 mil
Launcher – Tgt AZ (0.01mil)	1556.21 mil

FIRE ORDER

Unit to Fire A-1-16 Lchr No 2

FP No 12 Tgt No XZ176Ø

WARNING ORDER

Lchr No 2 FP No 12

Tgt No XZ176Ø Whd M234

HOB L TOT 1914ØØ

Tgt AZ 156Ø (10mil)

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 (crossed out)		
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

SECOND TRAJECTORY COMPUTATIONS (crossed out)

Range (RT)	m
FTR Entry Range (1,000m) –	m
△RT/100	± m
Alt Tgt (ALTT)	m
Lchr Alt (ALTL) –	m
Ht of Tgt Rel Lchr (HTL)	± m
HT of Tgt REL Lchr (500m) –	m
△HTL/100	±
ALTL/100	± m

Trial RB (Col 2)	m	+	–
± Col 3 × ± △RT 100			
± Col 4 × ± △HTL 100			
± Col 5 × ± △ALTL 100			
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 2-16 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 △ Range/100	– 2.49	② △ HL/100	+ 1.95	③ △ 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)	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 + 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 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 / 0.262	0.689
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		
Launcher-Tgt Azimuth	1556.21 mil	
	+	–
(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 / 0.836	4.631
Firing Azimuth (0.01mil) =	1557.05 mil	

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 (0.01mil)		0015.36 mil
6400 (if nec)	+	6400.00 mil
Sum	=	6415.36 mil
Firing Azimuth (0.01mil)	–	1557.05 mil
Orienting Angle (0.1mil)	=	4858.31 mil

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

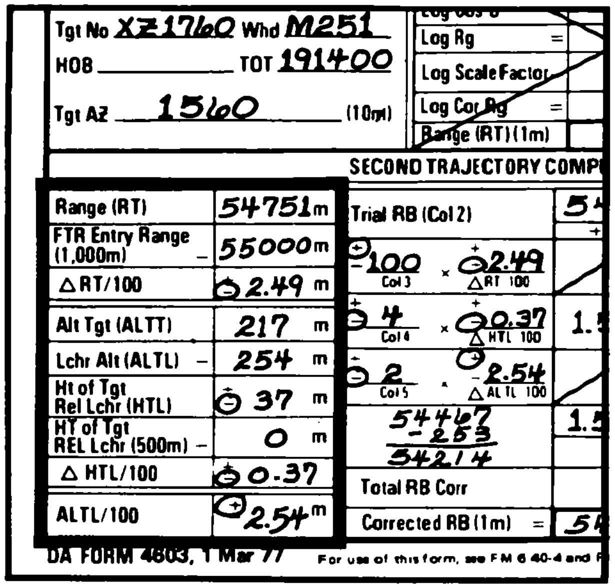


Figure 2-17. Computation of ΔRT/100, ΔHTL/100, and ALTL/100.

2-10. Nonnuclear Mission, M251 Whd

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 paragraph 2-8*e* through 2-8*i*.

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 (RT) and height of target relative to launcher (HTL). Divide launcher altitude (ALTL) by 100 (fig 2-17).

(2) With the launcher-target range (RT) and the launcher altitude, enter table B of FTR LANCE ADD-A-1 and extract the appropriate elevation, sustainer cutoff 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 (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 ΔRT/100, ΔHTL/100, and ALTL/100, and algebraically add

Lchr No 2	FP No 12	Log dN	
Tgt No XZ1760	Whd M251	Log Cos B	
HOB	TOT 191400	Log Rg =	
Tgt Az 1560 (10m)		Log Scale Factor	
		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 m		
			+	−		+	−	
FTR Entry Range (1,000m) −	55000 m	(−)100 Col 3 × (−)2.49 ΔRT 100		249.0	+100 × (−)0.37 ΔHTL/100		37.0	
ΔRT/100	(−)2.49 m							
Alt Tgt (ALTT)	217 m	(+)4 Col 4 × (−)0.37 ΔHTL 100	1.5		Total HBL Corr		37.0	
Lchr Alt (ALTL) −	254 m							
Ht of Tgt Rel Lchr (HTL)	(−)37 m	(−)2 Col 5 × (+)2.54 ΔALTL 100		5.1	Corrected HL (1m) =	738 m		
HT of Tgt REL Lchr (500m) −	0 m	54467 −253 = 54214	1.5	254.1	775 − 37 = 738			
ΔHTL/100	(−)0.37			1.5				
		Total RB Corr		252.6				
ALTL/100	(+)2.54 m	Corrected RB (1m) =	54214 m					

DA FORM 4803, 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 2-18. Computation of corrected RB and HL.

the resulting products to determine the total correction to the trial range to burst (RB). Algebraically add the total correction to the trial RB to determine the corrected RB.

(4) Multiply △HTL/100 by 100 and algebraically add to the trial height of burst 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).

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

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

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 △ Range/100	(+) 2.14	② △ HL/100	(+) 2.38	③ △ 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)	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.

Range (1000m) —		HL (500m) —		ALTL (500m) —	
① △ Range/100	⊕ 2.14	② △ HL/100	⊕ 2.38	③ △ ALTL/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	TRIAL TIME PARAMETER (Col 6)	110.24 sec		

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

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 and record these values in spaces ④, ⑤, ⑥, and ⑦ at the top of the form (fig 2–20).

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).

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)	+	−
	3728.33			110.24 sec	
⊕ 3.54 (Col 3) × ① ⊕ 2.14	7.576		⊕ 0.12 (Col 7) × ① ⊕ 2.14	0.257	
⊕ 2.92 (Col 4) × ② ⊕ 2.38	6.950		⊖ 0.15 (Col 8) × ② ⊕ 2.38		0.357
⊖ 0.19 (Col 5) × ③ ⊖ 2.46	0.467		⊖ 0.06 (Col 9) × ③ ⊖ 2.46	0.148	
(A1) ⊕ 4.92 × ④ ⊕ 0.37	1.820		(B1) ⊕ 0.18 × ④ ⊕ 0.37	0.067	
(A2) ⊖ 7.75 × ⑤ ⊕ 0.83		6.432	(B2) ⊕ 0.67 × ⑤ ⊕ 0.83	0.556	
3728.33 + 10.38 = 3738.71	16.813	6.432	110.24 + 0.67 = 110.91	1.028	0.357
	6.432			0.357	
	10.381			0.671	
Corrected RF =	3738.71		Corrected TP =	110.91 sec	
			TP Correction	⊖ 0 sec	
Range Factor (Nearest Whole No) =	3739		Fuze Setting ~~(NUC 1.0 sec)~~ (HE 0.1 sec) 110.91 =	110.9 sec	

FIRING AZIMUTH	+	−
Launcher-Tgt Azimuth	1556.21 mil	
(C1) 4.191	4.191	
(C2) ⊖ 8.23 × ⑥ ⊕ 0.56		4.609
(C3) ⊕ 3.07 × ⑦ ⊕ 0.03	0.092	
1556.21 − 0.33 = 1555.88	4.283	4.609
		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

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 2-25 ②).

1555.88		4.283
		0.326
Firing Azimuth (0.01ᵯ)	=	1555.88 ᵯ
ORIENTING ANGLE		
Az of OL (0.01ᵯ)		0015.36 ᵯ
6400 (if nec)	+	6400.00 ᵯ
Sum	=	6415.36 ᵯ
Firing Azimuth (0.01ᵯ)	−	1555.88 ᵯ
Orienting Angle (0.1ᵯ)	=	4859.48 ᵯ

Figure 2-22. Computation of the orienting angle.

