FM 6-40-1

FIELD MANUAL

FIELD ARTILLERY
HONEST JOHN ROCKET GUNNERY

HEADQUARTERS, DEPARTMENT OF THE ARMY
JUNE 1972

Cy2

RESCINDED Per DA Pam 310-1 4 Nov 1980

CHANGE No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *15 August 1973*

FIELD ARTILLERY HONEST JOHN GUNNERY

FM 6-40-1, 8 June 1972 is changed as follows:

1. The new chapter 4 covers the operation of the M-18 gun direction computer in the HONEST JOHN application with Revision I program tapes.
Changed material is indicated by a star.

2. Remove old pages and insert new pages as indicated below.

Remove pages—	*Insert pages—*
4-1	4-1 through 4-51

3. File this transmittal sheet at the front of the publication for future reference.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-11A requirements for Field Artillery Honest John/Little John Rocket Gunnery (qty rqr block no. 45).

***This change supersedes FM 6-3-2, 19 October 1967, and (S) FM 6-3-2A, 24 September 1965, upon receipt of the Revision I HONEST JOHN FADAC program tapes.**

☆U.S. GOVERNMENT PRINTING OFFICE: 1973—510-862/3696A

FIELD MANUAL }
No. 6-40-1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *8 June 1972*

FIELD ARTILLERY
HONEST JOHN ROCKET GUNNERY

*This manual supersedes FM 6-40-1, 9 September 1964.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1–1. Purpose

This manual explains the field artillery Honest John gunnery problem and presents a practical solution to that problem. It is a guide for Honest John unit commanders and members of their staffs on field artillery rocket gunnery.

1–2. Scope

a. This manual encompasses all aspects of the gunnery problem from the time that the rocket is issued from the special ammunition supply point (SASP) until it is fired. The material presented herein is applicable to both nuclear and nonnuclear warfare and agrees with the following international stardardization agreements:

TITLE	*NATO STANAG*	*ABCA QSTAG*
Standard Ballistic Meteorological Message	4061 (3d Ed)	120
A Standard Artillery Computer Meteorological Message	4082	

b. The scope includes—

(1) Fundamentals of rocket ballistics.

(2) Fire direction, including both manual and computer (FADAC) procedures.

(3) Miscellaneous gunnery information.

1–3. 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: ATSFA-PL-FM, Fort Sill, Oklahoma 73503.

1–4. References

See appendix A for a list of references.

Section II. BALLISTICS

1–5. General

The study of ballistics pertaining to cannon is usually divided into internal and external ballistics. In order to provide a background for understanding the complete Honest John gunnery problem, the discussion of ballistics pertaining to rockets is based on a similar division. The effects on that portion of the flight prior to burnout of the rocket motor are referred to as propulsion ballistics. The effects on that portion of the flight after burnout are referred to as free-flight ballistics.

1–6. Propulsion Ballistics

Atmospheric conditions have considerable effect on a rocket during powered flight.

a. Variations in Thrust. Variations in rocket motor thrust result from variations in surface air pressure (atmospheric pressure at the firing position), propellant weight, and propellant temperature. The ranges and heights of burst relative to the launcher corresponding to the listed firing table elevations are based on the following standard values at the time of firing:

Ballistic factor	*Standard value MGR-1A*	*Standard value MGR-1B*
Surface air pressure	1,013 millibars	1,013 millibars
Propellant weight	2,050 pounds	
Propellant weight correction		0.0 pounds
Propellant temperature	77° F	77° F

(1) Since changes in air pressure affect the thrust delivered by a rocket motor, variations in thrust at different altitudes are to be expected.

Since the atmospheric pressure decreases with increasing altitudes, the thrust will increase when the rocket is propelled to a higher altitude. Therefore, if the surface air pressure (atmospheric pressure) at the firing position is below the standard value of 1,013 millibars, the thrust delivered by the rocket will increase, causing the rocket to exceed the firing table range.

(2) The velocity of a rocket at burnout increases with propellant weight. Thus, a propellant weight greater than the standard value for the rocket will create increased velocity, causing the rocket to attain a range greater than the firing table range.

(3) Experience has shown that propellant temperature materially affects performance. A given solid propellant will operate at a higher thrust (F) on a hot day than on a cool day. The firing duration (t) will be shorter, but the total impulse (I) will not be changed significantly. Therefore, using the formula $F = \frac{I}{t}$, a propellant temperature that exceeds the standard value will cause a decrease in the firing duration (t) and an increase in thrust (F), which will cause the rocket to attain a range greater than that shown in the firing tables.

Note: Operational firing temperature limits of the MGR-1B rocket motors (M66 and M66A1) are −30° F and +120° F. Above 100° F, the performance reliability of the M66 and M66A1 rocket motors can be expected to decrease. At 120° F, the reliability is 91 percent with an assurance of 90 percent.

b. Low-Level Wind Variations. Propulsion ballistics include the effects of low-level winds on the rocket during the powered flight. Low-level winds have a considerable effect on both the range and deflection. Because of the location of the fins in relation to the center of gravity, the rocket turns into the wind after leaving the launcher and maintains this attitude throughout its flight. During powered flight, the thrust of the rocket will cause it to be propelled in the direction in which the nose is pointed. Since the nose is turned into the wind, the rocket will follow a path into the wind and away from the azimuth on which it was fired (fig 1-1). The magnitude of this deviation into the wind depends on the force of the wind against the surface of the rocket. Therefore, corrections based on low-level wind velocity and direction must be applied away from the wind to compensate for the low-level wind effects during powered flight.

c. Drift. When an MGR-1B rocket is to be fired, a correction to deflection must be applied to compensate for the effects of drift. During the propulsion stage, an approximately constant drift to the left occurs regardless of other factors that affect the rocket. Drift corrections are found in the appropriate firing table.

Note: This drift to the left differs from, and should not be confused with, the concept of drift applicable to cannon artillery fires.

1-7. Free-Flight Ballistics

Free-flight ballistics is the study of the motion of the rocket and the factors affecting that motion after burnout. The factors to be considered are the effects of meteorological conditions, rotation of the earth, and rocket empty weight.

a. Meteorological Effects. The trajectory of a free-flight rocket is influenced by the velocity and direction of the wind and by the temperature and density of the air through which it passes. The ICAO (International Civil Aviation Organization) standard atmosphere has been used as a basis for determining the standard trajectory for the firing table data.

(1) The ballistic met message is a coded tabulation of meteorological information. It is divided into an introduction, which primarily contains identifying information, and a body, which contains meteorological data. The body of the message consists of a sequence of lines, numbered from 00 to 15, with each line consisting of two 6-digit groups. Each line furnishes information of the ballistic wind (azimuth and velocity), ballistic air temperature, and ballistic air density. Ballistic wind direction is measured to the nearest 100 mils, ballistic wind speed to the nearest knot, ballistic air temperature to the nearest 0.1 percent of standard, and ballistic air density to the nearest 0.1 percent of standard.

(2) The computer met message is similar to the ballistic met message except that the body of the message consists of a sequence of lines, numbered from 00 to 26, with each line consisting of two 8-digit groups. Each line furnishes information of the unweighted (not ballistic) wind azimuth and speed, air temperature, and air pressure. Wind direction is measured to the nearest 10 mils, wind speed to the nearest knot, temperature to the nearest 0.1 degree Kelvin, and air pressure to the nearest millibar.

(3) The MGR-1A firing tables (FTR's 762-A-2, -B-2, -C-1, -D-1, -E-1, and -F-1) were constructed for use with the US ordnance stand-

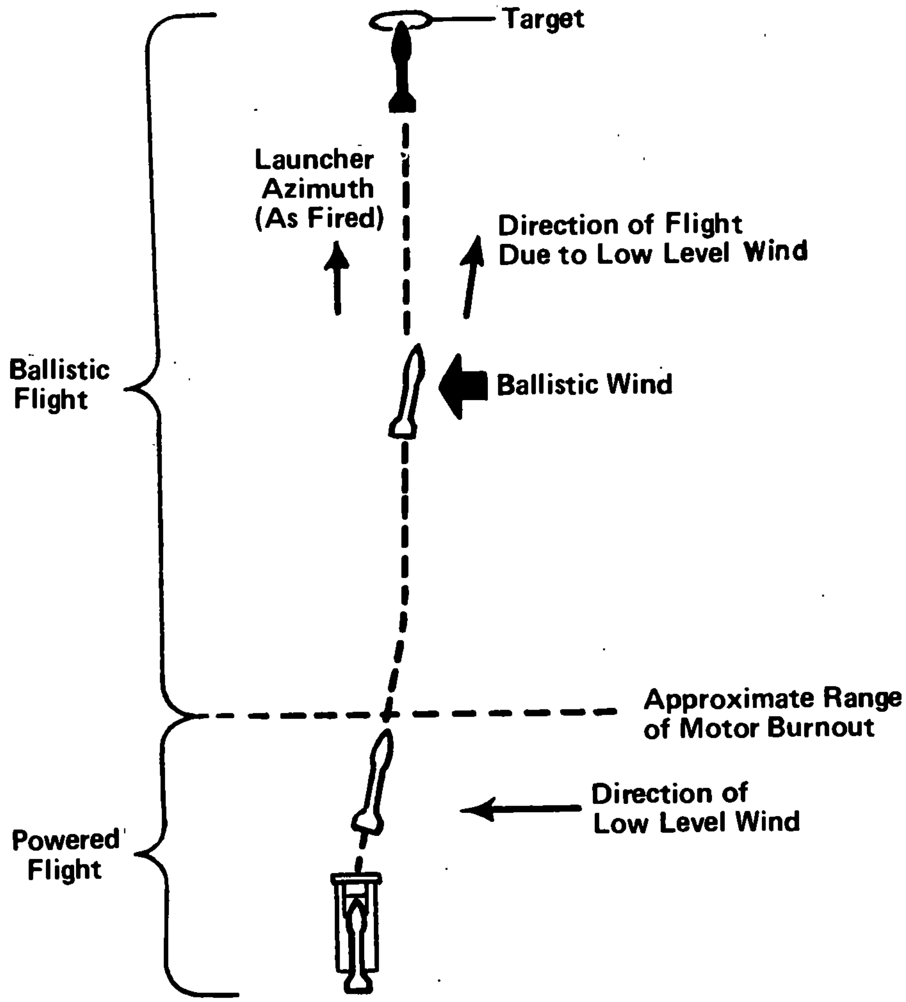


Figure 1-1. Low-level and ballistic wind effects.

ard met message, which was used prior to the advent of the NATO ballistic met message. Therefore, when these tables are used with a ballistic met message, data from the message must be converted as shown in (*a*) through (*c*) below before meteorological corrections can be determined. (Only one line of the met message is used in manual computations and, therefore, only one line must be converted.)

(*a*) Convert the ballistic wind speed from knots to miles per hour.

(*b*) Convert the air temperature from percent of standard at the MDP (meteorological datum plane) to degrees Fahrenheit.

(*c*) If the surface pressure is obtained from the heading of the message, convert the surface pressure from percent of standard at the MDP to millibars and correct for the difference in altitude between the MDP and the firing point. (Normally, the surface pressure is measured with a barometer at the firing point and the reading is therefore already in millibars.)

(4) The MGR-1B firing tables were designed for use with the ballistic met message; therefore, the only conversion of data required is the conversion of surface air pressure from millibars to percent of standard when the surface air pressure is measured with a barometer at the firing site.

(5) Corrections for meteorological conditions are based on deviations from ICAO standard atmosphere which exist at the time of firing, as denoted on DA Form 3675 for the ballistic met message for manual computations and on DA Form 3677 for the computer met message for FADAC computations. (For additional information on met messages, see section 1 chapter 21, FM 6-40.)

b. Rotation of Earth. Corrections to compensate for the rotation of the earth must be applied to azimuth, elevation, and time of flight. A full explanation is given in chapter 2, FM 6-40.

c. Rocket Empty Weight. The rocket empty weight is defined as the in-flight weight of the rocket at the point on the trajectory at which propellant burnout occurs. The standard empty weight of the rocket (motor assembly and warhead section) is given in paragraph 4 of the introduction to the applicable firing tables. If the rocket empty weight is less (more) than standard, the rocket motor thrust will propel the rocket to a greater (lesser) range than the firing table range. Corrections for empty weight variations are applied to elevation and time of flight in the appropriate direction.

d. Ballistic Wind Velocity and Direction. After motor burnout, the rocket assumes a ballistic trajectory similar to that of a cannon projectile. The rocket will remain alined into the wind; however, since no thrust is being applied, it will move with the wind in the same manner as the cannon projectile. Therefore, corrections based on upper ballistic wind velocity and direction must be applied to the firing azimuth in the opposite direction to the wind to compensate for the upper ballistic wind effects during free flight.

1-8. Noncorrectable Variables

Noncorrectable variables are those which cannot be accurately predicted or measured by use of present procedures and techniques.

a. Launcher Alinement Limitations. The launcher rail provides the only means of guidance for the Honest John rocket. The using unit can measure the horizontal and vertical deviations of the launching beam to determine serviceability; however, the unit has no means of correcting an alinement error if one exists.

b. Thrust Malalinement. Spin is imparted to the rocket by the spin rockets to reduce the effects of thrust malalinement caused by manufacturing imperfections, uneven burning, and other factors that cause variations in thrust. The spin imparted to the rocket is maintained by a canted fin assembly during the flight.

c. Cracking or Flowing of Propellant. Storing a rocket at temperatures above the maximum limit or below the minimum limit may cause the propellant to crack or flow. Dropping the rocket motor or subjecting it to any shock may cause the propellant to crack. Either cracking or flowing of the propellant will cause unpredictable thrust variations. If the rocket motor is exposed to ambient temperatures in excess of storage limits stenciled on the motor or is damaged by rough handling, return the motor to the support unit for disposition.

d. Aerodynamic Malalinements. The rocket must be handled in a manner that will insure retention of proper aerodynamic characteristics. The rocket motor and warhead section must not be dented, scratched, or otherwise damaged. Screwheads must be flush with the skin surface. The rocket should not be painted unless it is absolutely necessary for maintenance purposes. If painting becomes necessary, return the motor to the support unit for disposition since complete painting of rocket motors is performed at depot. Painting of rocket components by organizational personnel is limited to spot painting. Damage criteria and spot painting instructions are contained in TM 9-1340-202-12.

e. Variations in Specific Impulse. Lot-to-lot variations in the propellant grains and variations in propellant temperature cause variations in the specific impulse delivered by the rocket motor. Lot-to-lot variations cannot be corrected for but variations due to changes in propellant temperature can be minimized if the rocket motor is properly temperature conditioned prior to firing.

CHAPTER 2

FIRE DIRECTION, GENERAL

Section I. FIRE DIRECTION ORGANIZATION

2-1. General

The battalion fire direction center (FDC) consists of the fire direction and communications personnel necessary to insure efficient fire direction. These personnel are responsible for the computation of the gunnery problem and transmission of fire commands to the firing battery (or section) when the battery is operating under the control of the battalion. If the firing battery (or section) is operating independently (decentralized), the battalion FDC will monitor fire missions from the division or corps fire support element (FSE) and will provide a computation check.

2-2. Personnel

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

(1) S3.

(2) Assistant S3.

(3) Operations sergeant.

(4) Chief fire direction computer.

(5) Fire direction computers.

(6) Radiotelephone operators.

(7) Switchboard operator (nondivisional battalion).

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

(1) Battery executive officer.

(2) Chief fire direction computer.

(3) Assistant chief fire direction computer.

(4) Fire direction computers.

(5) Radiotelephone operators.

2-3. Duties of Fire Direction Personnel

Duties pertaining to fire direction are identical for personnel of the battery and battalion fire direction centers. Personnel are assigned specific duties, which they perform in a prescribed sequence and manner in order to eliminate confusion and to facilitate speed and accuracy. The following prescribed duties are based on a battalion organization; however, personnel in divisional batteries perform essentially the same duties as those performed by their counterparts of battalion level:

a. S3. The S3 is responsible for the supervision and operation of the fire direction center and the fire direction team. His duties include—

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

(2) Selecting the battery (launcher(s)) to fire.

(3) Designating the firing positions for a fire mission if not designated by higher headquarters.

(4) Issuing fire orders.

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

(6) Determining final minimum quadrant elevation.

b. Assistant S3. In the absence of the S3, the assistant S3 assumes the responsibility for the duties listed in *a* above. He is primarily responsible, however, for the processing of fire missions.

c. Operations Sergeant. The operations sergeant is the principal enlisted assistant to the S3. His duties include—

(1) Maintaining the situation and operation maps.

(2) Preparing records and reports.

(3) Such other duties as may be assigned by the S3 or assistant S3.

d. Chief Fire Direction Computer. The chief fire direction computer supervises the processing of fire missions. His duties include—

(1) Verifying the computations made by computers.

(2) Distributing met data.

(3) Maintaining firing charts.

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

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

(6) Acting as operations sergeant in the latter's absence.

e. Fire Direction Computers. The fire direction computers convert calls for fire and fire orders into fire commands for individual launchers. FADAC is the primary means of determining firing data; firing data may also be computed manually. Duties of the computers include—

(1) Recording the call for fire.