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

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
FIRE COMANDS		
SCO/(ARM TIME HE ONLY)		E/80

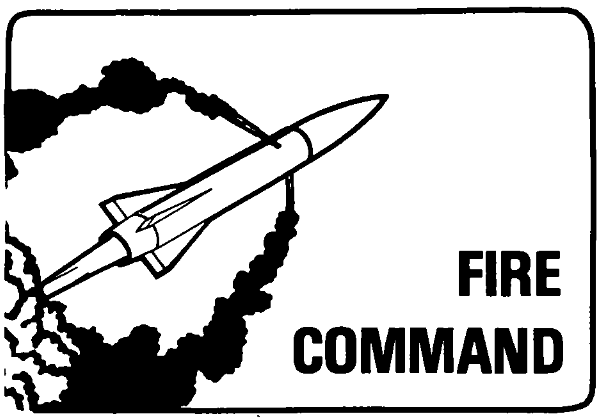
Figure 2-23. Time-of-flight computations.

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

110.91		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
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
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.

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



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		XZ176	

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 M251

HDB ______ 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 M251

HDB ______ TOT 191400

Tgt AZ 1560 (10m̸)

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 (0.01m̸)	1556. 21 m̸

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 m̸
Bearing	⊕1556. 21 m̸
Launcher − Tgt AZ (0.01m̸)	1556.21 m̸

RANGE TO TARGET (RT)

dE Greater than dN	
Log dE	4. 737 8206
Log Sin B −	9. 999 6985
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	m
HDB 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
FTR Entry Range (1,000m) −	55000 m
△RT/100	⊖2.49 m
Alt Tgt (ALTT)	217 m
Lchr Alt (ALTL) −	254 m
Ht of Tgt Rel Lchr (HTL)	⊖ 37 m
HT of Tgt REL Lchr (500m) −	0 m
△ HTL/100	⊖0.37
ALTL/100	⊕2.54 m

Trial RB (Col 2)	54467 m	
	+	−
⊖100 (Col 3) × ⊖2.49 (△RT 100)		249.0
⊖4 (Col 4) × ⊖0.37 (△HTL 100)	1.5	
⊖2 (Col 5) × ⊕2.54 (△ALTL 100)		5.1
54467 − 253 = 54214	1.5	254.1
		1.5
Total RB Corr		252.6
Corrected RB (1m) =	54214 m	

Trial HBL (Col 6)	775 m	
	+	−
+ 100 × ⊖0.37 (△HTL/100)		37.0
Total HBL Corr		37.0
Corrected HL (1m) =	738 m	

775
− 37
738

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 . Completed 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) △ Range/100	⊕ 2.14	(2) △ HL/100	⊕ 2.38	(3) △ ALTL/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)	(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		
Launcher-Tgt Azimuth	1556.21 mil	
	+	−
(C1) 4.191	4.191	
(C2) ⊖ 8.23 × (6) ⊕ 0.56		4.609
(C3) ⊕ 3.07 × (7) ⊕ 0.03	0.092	
1556.21 − 0.33 = 1555.88	4.283	4.609
		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
Firing Azimuth (0.01 mil) −	1555.88 mil
Orienting Angle (0.1 mil) =	4859.48 mil

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). Completed computer's record for nonnuclear warhead (M251)—reverse side.

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 XZ176D
Tgt Grid 14SMP10655 35275
Tgt Alt 217 m Whd M252
HOB IMPACT 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 (0.01 mils)	1556.21 mils

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 mils
Bearing	⊕1556.21 mils
Launcher − Tgt AZ (0.01 mils)	1556.21 mils

FIRE ORDER

Unit to Fire A-1-16 Lchr No 2
FP No 12 Tgt No XZ176D

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

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)	⊖37 m

WARNING ORDER

Lchr No 2 FP No 12
Tgt No XZ176D Whd M252
HOB IMPACT TOT 191400
Tgt AZ 1560 (10 mils)

dN Greater than dE (crossed out)	
Log dN	
Log Cos B −	
Log Rg =	
Log Scale Factor −	
Log Cor Rg =	
Range (RT) (1m)	m

SECOND TRAJECTORY COMPUTATIONS (crossed out)

Range (RT)	m
FTR Entry Range (1,000m) −	m
△RT/100	± m
Alt Tgt (ALTT)	m
Lchr Alt (ALTL) −	m
Ht of Tgt Rel Lchr (HTL)	± m
HT of Tgt REL Lchr (500m) −	m
△ HTL/100	±
ALTL/100	± m

Trial RB (Col 2)	m	
	+	−
± Col 3 × ±△RT 100		
± Col 4 × ±△HTL 100		
± Col 5 × ±△ALTL 100		
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.

2-11. Practice Nuclear Mission, M252 Whd

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.

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 (20mil)	1560 mil	④ Cos 2L	⊕ 0.37	⑥ Sin L	⊕ 0.56
Lat of Lchr (1°)	34 (N)	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
3775.15 / −12.13 / 3763.02	3.999	16.128
		3.999
		12.129
Corrected RF =	3763.02	
Range Factor (Nearest Whole No) =	3763	

TRIAL TIME PARAMETER (Col 6)	116.43 sec	
	+	−
⊕ 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	
116.43 / +0.73 / 117.16	1.025	0.299
	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 =	105.0 sec	

FIRING AZIMUTH		
Launcher-Tgt Azimuth	1556.21 mil	
	+	−
(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 mil) =	1557.05 mil	

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) 121.04 =	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 (0.01 mil)	0015.36 mil
6400 (if nec) +	6400.00 mil
Sum =	6415.36 mil
Firing Azimuth (0.01 mil) −	1557.05 mil
Orienting Angle (0.1 mil) =	4858.31 mil

FIRE COMMANDS	
SCO/(ARM TIME HE ONLY)	T
Elevation	853.3
Range Factor	3763
Orienting Angle	4858.31
Fuze Setting	105.0
Time to Fire	191357:59

Figure 2-26, ② . Computer's record for practice nuclear warhead—reverse side.

Although fuze setting is not required for firing the M252 warhead, fuze setting computations should be completed in order 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 .

CHAPTER 3

Fire Direction With the M18 Gun Direction Computer, FADAC

Section I. Organization and Equipment

The M18 gun direction computer (FADAC) is used to compute the necessary laying and firing data for the Lance missile, and, in addition, may be used to solve specific survey problems and to store target, firing point, and observer information.

3-1. Fire Direction Personnel

a. The Lance fire direction center organization at the battalion headquarters and in the firing batteries provides the personnel required for operations using the FADAC. The fire direction computer is assigned the duties of FADAC operator while the duties of the other personnel are essentially the same as in the manual fire direction center organization discussed in chapter 2.

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

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 the members of the fire direction center. The individuals assigned the duties of operating the generator must be trained 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 perform dynamic checks of its internal operations as well as tests of 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, *Operator's Manual: Computer, Gun Direction M18.*

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).