(2) Recording the fire order.

(3) Recording met messages.

(4) Recording the location of the firing position.

(5) Recording the firing platoon (section) commander's report.

(6) Computing the vertical interval, azimuth, and range from the firing position to the target.

(7) Computing initial laying data.

(8) Computing corrections for nonstandard conditions and announcing data to the firing section personnel.

(9) Obtaining and recording low-level wind data.

(10) Computing low-level wind corrections (unless they are computed at the firing section).

(11) Recording the time the mission was fired.

(12) Making appropriate entries on the ammunition report for expended rounds.

(13) Recording surveillance information as it is received.

f. Radiotelephone Operators. The radiotelephone operators must be trained in FDC communications procedures. Specific duties of the radiotelephone operators include—

(1) Operating radio(s) or telephone(s) in the fire direction center.

(2) Transmitting warning orders and firing data to the battery (section) designated in the fire order.

(3) Reporting data received from the firing section and completion of the mission.

(4) Making communications checks as directed.

(5) Apply communications security (COMSEC) in operating his radio(s) or telephone(s).

g. Switchboard Operator. The switchboard operator must also be trained in FDC communications. His duties include—

(1) Installing and operating the FDC switchboard.

(2) Assisting in the installation of radio/wire integration and local FDC circuits.

(3) Performing the necessary communications checks to insure that the FDC circuits operate properly.

(4) Be familiar with communications security (COMSEC) procedures pertaining to wire communications security.

Section II. FIRE DIRECTION PROCEDURES

2-4. General

a. Definition. 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.

b. Principles. The methods employed in fire direction must insure—

(1) Continuous, accurate, and timely fire support under all conditions of weather, visibility, and terrain.

(2) Flexibility sufficient to engage all types of targets over a wide area.

(3) Prompt massing of fires of all available units in any area within range.

(4) Prompt distribution of fires simultaneously on numerous targets within range.

2-5. Call for Fire

The fire support element of the higher headquarters exercising tactical control over the fires of the Honest John unit will order the mission to be fired. The call for fire will include applicable elements as follows:

Element	*Example*
a. Identification	THIS IS FIREPOWER 3
b. Warning	FIRE MISSION
c. Unit to fire	LONG SHOT
d. Launcher(s) to fire	ONE LAUNCHER
e. Firing position number	FIRING POSITION NUMBER 1
f. Target number	NA2129
g. Target grid	NP2526141419
h. Target altitude	400 METERS
i. Type rocket	MGR-1B
j. Warhead	M144
k. Fuze/height of burst *	AIR/HIGH
l. Total number of rockets	ONE ROCKET
m. Time on target	TIME ON TARGET 0530
n. Time on target, no later than	TIME ON TARGET NO LATER THAN 0550
o. Remarks	

*See FM 6-40-1A.

2-6. Fire Order

a. Fire Order. The fire order consists of some or all of the following elements and is announced in the sequence indicated:

Element	*Example*
(1) Unit to fire	LONG SHOT BRAVO
(2) Launcher number	LAUNCHER NUMBER 4
(3) Firing position number	FIRING POSITION NUMBER 1
(4) Target number	NA2129

b. Launcher to Fire and Firing Position. Selection of the launcher(s) to fire and firing position(s) is based on the following considerations:

(1) State of readiness.

(2) Time available.

(3) Location of launchers.

(4) Location of the target.

(5) Previous commitments.

(6) Availability of ammunition.

2-7. Sequence of Commands

Fire commands originate in the FDC and include all data necessary for positioning, laying (pointing in a known direction), and firing the rocket. Low-level wind corrections are applied by firing section personnel just prior to firing. These corrections may be determined at either the FDC or the firing position. Fire commands are normally sent to the firing section in four phases as shown in *a* through *e* below.

a. Warning Order. The first phase, the warning order to the firing section personnel, includes the following elements:

Element	*Example*
(1) Launcher to fire	LAUNCHER NUMBER 4
(2) Firing position	FIRING POSITION NUMBER 1
(3) Type rocket	MGR-1B
(4) Type warhead	M144
(5) Fuze option *	AIR
(6) Height of burst option *	HIGH
(7 Method of fire	ONE ROUND, AT MY COMMAND
(8) Time of fire	TIME ON TARGET 0530

*See FM 6-40-1A.

b. Initial Laying Data. The second phase, initial laying data, includes the following elements:

Element	*Example*
(1) Azimuth of the orienting line	AZIMUTH OF ORIENTING LINE 1020
(2) Azimuth of fire	AZIMUTH OF FIRE 4625
(3) Orienting angle	ORIENTING ANGLE 2795
(4) Trial quadrant elevation	QUADRANT 688

c. Corrected Firing Data. The third phase, firing data corrected for nonstandard ammunition and weather (met) conditions, includes the following elements:

Element	*Example*
(1) Corrected deflection	DEFLECTION 1451

Element	*Example*
(2) Fuze setting	TIME 84.1
(3) Corrected quadrant elevation	QUADRANT 662.2

d. Low-Level Wind Corrections. The fourth phase, low-level wind corrections are applied just prior to firing. Elements of these corrections and data fired are as follows:

Element	*Correction*	*Example*
(1) Deflection fired	L24	DEFLECTION 1475
(2) Quadrant elevation fired	+14.4	QUADRANT 676.6

2-8. Firing Data

a. The computation of firing data for Honest John rockets consists of determining an accurate firing azimuth (deflection), time of flight (fuze setting), and quadrant elevation, without the benefit of registration or adjustment. This is a predicted fire technique in which corrections for all measurable variations from established standard conditions are computed and applied to trial data.

b. The sample missions in chapter 3 illustrate the detailed computational procedures. The starting point in the determination of firing data is the computation of the bearing angle and the resultant azimuth of fire, the launcher-target range, and the height of target or burst with respect to the launcher, based on the locations of the launcher and the selected target or burst point. Once these data have been determined, the initial laying data to include trial quadrant elevation and trial time of flight are computed. These data would cause a burst to occur at the desired point if all conditions equaled the standards defined in the appropriate firing tables. Corrections to deflection, time of flight, and quadrant elevation are computed and applied for nonstandard ammunition and weather conditions, for the effects of the earth's rotation, and for drift (MGR-1B only). In addition, a correction to time of flight to obtain fuze setting is required with selected fuzes. Corrections for the effects of low-level winds are determined and applied to the corrected deflection and quadrant elevation as close to the time of fire as possible. The unit FDC is responsible for the determination of all data; however, the low-level wind corrections may be determined by the firing section personnel.

c. The computations involved are similar to those used in other field artillery predicted fire techniques. A principal difference is that site is not used in the rocket gunnery problem. The firing tables are arranged in a two-dimensional format and provide directly for horizontal range and height combinations. The quadrant elevation is the angle of elevation obtained by entering the tables with range and height with respect to the launcher. Also, in the rocket firing tables, the unit corrections for variations from standard conditions are described in mils and seconds rather than in meters.

d. The unit corrections for variations from standard conditions which are contained in Honest John firing tables are displayed for all instances where a correction for a nonstandard condition may be made. However, there are cases in which blank spaces appear in the unit correction factor columns. In these cases, the rocket should not be fired because it would not be possible to predict behavior. Should the commander desire to fire under these conditions, the unit correction factor should be taken from the last listed figure in the same column, if the column contains any entries at all, or from a previous listed range, if the column is totally blank. In no case should the rocket be fired without any correction for that particular nonstandard condition, since this would result in more error than using the last listed value.

e. Computing fuze settings in the FDC consists of finding the trial time of flight, correcting it for nonstandard conditions, and applying any fuze correction from the firing table. For the M421 fuze, this value then becomes the fuze setting placed on the fuze for the following warheads: M38, M144, M186, and M190. However, for the M6 warhead which uses the M411 fuze, an additional fuze correction is found packed with each individual fuze. This value is algebraically added to the fuze setting computed in the FDC and the result is then the fuze setting placed on the fuze.

CHAPTER 3

MANUAL COMPUTATIONS

Section I. COMPUTER'S RECORD AND WEIGHTS

3-1. Computer's Record Data Correction Sheet (Free Rocket) (DA Form 6-56)

a. The computer's record data correction sheets assist the fire direction computer in computing and recording firing data. DA Form 6-56 (fig 3-1①, 3-1②, 3-4①, 3-4②, 3-8①, and 3-8②) is designed to be used with the ballistic met message and all Honest John firing tables. The ballistic met message must be converted to the US format for use with MGR-1A firing tables.

b. The procedure for using the computer's record is as follows:

(1) Record the call for fire from higher headquarters.

(2) Record the fire order.