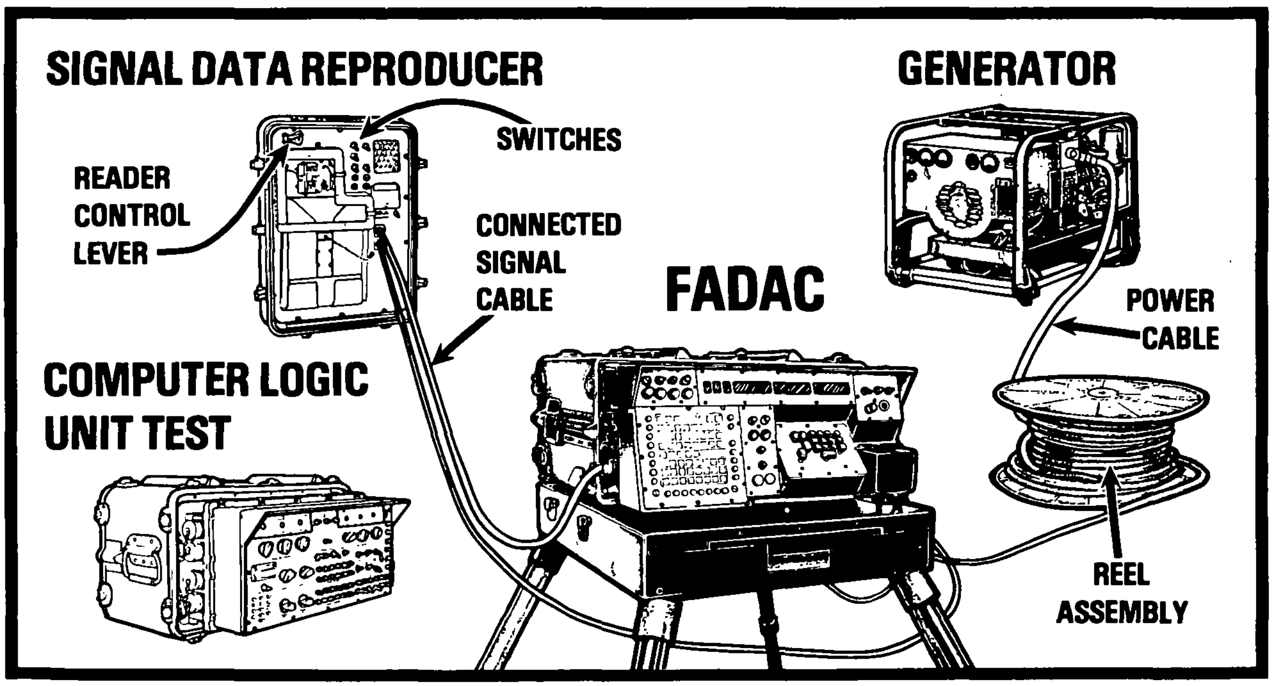


Figure 3-1. FADAC components.

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

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 signal data reproducer (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 below.

3-6. Loading the Program

a. The Lance program is entered into the FADAC by means of the signal data reproducer (SDR) AN/GSQ-64. 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 signal data reproducer AN/GSQ-64 connected to the FADAC, for memory loading.

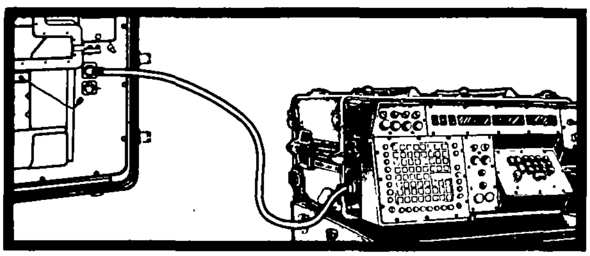


Figure 3-1 ① . Connected signal cable.

b. After the signal data reproducer (SDR) has been connected to the FADAC, the following procedures are used to load the program into memory (for further details, see TM 9-1290-326-12 and TM 9-1220-221-20).

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 cannister 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 cannister.
2	Set all switches in the DOWN position (fig 3-1 ②) and open the READ HEAD using the READER CONTROL LEVER.

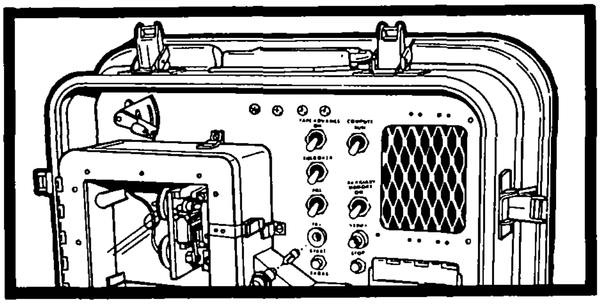


Figure 3-1 ② . Signal data reproducer switches.

STEP	ACTION
3	Pull the tape from the top of the cartridge and thread the tape through the reader 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.

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, (paragraph 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.)
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.)
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 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 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.

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 start FADAC 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, the 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 the 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, figure 3-2. Each of the seven sections of the control panel are identified on this figure.

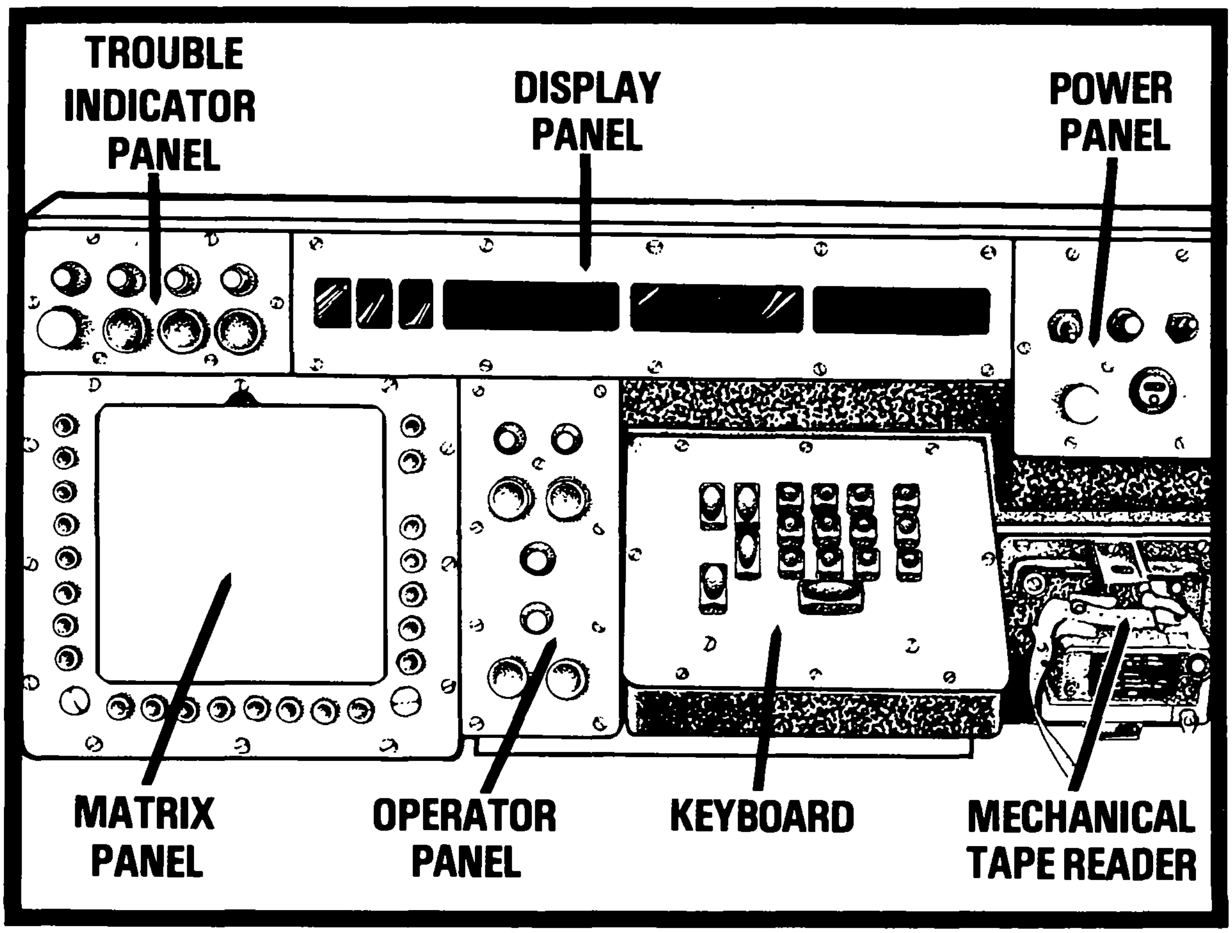


Figure 3-2. Computer control panel.