(3) Prepare the warning order and transmit it to the proper firing section(s).

(4) Obtain the position data from records in the FDC.

(5) Compute the initial laying data.

(6) Transmit the initial laying data to the firing section.

(7) Compute corrected data (determine met corrections and corrections for nonstandard ammunition effects).

(8) Transmit the corrected data to the firing section.

(9) Compute low-level wind corrections (if they are not computed by the firing section).

(10) Transmit the final firing data, including low-level wind corrections (unless low-level wind corrections are computed by the firing section), to the firing section.

(11) Record the fired data and the time the mission was fired.

3-2. Meteorological Data

Among conditions that affect a rocket is the state of the atmosphere through which it passes. The atmospheric (met) effects that must be considered in the computation of corrections are wind, temperature, density, and surface pressure. Basically, the method of computing met corrections for cannon artillery is applicable to rocket artillery. However, in rocket artillery gunnery, corrections are computed for and applied to quadrant elevation and time of flight rather than range. Since range, direction of fire, propellant weight and temperature, rocket empty weight, and other ballistic conditions vary from round to round, separate corrections must be computed for each rocket to be fired.

3-3. Computation of Weights

a. The weight of the MGR-1A and MGR-1B rockets may vary as much as 200 pounds, depending on the variations in weight of the individual components (motor assembly, warhead, propellant, and fins). This deviation may be from any one of four standard Honest John computed empty weights: the M3-series motor assembly with the heavy warhead (3,850 pounds), the M3-series motor assembly with the light warhead (3,520 pounds), the M66-series motor assembly with the heavy warhead (3,020 pounds), and the M66-series motor assembly with the light warhead (2,630 pounds). The M27, M47, and M48 nuclear warheads and the M190 chemical warhead are light warheads. The M6A1, M144, and M186 high-explosive warheads and the M38 flash-smoke warhead are heavy warheads. Several weights must be considered when computing the empty weight of the rocket.

(1) The motor assembly stenciled empty weight.

(2) The motor assembly stenciled gross weight.

(3) The stenciled propellant weight (MGR-1A only).

(4) The stenciled propellant weight differential (MGR-1B only).

(5) The stenciled warhead weight.

(6) The fin weight (not stenciled on the fins).

b. The computed empty weight used in FDC computations is the weight of the rocket at burnout and is the as-fired weight minus those components consumed during burning (for example, propellant, spin rocket propellant, and wiring). The computed empty weight for the MGR-1A rocket is the sum of the warhead weight, the stenciled empty weight, and the fin weight. The computed empty weight for the MGR-1B rocket is the sum of the warhead weight and the stenciled empty weight. (The MGR-1B rocket stenciled empty weight includes the weight of the fins). The stenciled weights appearing on rocket components are to be used in all empty weight computations. No additional weights are added for other components (for example, rear shoe adapters, closure plug, igniter, and fuzes). For propellant weight computations, an additional factor for motor age must be added to the stenciled propellant weight differential when the MGR-1B rocket is fired with a light warhead.

c. Certain M3-series rocket motor assemblies have been purposely stenciled in error (RAD lots 1-23, 1-24, and 1-28 through 1-38). The propellant weights stenciled on these rocket motors are to be used by the unit to compensate for a low-impulse propellant. To deviate from the motor stenciled propellant weights is not permissible.

d. There are two types of fins in use with the MGR-1A rocket. The weight for the appropriate fins must be allowed in all computations—166 pounds for the set of four M136A2 fins and 172 pounds for the set of four M136A2B1 fins. Weight used in FDC computations for firing the MGR-1A rocket may be obtained in one of two ways, depending on what weights are stenciled on the rocket. The procedure is as follows:

(1) If the empty weight of the motor is given, add to it the weight of the warhead section and the weight of the fins to obtain the total empty weight.

Example:

Motor empty weight	2,025
Plus warhead section weight	+1,634
Plus fin weight (M136A2B1)	+ 172
Equals total empty weight	=3,831

Data to be used in computations:

Empty weight	3,831
Propellant weight (as stenciled)	2,051

(2) If the motor empty weight is not given, add the spin rocket propellant weight to the propellant weight and subtract the sum from the gross motor weight. This is the equivalent of the stenciled motor empty weight. Then add the warhead section weight and fin weight to obtain the empty weight.

Example:

Propellant weight	2,049
Plus spin rocket propellant weight	+ 13.7
Sum of propellant weight and spin rocket propellant weight	=2,062.7
Gross motor weight	4,100
Minus sum of propellant weight and spin rocket propellant weight	−2,062.7
Equals empty motor weight	=2,037.3
Plus warhead section weight	+1,240
Plus fin weight (M136A2)	+ 166
Equals total empty weight	=3,443.3

Data to be used in computations:

Empty weight	3,443
Propellant weight (as stenciled)	2,049

Note: For all MGR-1A weight calculations, the weight difference between rear shoe adapters and rear shoe plates may be ignored.

e. Two weights are stenciled on the M66-series motor assembly of the MGR-1B rocket: the empty weight and the propellant weight differential. The stenciled empty weight is used unaltered in determining the computed empty weight. This stenciled empty weight includes the weight of the fins.

(1) When a heavy warhead is fired, the propellant weight differential is used unaltered.

Example (heavy warhead):

Motor empty weight	1,380
Plus warhead weight	+1,630
Equals computed empty weight	=3,010

Data to be used in computations:

Computed empty weight	3,010
Propellant weight differential (as stenciled)	−5.6

(2) When a light warhead is fired with the MGR-1B rocket, an additional propellant correction factor must be added to compensate for the age of the M66-series motors. The additional correction factor is determined from a

special table included in change 1 to the light warhead firing tables (FTR's 762-G-1, 762-I-1, and 762-K-1).

Example (light warhead):

Motor empty weight	1,380
Plus warhead weight	+1,235
Equals computed empty weight	=2,615
Propellant weight differential (as stenciled)	−5.6
Date motor loaded	May 1963
Date fired	June 1966
Age of motor	37 months
Additional correction from change 1 of the FTR	−22.3
Total propellant weight correction	−27.9

Data to be used in computations:

Computed empty weight	2,615
Total propellant weight correction	−27.9

Section II. SAMPLE MISSIONS—NORMAL CONDITIONS

3-4. Computation of Firing Data

In determining the procedure to be followed for computing firing data for the Honest John rocket, several factors must be considered. *For example:* The requirements of the mission dictate what type of warhead will be fired; the type of warhead determines the firing table to be used; the ambient temperature determines the method to be used to obtain unit corrections for nonstandard propellant temperature; and the conditions (NIGHTTIME or ALL OTHER THAN NIGHTTIME) existing at the time the round is to be fired determine which wind table will be used to determine corrections for low-level winds.

3-5. Sample Mission 1: MGR-1B Rocket With M38 Warhead

In this sample mission an MGR-1B rocket with M38 flash-smoke warhead is to be fired from an M386 launcher. This combination requires the use of FTR 762-H-1 for manual firing data computations. The propellant temperature is in the range 20° F to 77° F, the low-level wind is measured with an AN/PMQ-6 windset, the conditions are NIGHTTIME, and the surface pressure is measured with a barometer at the firing site.

a. The following call for fire is received at the FDC:

THIS IS FIREPOWER 3
FIRE MISSION
LONG SHOT
ONE LAUNCHER
TARGET NUMBER NA2122
TARGET GRID NP2337035505
TARGET ALTITUDE 357
ROCKET MGR-1B
WARHEAD M38
FUZE TIME/HEIGHT OF BURST +200
ONE ROCKET
TIME ON TARGET 0530

b. The S3 issues the following fire order:

LONG SHOT ALFA
LAUNCHER NUMBER 2
FIRING POSITION NUMBER 2
TARGET NUMBER NA2122

c. The following warning order, based on the call for fire and the S3's fire order, is sent to the firing section:

LAUNCHER NUMBER 2
FIRING POSITION NUMBER 2
ROCKET MGR-1B
WARHEAD M38
FUZE TIME
ONE ROUND, AT MY COMMAND
TIME ON TARGET 0530

d. All known values are entered on the Computer's Record Data Correction Sheet, DA Form 6-56, (fig 3-1① and ②).

(1) Target coordinates NP2337035505.

(2) Target altitude 357 meters.

(3) Height of burst relative to target +200 meters.

(4) Launcher coordinates NP4841035893.

(5) Launcher altitude 446 meters.

(6) Azimuth of orienting line 285 mils.

(7) Empty weight 3,010 pounds.

(8) Propellant weight correction +1.0 pound.

(9) Propellant temperature 49° F.

(10) Latitude of launcher 34° N.

(11) Surface air pressure (barometer) 965 millibars.