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 3-2 ①) 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 both a numbered button and a lettered button simultaneously (e.g., A1, B1, E1, E2), the operator can cause the FADAC to compute 10 independent sets of firing data and store these in 10 separate memory locations.

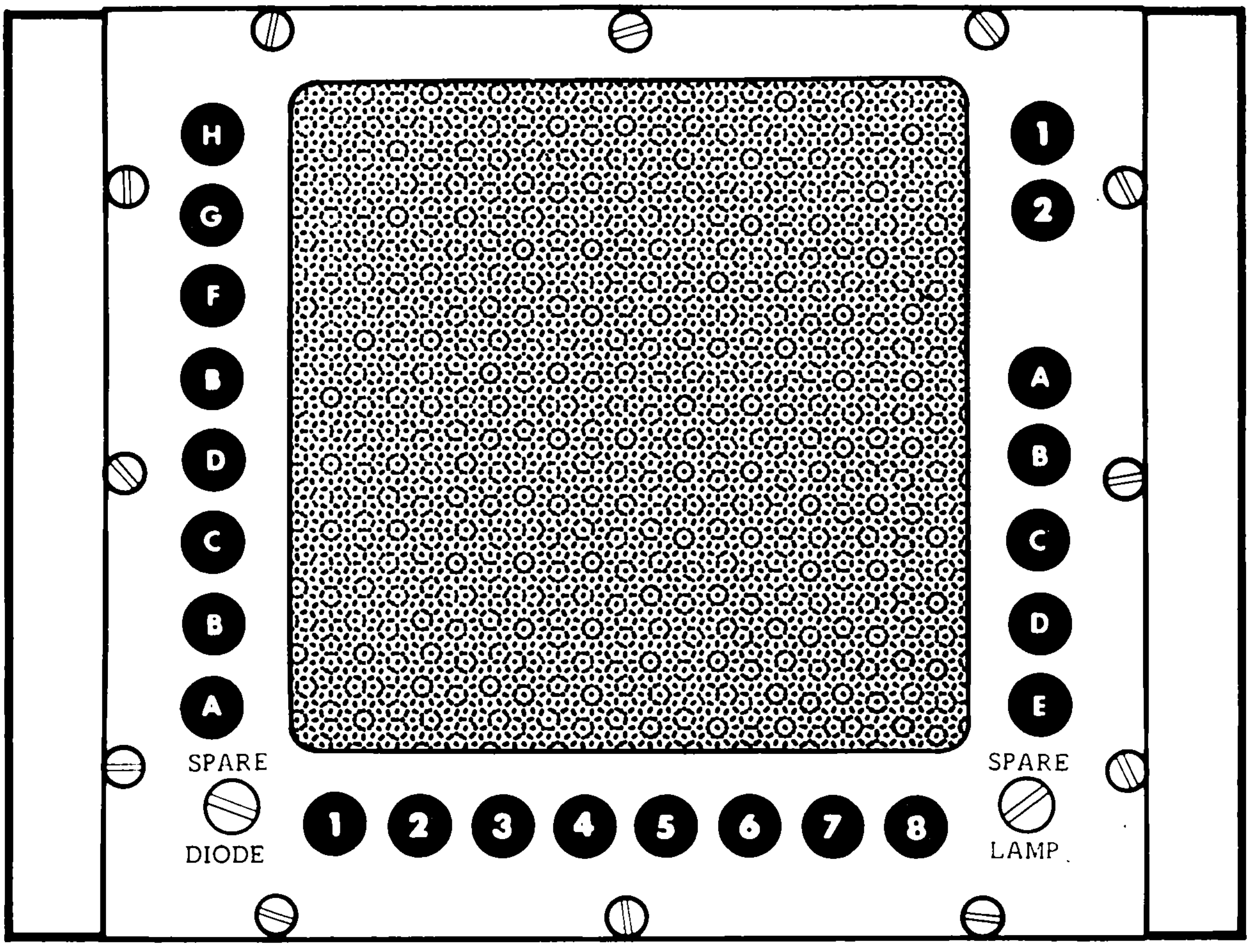


Figure 3-2 ① . Matrix panel.

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:

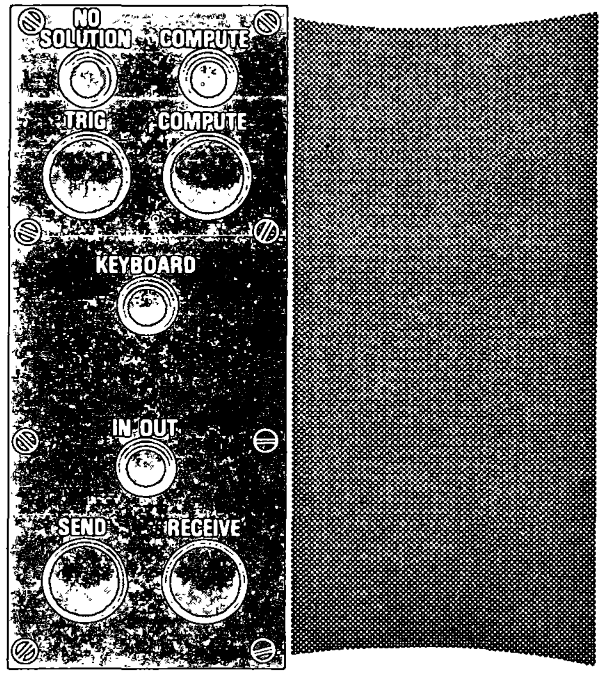


Figure 3-2 ② . Operator panel.

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 3-22.
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 3-2 ③) has five groups of keys. The description and use of each key is detailed in the following table:

Figure 3-2 ③ . 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.

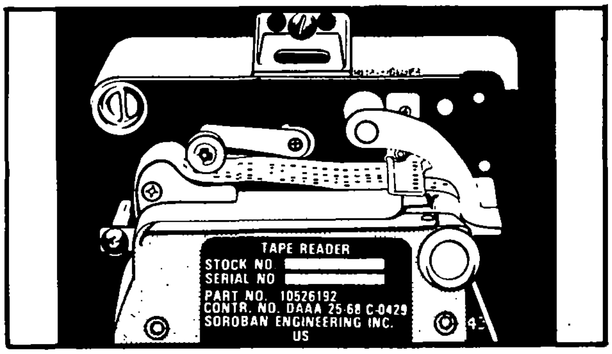


Figure 3-2 ④ . Mechanical tape reader.

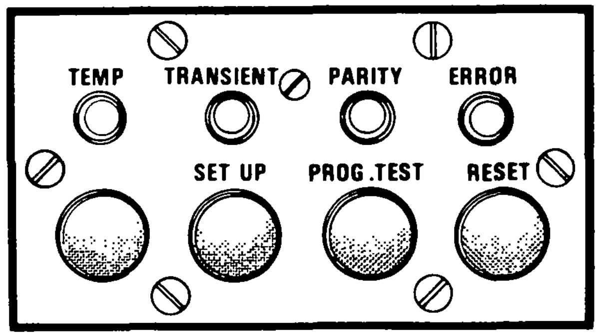


Figure 3-2 ⑤ . Trouble indicator panel.

d. Mechanical tape reader. The mechanical tape reader (fig 3-2 ④), 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 3-2 ⑤) has four indicators and three program control buttons. The description and use is detailed in the following tables:

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.

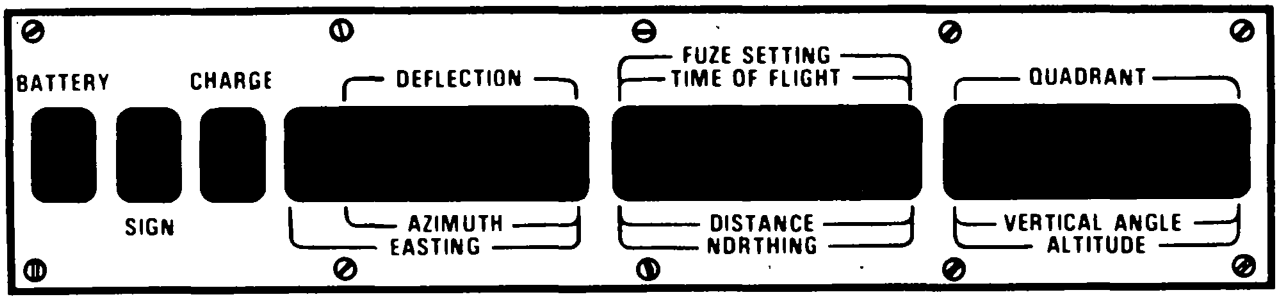


Figure 3-2 ⑥ . Display panel.

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 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 depend 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 Azimuth 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 3-2 ⑦), 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.

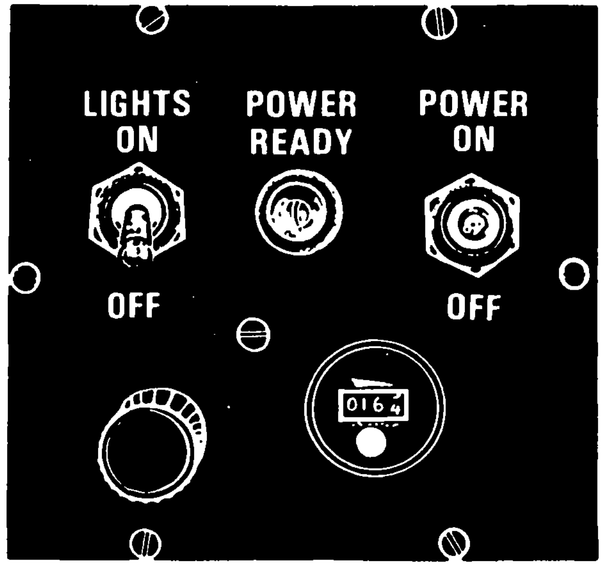


Figure 3-2 ⑦ . Power panel.

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 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 test is being made. If the test is successful, this 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 right-most 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, 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.

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 OATA	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 OATA	FIRING POINT LIST (1-17)		
134	FIRING POINT LIST (18-39)			
136	FIRING POINT LIST (39-48)	TEMPORARY OATA	OBSERVER LIST	

Figure 3-3. Memory map.

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. ABCDEFGHIJKLMNOPQRSTUVWX YZ0123456789

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

f. A marginal test has also 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 insures 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.

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 (sample matrix) 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 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, paragraph 3-22.

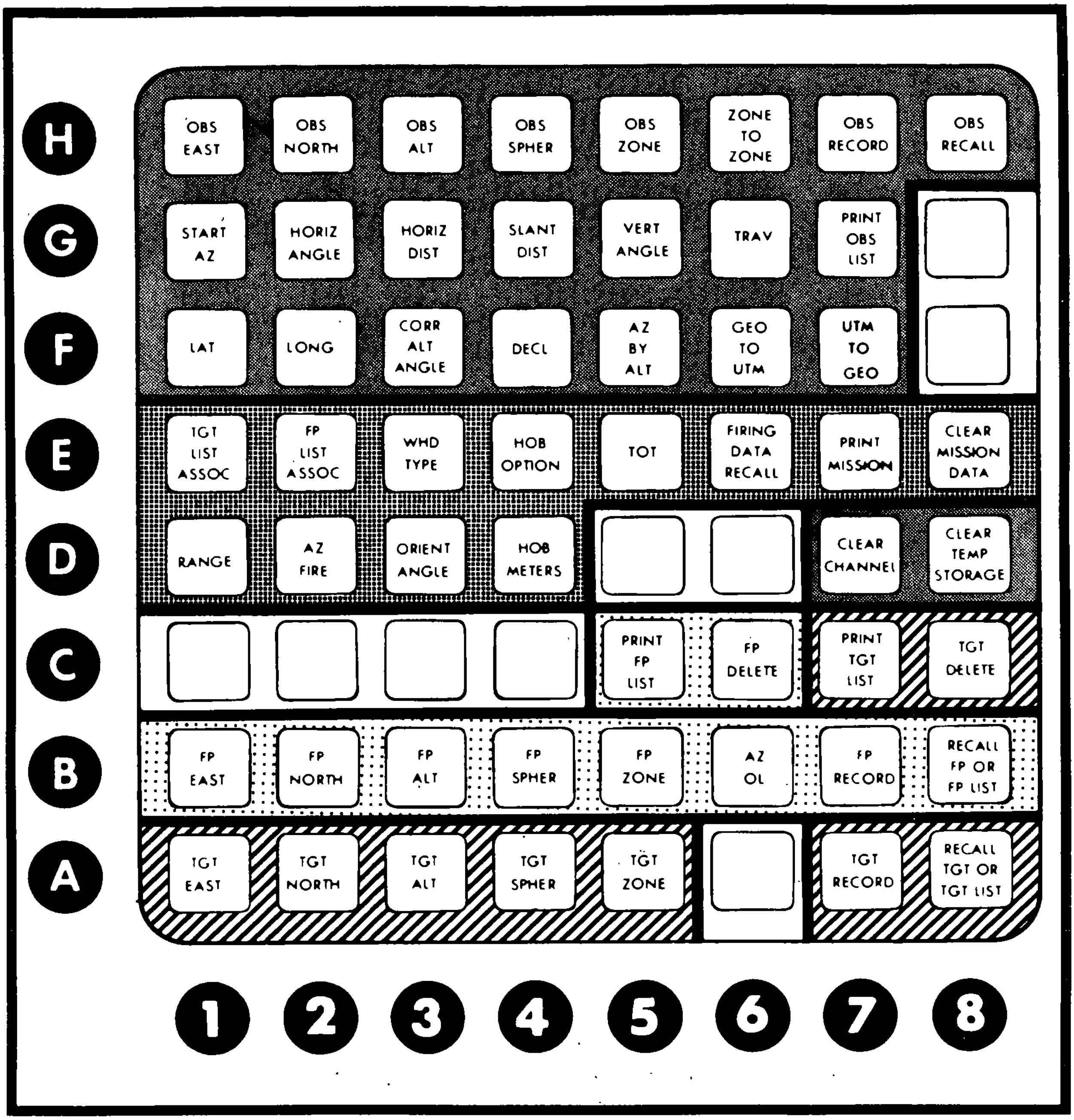


Figure 3-4. The matrix overlay.

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 is entered on its storage list. 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 azimuth of the orienting line 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 5-241-1.

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 Inputs

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 3-21, 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 altitude	A-3 (TGT ALT)
Target zone	A-5 (TGT ZONE)
Firing point 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 prblem 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), and 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

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 to 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 contains special information as to its use.

Notes:

1. 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.
2. The output for the solution to all survey computations is by teletypewriter. See paragraph 3-7, step 10, for the procedure to connect the teletypewriter to the FADAC.