(12) Launcher aiming point deflection 1,443 mils.

COMPUTER'S RECORD DATA CORRECTION SHEET (FREE ROCKET)

For use of this form, see FM 6-40-1; the proponent agency is U.S. Continental Army Command.

UNIT	Lchr Lat (N)	Time and Date Fired	Min QE	FPC / FDC	Tgt Nr / Rkt Mtr SN
3/2	34 °S	0530 28 AUG 70		FPC 185 mils; FDC 242 mils	Tgt Nr NA 2122; Rkt Mtr SN 3130

FIRE MISSION

FIREPOWER 3, FM,
Unit to Fire 3/2, Lchr (e) to Fire 1,
FP Nr ____, Tgt Nr NA 2122,
Tgt Grid NP 23370 35505,
Tgt Alt 357 m, Type Rkt MGR-1B,
Whd M 38, Fz/HOB TI/+200,
Total Nr Rkts 1,
TOT 0530, TOT NLT ____,
Remarks ____

FIRE ORDER

Unit to Fire A/3/2, Lchr Nr 2,
FP Nr 2, Tgt Nr NA 2122.

WARNING ORDER

Lchr Nr ____, FP Nr ____,
Tgt Nr ____, Type Rkt ____,
Whd ____, Fz/HOB ____,
TOT ____, Pred. TOF ____,
Tgt Az ____,
Nr Rkts per Lchr ____.

SEE DA FORM 2257-R

COMPUTATION OF RANGE AND BEARING

Tgt Coord	23370	35505
Lchr Coord	48410	35893
	dE -25040	dN -388

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

BEARING

Log dE	4.398634
Log dN	− 2.588832
Log Tan Bearing	1.809802
Bearing	1584.2 mils

AZIMUTH

0 / 3200 / 6400	3200 mils
Bearing	(+) 1584 mils
Az of Fire	4784 mils

RANGE

dE Greater than dN

Log dE	4.398634
Log Sin B	− 9.999948
Log Rg	4.398686
Range	25,043 m

dN Greater than dE

Log dN	
Log Cos B	−
Log Rg	
Range	m

Computation ** Range (10m) 25,040 m

HOB REL TO LCHR

Tgt Alt	357 m
HOB rel to Tgt **	+ 200 m
Alt of Burst	= 557 m
Alt of Lchr	− 446 m
HOB rel to Lchr	= +111 m
HOB rel to Lchr (10m)	+110 m

ADDENDUM COMPUTATIONS

Alt Tgt	m	H_B	m	R_B(Trial)	m
Alt Lchr	− m	H_T (1m)	− m	Met Corr to R_B	± m
Ht of Tgt rel Lchr—H_T (1 m)	= m	HOB above Tgt	= m	R_B(Corr) (1m)	= m
(10 m)	= m			(10 m)	= m

Line Nr	Wind Az	Wind Vel	Temperature	Density

Alt Tgt	m
Alt MDP	− m
Alt Diff	m

Density Correction ____
Corrected Value ____

Wind Az (100 mils)	mils
+6400 (if nec)	+ mils
Sum	= mils
Az of Fire (100 mils)	− mils
Chart Dir of Wind	= mils

CROSS WIND L/R ____ X ____ = L/R ____ X ____ = L/R ____ mils
Comp Vel Unit Corr Df Corr

Computations :

RANGE WIND H/T ____ X ____ = H/T ____ Knots
Comp Vel

BALLISTIC FACTORS	Std	Known	Variation from Std	Unit Corr	Rg Corr +/−
Density	100%		D I		
Range Wind	0 Kn		H T		
Met Corr to R_B (Trial)					±

**See FM 6-40-1A

DA FORM 6-56 1 FEB 69 — REPLACES EDITION OF 1 JUL 61, AND DA FORM 2256-1-R, 1 JAN 62, WHICH ARE OBSOLETE.

Figure 3-1①. Computer's record data correction sheet (Free Rocket), DA Form 6-56 (front) (sample mission 1).

Firing Table Entry Range (10 m) Comp Range or R_B (Corr) 25,040 m	Firing Table Entry Height of Burst (10 m) HOB rel to Lchr or H_B +110 m
Alt of Lchr 446 m · Az of Fire 4784 mil	Latitude of Lchr (10°) 30 (N)/S · Df Corr L (Adden) R ___ mil

Initial Laying Data*	
*Az of OL	285 mil
+6400 (if nec)	+6400 mil
Sum	= 6685 mil
*Az of Fire	−4784 mil
Difference	= 1901 mil
−3200 (if nec)	− mil
*Orienting Angle	= 1901 mil
*QE (Trial) (1 mil)	468 mil

Computations (QE (Trial), TF (Trial), and Surface Pressure):

QE

466.7 + (10/100)(3.6) = 466.70+0.36= 467.06

467.06 + (40/100)(3.2) = 467.06+ 1.28 = 468.34 = 468.3

TF

56.45 + (10/100)(-0.04) = 56.450-0.004=56.446

56.446+ (40/100)(0.38) = 56.446+0.152=56.598 =56.60

Surface Pressure = 965 mb = 95.2 %

Alt Lchr (10m)	450 m
Alt MDP (10m)	− 360 m
Lchr (above)/below MDP	+ 90 m
Az of Wind (100 mil)	3800 mil
+6400 (if nec)	+ 6400 mil
Sum	= 10200 mil
Az of Fire (100 mil)	− 4800 mil
Chart Dir of Wind	= 5400 mil

Met Station			Use	Type	Oct	Latitude			Longitude		
M	E	T	B	3	1	3	4	4	9	8	2
Day		B. Time		E. Time		Altitude MDP			Sur. Press. (MDP)		
2	8	1	0	0	0	0	3	6	9	6	3
Line Nr		Wind Az		Wind Vel		Temperature			Density		
0	7	3	8	0	3	0	3	5	9	4	1
Density-Temperature Corr						−	0	2	−	0	9
Corrected Values					1	0	3	3	9	3	2

CROSS WIND (L)/R .83 x 03 = (L)/R 2 x .52 = (L)/R 1 mil (Comp · Vel · Unit Corr)

RANGE WIND (H)/T .56 x 03 = (H)/T 2 Kn/mph (Comp · Vel)

BALLISTIC FACTORS	Std	Known	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant Temperature	77°F	___° Decrease 49	8.12		+0.29	(D)I 28	+.019	0.532	
Propellant Weight	lb	+1.0		0.58	−0.58	D(I) 1.0	−.044		0.044
Surface Pressure	100% / 1013 mb	95.2		2.50	−0.52	(D)I 4.8	−.039		0.187
Density	100%	93.2		30.12	−4.43	(D)I 6.8	−.433		2.944
Air Temperature	100% / 59°F	103.3	4.32		+1.31	D(I) 3.3	+.097	0.320	
Empty Weight	3020 lb	3010		1.60	−0.16	(D)I 10	−.009		0.090
Range Wind	0 Kn / 0 mph	H2	1.08		+0.54	(H)T 2	+.063	0.126	
			13.52	34.80	Met Corr to QE & TF			0.978	3.265
				13.52					0.978
				21.28					2.287

DEFLECTION	L	R	QUAD ELEV +	QUAD ELEV −		FUZE SETTING +	FUZE SETTING −
Df Corr (Adden)							
Cross Wind Corr	1						
Rotation Corr	2						
Drift Corr		6		21.3	Met Correction		2.29
	3	6	2.6		Rotation Correction		0.00
		3					
Total Df Corr		3		18.7	Total QE & TF Correction		2.29

LLW CORR — CROSS (Df) L/(R) 9 x 4.1 = L/(R) 37 (Vel · Unit Corr · LLW) — RANGE (QE) (H)/T − 6 x 1.53 = (+) − 9.2 (Vel · Unit Corr · LLW)

Aiming Point Df	1443	QE (Trial) (0.1 mil)	468.3	TF (Trial) (0.01)	56.60
Df Correction	L(R) 3	QE Correction	± 18.7	TF Correction	± 2.29
Df (Corrected)	1440	QE (Corrected)	449.6	TF (Corrected (.1))	54.3
Low Level Wind	L(R) 37	Low Level Wind	(+) 9.2	Fuze Corr	(+) 0.2
Df FIRED	1403	QE FIRED	458.8	FS FIRED	54.5

Figure 3-1②. Computer's record data correction sheet (Free Rocket), DA Form 6-56 (reverse) (sample mission 1).

e. The FDC receives the following ballistic met message:

METB31	344982
281000	036963
002804	987976
013809	999964
024512	019951
034614	028942
044508	034941
054803	034940
064001	034939
073803	035941
084006	039939
094307	037943
140707	037949

f. Initial data to lay the launcher are computed and recorded on the computer's record data correction sheet.