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 remarks 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.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
TGT North	A-2	No	1. Press the SM key. 2. Type in the target northing. 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. Input values for the Northern Hemisphere must not exceed 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.	1. Press the RECALL key.	1. Range of input is from -2000 through +6500 meters.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			2. Press the + or - key and type in the target altitude. 3. Press the ENTER key.	2. Data 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 SPHER	A-4	No	1. Press the SM key. 2. Type in the appropriate one-digit spheroid flag. Clarke 1866 1 International 2 Clarke 1880 3 Everest 4 Bessel 5	1. Press the RECALL key. 2. Target spheroid flag 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 5. 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.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
(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). 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.	1. NA	1. Inputs for functions A-1 through A-5 must have been made. 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.	1. Use the entry procedures to recall a specific target or use steps 2	1. After the target data have been recalled, the individual

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			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 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).	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. 3. Same as entry procedures step 4.	recall procedures for functions A-1 through A-5 will be valid.
FP EAST	B-1	No	1. Press the SM key. 2. Type in the firing point easting. See remark 1. 3. Press the ENTER key.	1. Press the RECALL key.	1. The remarks for 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. Data cannot be recalled after the firing point has been recorded. See remark 3 and refer to function B-8.	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 firing point northing. See remark 1. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the firing point 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.
FP ALT	B-3	No	1. Press the SM key. 2. Press the + or – key and type in the firing point altitude. 3. Press the ENTER key.	1. Press the RECALL key. 2. Data cannot be recalled after the firing point has been recorded. See remark 3 and refer to function B-8.	1. Range of input is from 0 through +3000 meters. When a negative launcher altitude is encountered,

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
					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.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
FP SPHERE	B-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. Firing point spheroid flag cannot be recalled after the firing point has been recorded. See remark 2 and refer to function B-8.	1. Entry and recall procedures are the same as for function A-4. 2. Set to minus zero by function B-7.
FP ZONE	B-5	No	1. Press the SM key. 2. Type in a plus sign if the firing point 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 firing point 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 azimuth of the orienting line.	1. Press the RECALL key. 2. Data cannot be recalled after the firing	1. Range of input is from 0 through 6400 mils.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. Press the ENTER key.	point has been recorded. See remark 2 and refer to function B-8.	2. Set to minus zero by function B-7.
FP RECORD	B-7	No	1. Press the SM key. 2. Type in the 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 azimuth of the OL (from one to four digits).	NA	1. Inputs for functions B-1 through B-6 must have been made. 2. Use of this function sets the values in functions B-1 through B-6 to minus zero.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
RECALL FP	B-8	No	1. Press the SM key. 2. Type in the firing point list number (1 through 48). 3. Press the ENTER key and the designated firing point 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 UTM 100,000-meter grid square high order digits (three digits), and the UTM grid zone number (one or two digits), and the azimuth of the OL (from one to four digits).	1. Use the entry procedures to recall a specific firing point or use steps 2 and 3 below to recall a mission associated firing point. 2. Press the appropriate mission association buttons and then press the RECALL key. The mission firing point grid and altitude will be displayed and the KEYBOARD indicator will light. 3. Same as entry procedures step 4.	1. After the firing point data have been recalled, the individual recall procedures for functions B-1 through B-6 will be valid.
(Blank)	C-1				Not used.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
(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 firing points, see step 3 below; or, to print only the data for a specific firing point, type the number of that firing point. 3. Press the ENTER key.	NA	1. The tele-typewriter must be turned on before using this function.
FP DELETE	C-6	No	1. Press the SM key. 2. Type in the firing point list number. 3. Press the ENTER key. The KEYBOARD indicator will light. 4. Type 0.	NA	1. The data stored in the memory location assigned by the list number entered in step 2 is 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
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	1. 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	1. The data stored in the memory location assigned by the list number entered in step 2 are set to minus zero by this function.
RANGE	D-1	Yes	1. Press the SM key. The FADAC will compute and display the firing point-target range in meters.	1. Press the RECALL key.	1. Before this function can be used, a target and a firing point must have been mission associated.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
					2. Set to minus zero by function E-8.
AZ FIRE	D-2	Yes	1. Press the SM key. The FADAC will compute and display the firing point-target azimuth.	1. Press the RECALL key.	1. The remarks for function D-1 also apply to this function.
ORIENT ANGLE	D-3	Yes	1. Press the SM key. The FADAC will compute and display the orienting angle (Uncorrected).	1. Press the RECALL key.	1. The remarks for function D-1 also apply to this function. 2. The corrected orienting angle is computed and displayed as the first part of the fire mission display after ballistic computation. See figure 3-5.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
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. 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.	NA	1. See paragraph 3-10, program test 2 procedures, and figure 3-3. 2. Three digits must always be entered in step 2; e.g., channel 76 must be entered 076. 3. The contents of each channel of the hot storage section of memory is shown graphically in figure 3-3, Memory map.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
CLEAR TEMP STORAGE	D-8	No	1. Press the SM key. 2. Type 0.	NA	1. 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: Spheroid flag (one digit), the UTM 100,000-meter grid square high order digits (three digits), and the UTM grid zone number.	NA	1. 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
FP LIST ASSOC	E-2	Yes	1. Press the SM key. 2. Type in the firing point 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 azimuth of the OL (from one to four digits).	NA	1. A firing point must be recorded on the firing point 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.	1. Press the RECALL key.	1. Set to zero by function E-8.
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.	1. Press the RECALL key.	1. 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.	1. Press the RECALL key.	1. 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 the SM key and 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	1. See figure 3-5 for the firing data display format.

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
PRINT MISSION	E-7	Yes	1. Insure that the teletypewriter is connected and turned on. 2. Press the SM key.	NA	1. The printout format is illustrated in paragraph 3-27 f(3).
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	1. This function erases all of the data input for a specific mission and sets all mission-associated functions to minus zero.
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.	1. Press the RECALL key. 2. Data cannot be recalled after a problem has been computed. See remark 2.	1. Range of input is from -80.30.00 through +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
			3. Type in the latitude to the nearest 0.001 second separating the degrees, minutes, and seconds with a decimal point. 4. Press the ENTER key.		
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 a decimal point. 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 from 00.00.00 through 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	1. Press the RECALL key. 2. Data cannot be recalled after the problem has been	1. Used only to enter the corrected altitude angle of the celestial body in the

Table 3-6. Detailed Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			angle must have been corrected for parallax and/ or refraction. 3. Press the ENTER key.	computed. See remark 2.	azimuth-by-altitude survey computations. 2. Set to minus zero during computations.
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	The procedures for computing azimuth by altitude with UTM coordinates are: 1. Using matrix locations H-1, H-2, H-4, and H-5, enter the observer's	NA	1. Used to indicate the position of the celestial body relative to the observer and to initiate the azimuth-by-altitude survey computations.

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Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			easting, northing, spheroid, and zone. 2. Using matrix locations G-2, enter the clockwise horizontal angle from the azimuth mark to the celestial body. 3. Using matrix locations F-3 and F-4, enter the corrected altitude angle and the declination of the celestial body. 4. Using matrix locations 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, verify that all data required		2. Geographic coordinates may be entered in lieu of the UTM data. See steps 1 and 2 below.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			for the solution of the problem have been entered, and then the teletypewriter will print out the input data and the following solution data: True azimuth, grid convergence, and grid azimuth. The procedures for computing azimuth by altitude using geographic coordinates are: 1. Using matrix locations F-1, F-2, and H-4, enter the latitude, longitude, and observer's spheroid. 2. Using matrix locations G-2, enter the clockwise horizontal angle from the azimuth mark to the celestial body.		

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. Using matrix locations F-3 and F-4, enter the corrected altitude angle and the declination of the celestial body.		
			4. Using matrix locations 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, verify that all data required for the solution of the problem have been entered, and then the teletypewriter will print out the input data and the following solution data: True azimuth, grid and convergence, and grid azimuth.		

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
GEO TO UTM	F-6	No	The procedures for computing UTM coordinates from geographic coordinates are: 1. Using matrix locations F-1 and F-2, enter the latitude and the longitude to be converted. 2. Using matrix locations H-4, enter the appropriate spheroid flag. (Spheroid flags are shown under the entry procedures for functions A-4.) 3. 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 solution of the problem have been entered. Then the teletypewriter will —continued	NA	1. Used only to initiate the computation of UTM grid coordinates from geographic coordinates. 2. See note 2.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			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: 1. 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. 2. 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 converted latitude and longitude.	NA	

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
HORIZ ANGLE	G-2	No	1. Press the SM key. 2. Type in the horizontal angle to the nearest 0.001 mil. 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. This function is used only to enter the horizontal angle in traverse and azimuth-by-altitude survey procedures. 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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
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.
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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
TRAV	G-6	No	The procedure for solving a traverse problem is: 1. Press the SM key. 2. 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. 3. 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. 4. 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

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			5. Using function G-2, enter the horizontal angle. 6. Using function G-3 or G-4, enter either the horizontal distance or the slant distance. 7. 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.		be recalled using function H-8 before the traverse can be continued. 3. During the computation of an offset traverse, the KEYBOARD indicator will not light after the printout. Refer to step 8. 4. Set to minus zero when the traverse mode is terminated. 5. See note 2.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			8. If the KEYBOARD indicator lights, repeat step 2 (if the KEYBOARD indicator does not light, an offset traverse is being computed. In this case, enter the data for the next offset leg starting with step 5.) 9. Return to step 5 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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
OBS EAST	H-1	No	1. Press the SM key. 2. Type in the observer easting. 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-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.
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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
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.
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	1. Press the RECALL key. 2. Data cannot be recalled after the observer has been recorded. See remark 2	1. Range of input is from 1 through 60. 2. Set to minus zero by function H-7.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			the observer is in the Southern Hemisphere. 3. Type in the UTM grid zone number. 4. Press the ENTER key.	and refer to function H-8.	
ZONE TO ZONE	H-6	No	The procedures for solving a zone-to-zone coordinate transformation are as follows: 1. Using matrix functions H-1 through H-5, enter the coordinates, altitude, grid zone, and the spheroid location to be transformed. 2. Press the matrix buttons and then press the SM key.	NA	1. Used only to enter the UTM grid zone number of the zone to which coordinates are being transformed. 2. Transformation can only be computed between adjacent zones. 3. See note 2.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
			3. 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. 4. Type in the number of the UTM grid zone to which the coordinates are to be transformed. 5. Press the ENTER key. 6. The teletypewriter will print the input grid, spheroid, and zone and the transformed grid, spheroid, and zone.		

Table 3-6. 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.

Table 3-6. Matrix Functions—Continued

Matrix Function	Matrix Location	Mission Assoc	Entry Procedures	Recall Procedures	Remarks
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 observer 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.	NA	

Section VI. Output

3-19. 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 that 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 must be pressed in order 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.

(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 sustainer cutoff setting flag.

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

(5) The fifth window, labeled 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, labeled 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.

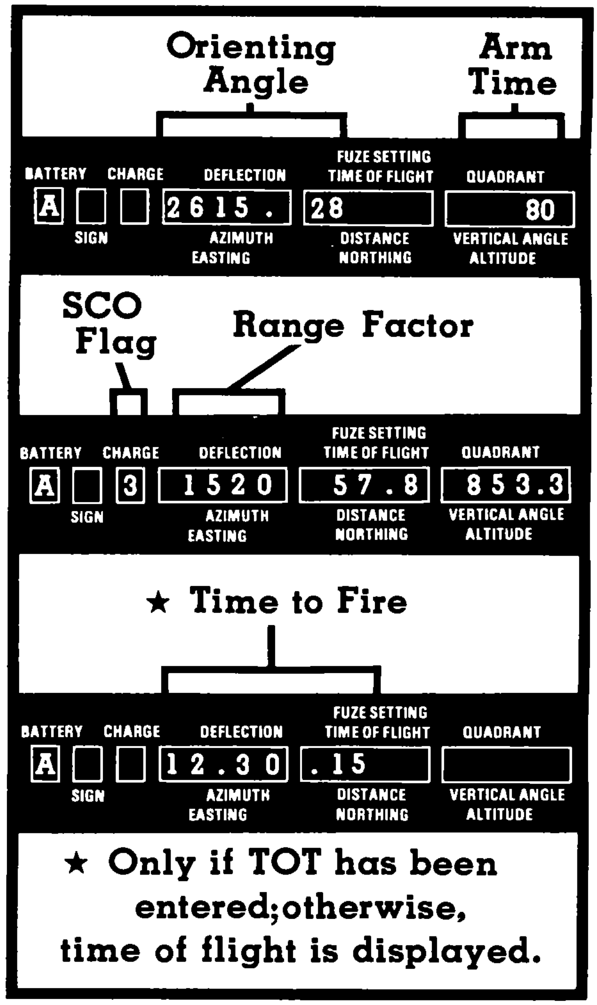

Figure 3-5. Firing data displayed in three parts.

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 sustainer cutoff 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, provided a time on target (TOT) entry was made in matrix location E-5; otherwise, time of flight is displayed.

3-20. 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).

3-21. 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.

3-22. Flags and No Solution Displays

a. Input or output information to designate the type warhead, sustainer cutoff setting, the location of a point in the Northern or Southern Hemisphere, or which spheroid data are to be used in computations is accomplished 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 (for example, a number larger or 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 is shown in section II of the flag card illustrated in figure 3-6.

PROGRAM WILL DISPLAY 2 00000 00000 00559 FOLLOWING A SUCCESSFUL SUM CHECK.

SECTION I—FLAGS

	FLAG
1. WARHEAD TYPE (E3)	
M-234A/M-252A	1
M-234B/M-252B	2
M-234C/M-252C	3
M-251	4
2. HOB OPTION (E4)	
IMPACT	0
LOW AIR	1
HIGH AIR	2
3. HEMISPHERE (A5, B5, H5, F1, F2)	
NORTHERN	+
SOUTHERN	-
EASTERN	+
WESTERN	-
4. SPHEROID (A4, B4, H4)	
CLARKE 1B66	1
INTERNATIONAL	2
CLARKE 18B0	3
EVEREST	4
BESSEL	5

5. SUSTAINER CUTOFF

NONNUC	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

6. MULTIPLE DISPLAY	
TERMINATE	●
INITIATE NEXT DISPLAY	ENTER
7. ENABLE/DISABLE	
ENABLE	0
DISABLE	9
B. 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 DURING INPUT OR COMPUTATION
NSL & 4	RECALL OF MISSILE PRESETTINGS FOR A MISSION THAT 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; INCORRECT CHANNEL NUMBER READ FROM CLEAR HOT STORAGE TAPE
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

Figure 3-6. The flag card.

Section VII. Solving Problems

The Lance missile program is used to compute firing data for the missile and solve survey problems. The capability for solving survey problems provides the fire direction center with a limited capability to compute survey problems that are indigenous to the 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.

3-23. 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 3-19.
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.)
9	The firing data are transmitted to the firing platoon.
10	The operator then uses matrix function E-7 (PRINT MISSION) to

STEP	ACTION
	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.

3-24. 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 are 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 3-26.

3-25. 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 NSL indicator 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.

3-26. 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 (STA)	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 TP 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 coordinate 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.

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

(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: 3951000.00

(c) Observer's spheroid flag: 2

(d) Observer's zone: 40

(e) Horizontal angle: 2926.11 mils

(f) *Corrected altitude angle: 382.14 mils

(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.

(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; 2;	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 2 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

3-27. 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; 2;	ENTER
5	B-5 FP ZONE	SM; +33;	ENTER
6	B-6 FP 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 fire direction center.

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

3-28. 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 a fire direction center 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.

3-29. 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 table 3-7 as a guide to diagnose and attempt to correct troubles before notifying maintenance personnel.