(1) *Bearing.* In the COMPUTATION OF RANGE AND BEARING block, enter the coordinates of the launcher and target. In this example, since the easting and northing coordinates of the launcher are larger than those of the target, it is easily determined that the launcher is northeast of the target and that the direction of fire will be southwest. For convenience in remembering the direction of fire, draw an arrow in the third quadrant of the "Bearing" block in the upper right-hand corner of the form. (This corresponds to a −dE and −dN.) Obtain the logarithmic values of dE and dN from the logarithmic tables (TM 6-230). Enter the values in the BEARING block and determine the difference. This difference is the log tangent of the bearing, and the antilog of the difference is the bearing (1,584.2mils).

(2) *Azimuth of fire.* Enter the bearing obtained ((1) above) to the nearest mil (1,584 mils) in the appropriate space in the AZIMUTH block at the right-hand side of DA Form 6-56. Since the bearing is in the third quadrant, add 3,200 mils to the bearing to obtain the azimuth of fire (4,784 mils).

(3) *Launcher-target range.* First, determine which is the greater, dE or dN, and enter the values obtained from the log table on the appropriate lines of the RANGE block. Compute the range (25,043 meters) and enter this value to the nearest 10 meters (25,040 meters) in the Computation Range space.

(4) *Height of burst relative to launcher.* In the HOB REL TO LCHR block, enter the target altitude (357 meters) and the HOB relative to the target (200 meters). This information is obtained from the FIRE MISSION block. Add these two values to obtain the altitude of the burst (557 meters); subtract the altitude of the launcher (446 meters) to obtain the height of burst relative to the launcher (+111 meters). Record this value to the nearest 10 meters (+110 meters) in the space provided.

(5) *Second trajectory (ADDENDUM) computations.* This sample mission does not include second trajectory computations; therefore, all subsequent computations are made on the reverse side of DA Form 6-56. At the top of the form, enter the following values that were computed on the front side of the form:

Firing table entry range (computation range)	25,040 meters
Firing table entry height of burst	+110 meters
Altitude of launcher	446 meters
Azimuth of fire	4,784 mils
Latitude of launcher (nearest 10°)	30° N

(6) In the INITIAL LAYING DATA block, enter the azimuth of the orienting line (285 mils), add 6,400 mils, subtract the azimuth of fire (4,784 mils), and obtain the value of the orienting angle (1,901 mils).

Note: The blank space on the reverse side of DA Form 6-56 may be used for computing the trial QE, trial TF, and surface pressure (*g*, *h*, and *j* below).

g. The trial QE is determined by entering table G of FTR 762-H-1 with the range to the nearest 200 meters and obtaining the elevation from column E2 corresponding to the firing table entry height of burst (HOB relative to the launcher) in column E1.

Note: Since some free rocket firing tables list entry ranges in 200-meter intervals, it may be necessary in some cases to examine the exact computed launcher-target range (before expression) to determine the proper entry range. For conformity in entering the firing tables, the following example is furnished as a guide: For launcher-target ranges of 24,900 to 25,099 meters inclusive, the entry range is 25,000 meters; for launcher-target ranges of 25,100 to 25,299 meters inclusive, the entry range is 25,200 meters.

(1) In this example, to obtain the elevation (colm E2) corresponding to the launcher-target range of 25,040 meters, enter table G at range 25,000 meters and HOB +100 meters (colm E1). The elevation for an HOB of +100 meters is 466.7 mils. To find the elevation for an HOB of +110 meters, interpolate between +100 meters and +200 meters as follows:

	HOB			EL	
100	200			470.3	3.6
	110	10	X	?	
	100			466.7	

$$\frac{10}{100} = \frac{X}{3.6} \text{ or } X = 3.6\left(\frac{10}{100}\right) = +0.36$$

Therefore, the elevation corresponding to HOB +110 meters and range 25,000 meters = 466.70 + 0.36 = 467.06 mils.

Note: Interpolation begins at the elevation corresponding to the lower listed value for HOB relative to the launcher. For conformity in entering the firing tables, the following example is furnished as a guide: For HOB's relative to the launcher of +100 meters to +199 meters inclusive, interpolation will begin at the elevation corresponding to HOB +100; for HOB's relative to the launcher of +200 meters to +299 meters inclusive, interpolation will begin at the elevation corresponding to HOB +200.

(2) Since the elevation was obtained at an entry range of 25,000 meters, an elevation change must be computed for the additional 40 meters of range beyond 25,000 meters. This is accomplished by use of the c factor in column E3 of table G. Enter the table at the nearest 100-meter HOB (+100) and obtain the corresponding c factor (+3.2). This factor represents the number of mils in elevation necessary to change the range 100 meters. Compute elevation change corresponding to the additional 40 meters in range as follows: 40/100 × 3.2 = 1.28 mils. Add this value to the elevation already computed for range 25,000 meters and HOB +110 meters (467.06) and obtain the trial QE of 468.3 mils (467.06 + 1.28 = 468.34 or 468.3 mils). Enter this value to the nearest mil in the QE (Trial) space of the Initial Laying Data block and to the nearest tenth mil in the QE (Trial) space at the bottom center of the form.

Note: In some cases it may be necessary to examine the exact computed HOB relative to the launcher (before expression) to determine the proper entry HOB for obtaining the c factor. For conformity in entering the firing tables, the following example is furnished as a guide: For HOB's relative to the launcher of +50 meters to +149 meters inclusive, the c factor is the listed value corresponding to HOB +100; for HOB's relative to the launcher of +150 meters to +249 meters inclusive, the c factor is the listed value corresponding to HOB +200.

(3) Transmit the initial laying data to the firing section:

(*a*) Azimuth of the orienting line	285 mils
(*b*) Azimuth of fire	4,784 mils
(*c*) Orienting angle	1,901 mils
(*d*) Trial QE	468 mils

Note: Each element of the initial laying data is transmitted to the firing section as soon as it is obtained to preclude any delay at the firing section.

h. The trial time of flight (TF) is determined in the same manner as the trial QE.

(1) Enter table H of the firing table with the same range (25,000) and HOB (+100). Determine the time of flight corresponding to range 25,000 meters and HOB +110 meters by interpolation as follows:

	HOB			TF	
100	200			56.41	−0.04
	110	10	X	?	
	100			56.45	

$$\frac{10}{100} = \frac{X}{-0.04} \text{ or } X = -0.04\ \frac{10}{100} = -0.004$$

Therefore, the time of flight corresponding to HOB +110 meters and range 25,000 meters is 56.446 seconds (56.450 − 0.0044 − 56.446 seconds).

(2) As with the trial QE, a time of flight change must be computed for the additional 40 meters of range beyond 25,000 meters. This is accomplished by use of the t factor in column T3 of table H. Enter the table at the nearest 100-meter HOB (+100) and obtain the corresponding t factor (.38). Compute the time of flight change corresponding to the additional 40 meters as follows: 40/100 × 0.38 = 0.152 second. Add this value to the time of flight computed in (1) above (56.446 + 0.152 = 56.598 or 56.60 seconds). Enter this value in the TF (Trial) space in the lower right-hand corner of the form.

Note: The trial time of flight is not sent to the firing section.

i. The date from the met message must be reduced to a form that can be used in computing corrections to the trial QE, trial TF, and deflection to compensate for nonstandard meteorological conditions.

(1) Enter the data from the heading of the met message in the appropriate spaces on the form.

(2) Enter table A with the trial QE of 468

mils and find the line number applicable to this particular fire mission (07).

(3) The data from line 07 (uncorrected for the difference in altitudes between the launcher and the MDP are 07 38 03 103.5 94.1. Enter these data in the appropriate spaces on the form.

(4) Since temperature and density vary appreciably with altitude, corrections must be applied to compensate for the difference in altitude between the launcher and the MDP. First, determine the difference in altitude between the launcher and the MDP, using the spaces on the left side of the form directly beneath the QE (Trial) space.

Altitude of launcher (446) to nearest 10 meters	450 meters
Minus altitude of MDP	−360 meters
Difference (Launcher above MDP) =	+ 90 meters

Next, enter table B at the height of the launcher with reference to the MDP (+90 meters) to obtain a correction to air temperature of −.2 percent and a correction to air density of −.9 percent. Apply these corrections to the air temperature and density recorded from line 07 of the met message.

	Temperature	*Density*
	103.5	94.1
	− 0.2	− 0.9
Corrected	103.3	93.2

Record the corrected data in the appropriate spaces on the form.

j. Surface air pressure measured with a barometer at the firing position (965 millibars) must now be converted to a percent of standard air pressure. Enter table C with 965 millibars to obtain 95.2 percent.