Table 3-7. FADAC Troubles and Operator Corrective Actions

Trouble Indication	Step	Corrective Action
1. No power.	1	Insure that the FADAC circuit breaker is in the ON position.
	2	Insure that the generator circuit breaker is in the ON position. Adjust the generator for 120/208-volt output.
	3	Turn off the generator; then check the power cable connections and tighten if necessary.
	4	Insure that the 4-wire hookup on the generator cable and bracket adapter is correct. (See TM 5-6115-271-14.)
2. No display for program test 1.		Insure that a lettered mission button has been pressed.
3. Unintelligible output on display panel.		Run program test 1.
4. Fails program test 1.		Reprogram.
5. Fails program test 2.		Clear the indicated channel of memory by following the instructions in table 3-6.
6. Automatically enters the wrong mode or fails to change modes as the result of a legal operator action.	1	Press the RESET button. If the failure recurs, turn off the FADAC, wait 30 seconds, then restart.
	2	If the failure recurs, repeat the above action, then run program test 1.
	3	Repeated failure indicates a need for hardware repair or a requirement for reprograming.

Trouble Indication	Step	Corrective Action
7. POWER READY light flashes.	1	Insure that the marginal test switch is in the OFF position.
	2	Remove rear cover unless cold weather operation requires that the rear cover remain on.
	3	Send the FADAC to maintenance for blower repair.
8. TEMP light flashes	1	The FADAC's internal temperature is outside the limits for safe operation. One or more of the following actions is indicated: Hot weather: a. Remove the computer from the direct sunlight. b. Check the air filters to insure they are not blocked or dirty. Cold weather: a. Install the rear cover. b. Protect the FADAC from wind.
9. TRANSIENT light flashes.	1	Press the RESET button. If pressing the RESET button fails to stop the flashing light, turn off the FADAC. Readjust the generator for 120/208-volt, 400-hertz output.
	2	Turn on the FADAC and run program test 1.
10. PARITY light flashes.	1	Press the RESET button. If this fails to stop the flashing light, turn off the FADAC. Wait 30 seconds, then restart.
	2	Run program tests 1 and 2.
11. ERROR light flashes.	1	Press the RESET button.
	2	Check all inputs relating to the problem solution. Correct erroneous data.
	3	Run program test 2.
12. NO SOLUTION light flashes.		See paragraph 3-23.

Note.
If the corrective actions fail to change the trouble indication, notify maintenance personnel.

APPENDIX A

References

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.

Army Regulations

310-25	Dictionary of United States Army Terms.
310-50	Authorized Abbreviations and Brevity Codes.
385-62	Firing Guided Missiles and Heavy Rockets for Training, Target Practice, and Combat.
385-63	Regulations for Firing Ammunition for Training, Target Practice, and Combat.
611-201	Enlisted Military Occupational Specialties.

Army Training and Evaluation Program

6-595	Field Artillery Battalion (Lance). (TBP)

Department of the Army Pamphlets

108-1	Index of Army Motion Pictures and Related Audio-Visual Aids.
310-series	Military Publications Indexes.

Field Manuals

5-25	Explosives and Demolitions.
6-2	Field Artillery Survey.
6-10	Field Artillery Communications.
6-15J-CM	Commander's Manual MOS 15J, Lance Operations/Fire Direction Specialist
6-15J 1/2	Lance Operations/Fire Direction Specialist Skill Level 1/2.
6-15J 3	Lance Operations/Fire Direction Specialist Skill Level 3.
6-15J 4	Lance Operations/Fire Direction Specialist Skill Level 4.
6-20	Fire Support in Combined Arms Operations.
6-40	Field Artillery Cannon Gunnery.
6-42	Field Artillery Battalion Lance.
6-141-1	Field Artillery Target Analysis and Weapons Employment: Nonnuclear.
(C) 6-141-2	Field Artillery Target Analysis and Weapons 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.
(S) 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.

Training Circulars

21-5-7	Training Management in Battalions

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)

Technical Manuals

6-231	Seven Place Logarithmic Tables.
9-1115-485-12	Operator and Organizational Maintenance (Prelaunch Procedures): M234 Atomic Warhead Section; M240 Training Atomic Warhead Section.
9-1220-221-10	Operator's Manual: Computer, Gun Direction M18.
9-1220-221-20/1	Organizational Maintenance Manual: Computer, Gun Direction M18.
9-1220-221-20/2	Organizational Maintenance Manual: Computer, Gun Direction M18 (Composite Test Tape Program Printout).
9-1290-326-12	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: XM198.
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 Explosive: 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.
9-4931-204-12/2	Operator's and Organizational Maintenance Manual: Test Set, Computer Logic Unit AN/GSM-70 (Composite Test Tape A Program Printout).
11-5820-401-12	Operator's and Organizational Maintenance Manual, Radio Sets AN/VRC Series.

Allied Communications Publications (ACP)

134(A)	Telephone Switchboard Operating Procedures.

DA Forms

4603	Computer's Record and Data Correction Sheet (LANCE) (available through normal AG publications supply channels).

Lance Program Tape Part Numbers

8213315-121/M	Lance Program Training Tape
(C) 8213315-99/M	Lance Program Tactical Tape (U)

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 FM 101-31-2 (S).

APPENDIX C

Organization of the FDC

C-1. General

The physical arrangement of the FDC has a significant effect on the efficient processing of a fire mission. Therefore, the arrangement of each FDC must be critically examined to insure that it helps rather than hinders the efforts of FDC personnel to provide timely and accurate fire. The basic concept of a good physical arrangement of the FDC requires: first, that it allows the FDO to observe the work of all personnel; second, that it allows the fire mission to be processed with a minimum of communication and movement; and third, that it provides all personnel with ready access to the equipment and data necessary to perform their tasks. To satisfy these requirements, the working area of the FDC must be restricted in size but large enough to allow the necessary freedom of movement. Additionally, each job should be established as a functional unit; that is, all the required equipment must be available and all information needed must be clearly displayed or tabulated for immediate use.

C-2. Operational Tips

a. Write a field SOP defining specific personnel duties and providing individual checklists.

b. Provide for efficient division of duties.

c. Require adherence to standard techniques and procedures.

d. Streamline fire orders and fire commands.

e. Follow maneuver progress; anticipate needs.

f. Organize and train for 24-hour operations.

g. Keep nonessential personnel and equipment out of the FDC.

h. Position the FDO to allow his supervision of all members of the FDC.

i. Use charts that are visible to all for recording various data; e.g., fire order and fire command standards.

j. Keep mission-essential data current.

k. Provide for appropriate checks and backup capability.

l. Process missions with as little communication or movement as possible.

C-3. Equipment Tips

a. "Build in" as much equipment as possible; attempt to reduce the amount of equipment that must be moved or set up (broken down) before the FDC is ready for action (prepared to move).

b. Place the FADAC on a swivel mount that allows the operator to work inside the carrier or from the lowered ramp (when the tent extension is being used).

c. Provide for rapid emplacement of the generators; a "generator trailer" can be "dropped" and the carrier moved far enough away to reduce the effect of generator noise.

d. Prewire and secure into position radio and wire gear to facilitate establishment of communications with other sections and units.

e. Insure often used equipment is stored in an easily accessible location while little used gear is placed out of the way.

f. Wire the carrier for adequate lighting of respective work areas.

g. Properly maintain all equipment or it will fail you when you need it most.

h. Through local authorization, obtain hand-held calculators to speed manual computations.

C-4. Arrangement Tips

a. Organize so that FDC personnel and equipment restrict movement as little as possible.

b. Establish a communication system that allows all personnel to hear the call for fire.

c. Position personnel who pass information to one another so that they are facing each other; e.g., recorder and computer.

d. Locate all forms, data, and equipment so they are readily available to appropriate FDC personnel.

e. When determining work areas, consider whether personnel are right or left handed.

APPENDIX D

Abbreviations from Teletypewriter Printout

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

INDEX

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