Note: If the surface air pressure measured with a barometer is unavailable, the surface air pressure from the heading of the met message may be used. This method of determining surface air pressure is outlined in paragraph 3-8.

k. The met message is now applicable to the firing problem being solved; but, before actual corrections can be determined for existing meteorological conditions, the ballistic wind data must be reduced to cross wind and range wind components.

(1) Determine the chart direction of the ballistic wind by subtracting the azimuth of fire from the azimuth of the ballistic wind, adding 6,400 mils if necessary.

Azimuth of ballistic wind	3,800 mils
	+ 6,400 mils
	10,200 mils
Azimuth of fire (4784 to nearest 100 mils)	− 4,800 mils
Chart direction of ballistic wind	5,400 mils

(2) Using this chart direction, enter the "Correction" Components of a Unit Wind table (table E, page 14) to obtain—

Cross wind correction component = L.83
Range wind correction component = H.56

The ballistic cross and range winds are the products of the wind velocity from line 07 of the met message (3 knots) and the correction components just determined. Hence,

Ballistic cross wind = L.83 × 3 = L2 knots
Ballistic range wind = H.56 × 3 = H2 knots

(3) A correction to deflection must be applied to compensate for the ballistic cross wind. Enter table F (range = 25,000 meters) and determine the unit correction factor for a ballistic cross wind of 1 knot (colm 11) to be 0.52 mil. The correction for a cross wind of L2 is L2 × 0.52 = L1 mil.

l. Corrections to QE and TF must be applied to compensate for nonstandard conditions of materiel and weather.

(1) First, compute variations from standard of all met and ammunition data and enter the variations from standard in the variation from standard column of the BALLISTIC FACTORS block of the form as shown in figure 3-2.

Note: For MGR-1A rocket motors, use the propellant weight. For MGR-1B rocket motors, use a propellant weight correction.

(2) Next, determine the unit corrections to QE and TF by entering tables G and H at range 25,000 meters and height +100 meters. The column chosen to obtain a unit correction for a variation from standard conditions depends on whether the variation is an *increase* or a *decrease.* Record each unit correction in the appropriate column of the BALLISTIC FACTORS block.

Note: In some cases it may be necessary to examine the exact computed HOB relative to the launcher (before expression) to determine the proper entry HOB for obtaining the unit correction factors. For conformity in entering the firing tables, the following example is furnished as a guide: For HOB's relative to the launcher of +50 meters to +149 meters inclusive, the unit correction factors are those listed values corresponding to HOB +100; for HOB's relative to the launcher of +150 meters to +249 meters inclusive, the unit correction factors are those listed values corresponding to HOB +200.

BALLISTIC FACTORS	Std	Known	Variation from Std
Propellant Temperature	___° Decrease		
	77°F	49	ⒹI 28
Propellant Weight	lb	+1.0	DⒾ 1.0
Surface Pressure	100% / ~~1013mb~~	95.2	ⒹI 4.8
Density	100%	93.2	ⒹI 6.8
Air Temperature	100% / ~~59°F~~	103.3	DⒾ 3.3
Empty Weight	3020 lb	3010	ⒹI 10
Range Wind	0 Kn / ~~0 mph~~	H 2	ⒽT 2

Figure 3–2. Ballistic factors and variations from standard (sample mission 1).

(3) Finally, multiply each unit correction factor ((2) above) by the corresponding variation from standard ((1) above) and record each product in the appropriate column (+ or −) of the BALLISTIC FACTORS block. Algebraically sum the products to determine the total met corrections to QE and TF. Sample computations are shown in figure 3–3.

(4) Record the QE correction (−21.28) to the nearest tenth mil (−21.3) in the appropriate column of the QUAD ELEV block and the TF correction (−2.287) to the nearest hundredth second (−2.29) in the FUZE SETTING block.

m. Corrections to deflection must be applied to compensate for rotation of the earth and drift of the rocket during the burning phase.

(1) Enter table I with the latitude to the nearest 10° (30° N), azimuth of fire to the nearest 400 mils (4,800 mils), and range to the nearest 2,000 meters (26,000 meters). The correction for rotation of the earth is L2 mils.

(2) Enter table J with the range to the nearest 1,000 meters (25,000 meters) and propellant temperature to the nearest 10° (50° F). The drift correction is R6 mils.

(3) Assuming an aiming point deflection of 1,443 mils and combining the correction for a cross wind (L1 mil) (*k*(3) above) with the cor-

BALLISTIC FACTORS	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant Temperature	8.12		+0.29	ⒹI 28	+.019	0.532	
Propellant Weight		0.58	−0.58	DⒾ 1.0	−.044		0.044
Surface Pressure		2.50	−0.52	ⒹI 4.8	−.039		0.187
Density		30.12	−4.43	ⒹI 6.8	−.433		2.944
Air Temperature	4.32		+1.31	DⒾ 3.3	+.097	0.320	
Empty Weight		1.60	−0.16	ⒹI 10	−.009		0.090
Range Wind	1.08		+0.54	ⒽT 2	+.063	0.126	
	13.52	34.80				0.978	3.265
		13.52	Met Corr to QE & TF				0.978
		21.28					2.287

Figure 3–3. Meteorological corrections to quadrant elevation and time of flight (sample mission 1).

rections for rotation of the earth (L2 mils) and drift (R6 mils), the corrected deflection is 1,440 mils (1443 + 1 + 2 − 6 = 1,440 mils).

Note: The standard rule for deflection applies: left—add; right—subtract.

n. Corrections to QE and TF must be applied to compensate for the rotation of the earth. Table K lists corrections for QE and TF at 0° latitude; these corrections must be multiplied by the appropriate factor (from the table beneath table K) to convert them to corrections for the latitude of the launcher.

(1) Enter table K at range 26,000 meters and azimuth 4,800 mils and extract the QE correction of +3 mils and TF correction of 0 seconds.

(2) Multiply the corrections by the correction factor for 30° N latitude (.87) to determine the corrections to QE and TF for rotation of the earth.

QE correction = +3 × 0.87 = +2.6 mils
TF correction = 0 × 0.87 = 0 seconds

(3) Record the QE correction in the QUAD ELEV block and the TF correction in the FUZE SETTING block.

o. The total corrections to QE and TF are the sums of the corrections for nonstandard conditions of weather and materiel and the corrections for rotation. Thus, the total QE correction = −21.3 (met correction) +2.6 (rotation correction) = −18.7 mils; the total TF correction = −2.29 (met correction) + 0 (rotation correction) = −2.29 seconds. Add these corrections to the trial QE and the trial TF to determine the corrected QE and TF.

Corrected QE = 468.3 + (−18.7) = 449.6 mils

Corrected TF = 56.60 + (−2.29) = 54.31 or 54.3 seconds

p. A correction to TF must be applied to compensate for a bias in the M421 timer. This correction (+0.2) is shown in table L. Add this correction to the corrected TF to determine the fuze setting to be fired (54.3 + 0.2 = 54.5 seconds). The following fire commands can now be sent to the firing section:

Deflection	1,440 mils
Time	54.5 seconds
Quadrant elevation	449.6 mils

q. Corrections to deflection and quadrant elevation must be applied to compensate for low-level winds. These corrections normally are computed approximately 2 minutes prior to firing and may be computed by the firing section commander at the firing point or by the FDC. The cross wind (R9 mph) and range wind (H6 mph) are obtained from the wind speed indicator of the wind measuring set.

Note: If low-level wind readings from a wind measuring set are not available, low-level wind values may be determined by the pilot balloon technique (first priority) (para 3–9*a*) or obtained from line 01 of the met message (para 3–9*b*).

(1) Since the conditions are NIGHTTIME, table M–2 is used for determining the correction factors. Enter table M–2 with the corrected QE to the nearest mil (450 mils). Determine the deflection correction to the nearest mil and the elevation correction to the nearest tenth mil.

Note: For ALL OTHER THAN NIGHTTIME conditions, table M–1 would be used.

(*a*) From table M–2, extract the deflection correction factor of 4.10. To determine the deflection correction, multiply the correction factor by the cross wind: 4.10 × R9 = R36.9 or R37 mils.

(*b*) From table M–2, extract the elevation (head wind) correction factor of +1.53. To determine the elevation correction, multiply the correction factor by the range wind: +1.53 × H6 = +9.18 or +9.2 mils.

Note: No low-level wind correction is applied to time of flight.

(2) To determine the deflection and QE to be fired, add the low-level wind corrections to the corrected deflection and corrected QE:

Deflection fired = 1,440 + (−37) = 1,403 mils

QE fired = 449.6 + 9.2 = 458.8 mils

3–6. Sample Mission 2: MGR–1B Rocket With M190 Warhead

In this sample mission, an MGR–1B rocket with M190 GB warhead is to be fired from an M386 launcher. This combination requires the use of FTR 762–G–1 and FTR 762–ADD–D–1 for manual firing data computations. The propellant temperature is in the range 20° F to −30° F, the low-level wind is measured with an AN/PMQ–6 windset, the conditions are ALL OTHER THAN NIGHTTIME, and the surface pressure is measured with a barometer at the firing site.

a. The following call for fire is received in the FDC:

THIS IS FIREPOWER 3

FIRE MISSION
LONG SHOT
ONE LAUNCHER
FIRING POSITION NUMBER 3
TARGET NUMBER NA2125
TARGET GRID NP4538065184
TARGET ALTITUDE 601
ROCKET MGR–1B
WARHEAD M190
FUZE TIME/HEIGHT OF BURST HIGH
ONE ROCKET
TIME ON TARGET 1130
TIME ON TARGET NO LATER THAN 1145

b. The S3 issues the following fire order:

LONG SHOT ALFA
LAUNCHER NUMBER 1
FIRING POSITION NUMBER 3
TARGET NUMBER NA2125

c. The following warning order, based on the call for fire and the S3's fire order, is sent to the firing section:

LAUNCHER NUMBER 1
FIRING POSITION NUMBER 3
ROCKET MGR–1B
WARHEAD M190
FUZE TIME
ONE ROUND, AT MY COMMAND
TIME ON TARGET 1130

d. All known values are entered on the Computer's Record Data Correction Sheet, DA Form 6–56 (fig 3–4 ① and ②).

(1) Target coordinates NP4538065184.

(2) Target altitude 601 meters.

(3) Launcher coordinates NP4926334126.

(4) Launcher altitude 451 meters.

(5) Azimuth of orienting line 1,721 mils.

(6) Empty weight 2,656 pounds.

(7) Propellant weight correction −11.3 pounds (stenciled propellant weight differential ±13.4 and motor age over 52 months).

(8) Propellant temperature 19° F.

(9) Latitude of launcher 34° N.

(10) Surface air pressure (barometer) 961 millibars.

(11) Launcher aiming point deflection 1437 mils.

e. The FDC receives the following ballistic met message:

METB31	344982
311700	036959
000501	980980
015208	995964
025017	014951
034914	019945
045212	023944
055910	025942
066308	026942
076209	024945
085713	025942
095618	028944
105730	028949

f. Initial data to lay the launcher are computed and recorded on the computer's record data sheet.

(1) *Bearing.* In the COMPUTATION OF RANGE AND BEARING block, enter the coordinates of the launcher and target. In this example, since the launcher easting is larger than the target easting and launcher northing is smaller than the target northing, it is easily determined that the launcher is southeast of the target and that the direction of fire will be northwest. For convenience in remembering the direction of fire, draw an arrow in the fourth quadrant of the "Bearing" block in the upper right-hand corner of the form. (This corresponds to a −dE and +dN.) Obtain the logarithmic values of dE and dN from the logarithmic tables (TM 6–230). Enter the values in the BEARING block and determine the difference. This difference is the log tangent of the bearing and the antilog of the difference is the bearing (126.7 mils).

(2) *Azimuth of fire.* Enter the bearing obtained in (1) above to the nearest mil (127 mils) in the appropriate space in the AZIMUTH block at the right-hand side of DA Form 6–56. Since the bearing is in the fourth quadrant, subtract the bearing from 6,400 mils to obtain the azimuth of fire (6,273 mils).

(3) *Launcher-target range.* First, determine which is the greater, dE or dN, and enter the values obtained from the log table on the appropriate lines of the RANGE block. Compute the range (31,300 meters) and enter this value to the nearest 10 meters (31,300 meters) in the Computation Range space.

(4) *Second trajectory (ADDENDUM) computations.* Since this example includes second trajectory computations, FTR 762–ADD–D–1 is used to determine the corrected range to burst (R_B (Corr)), the height to burst relative to the launcher (H_B), and the addendum deflection correction (df corr (adden)).

COMPUTER'S RECORD DATA CORRECTION SHEET *(FREE ROCKET)*

For use of this form, see FM 6-40-1; the proponent agency is U.S. Continental Army Command.

UNIT	Lchr Lat Ⓝ °S	Time and Date Fired	Min / QE	FPC / FDC	Tgt Nr / Rkt Mtr SN
3/2	34	1130 31 AUG 70		FPC 72 mil; FDC 237 mil	Tgt Nr NA 2125; Rkt Mtr SN 1832

FIRE MISSION

FIREPOWER 3, FM, Unit to Fire 3/2, Lchr(s) to Fire 1, FP Nr 3, Tgt Nr NA 2125, Tgt Grid NP 45380 65184, Tgt Alt 601 m, Type Rkt MGR-1B, Whd M190, Fz/HOB TI/HIGH, Total Nr Rkts 1, TOT 1130, TOT NLT 1145, Remarks ______.

FIRE ORDER

Unit to Fire A/3/2, Lchr Nr 1, FP Nr 3, Tgt Nr NA 2125.

WARNING ORDER

Lchr Nr ____, FP Nr ____, Tgt Nr ____, Type Rkt ____, Whd ____, HOB ____, TOT ____, Pred. TOF ____, Tgt Az ____, Nr Rkts per Lchr ____.

SEE DA FORM 4257-R

COMPUTATION OF RANGE AND BEARING

Tgt Coord	45380	65184
Lchr Coord	49263	34126
	dE ⊖ 3883	dN ⊕ 31058

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

BEARING

Log dE	3.589167
Log dN	− 4.492173
Log Tan Bearing	9.096994
Bearing	126.7 mil

AZIMUTH

0 / 3200 / 6400	6400 mil
Bearing	⊖ 127 mil
Az of Fire	6273 mil

RANGE

dE Greater than dN	
Log dE	
Log Sin B	−
Log Rg	
Range	m

dN Greater than dE	
Log dN	4.492173
Log Cos B	− 9.996631
Log Rg	4.495542
Range	31,300 m

Computation ** Range (10m) 31,300 m

HOB REL TO LCHR

Tgt Alt	m
HOB rel to Tgt **	+ m
Alt of Burst	= m
Alt of Lchr	− m
HOB rel to Lchr	= m
HOB rel to Lchr (10m)	m

ADDENDUM COMPUTATIONS

Alt Tgt	601 m	H_B	1388 m	R_B (Trial)	30,844 m
Alt Lchr	− 451 m	H_T (1m)	− + 150 m	Met Corr to R_B	⊖ 71 m
Ht of Tgt rel Lchr—H_T (1 m)	= +150 m	HOB above Tgt	= +1238 m	R_B (Corr) (1m)	= 30,773 m
(10 m)	= +150 m			(10 m)	= 30,770 m

Line Nr		Wind Az		Wind Vel		Temperature			Density		
0	3	4	9	1	4	0	1	9	9	4	5
Alt Tgt	601 m		Density Correction						−	2	4
Alt MDP	− 360 m		Corrected Value						9	2	1
Alt Diff	+ 241 m										

Wind Az (100mil)	4900 mil
+6400 (if nec)	+ 6400 mil
Sum	= 11300 mil
Az of Fire (100mil)	− 6300 mil
Chart Dir of Wind	= 5000 mil

CROSS WIND Ⓛ R .98 (Comp) x 14 (Vel) = Ⓛ R 14 x .23 (Unit Corr) = Ⓛ R 3 mil (Df Corr)

Computations :

RANGE WIND Ⓗ T .20 (Comp) x 14 (Vel) = Ⓗ T 3 Knots

BALLISTIC FACTORS	Std	Known	Variation from Std	Unit Corr	Rg Corr +/−
Density	100%	92.1	Ⓓ I 7.9	−12.3	−97.2
Range Wind	0 Kn	H3	Ⓗ T 3	+ 8.8	+26.4
				Met Corr to R_B (Trial) ⊕/⊖	70.8

R_B (TRIAL)

30,950 + (50/100)(-5) = 30,950 - 2.5 = 30,947.5

30,947.5 + (-100/100)(103) = 30,947.5 - 103.0 = 30,844.5 = 30,844

H_B

1338 + (50/100)(100) = 1338 + 50 = 1388

**See FM 6-40-1A

DA FORM 1 FEB 69 6-56 REPLACES EDITION OF 1 JUL 61, AND DA FORM 2256-1-R, 1 JAN 62, WHICH ARE OBSOLETE.

Figure 3–4①. Computer's record data correction sheet (Free Rocket), DA Form 6–56 (front) (sample mission 2).

Firing Table Entry Range (10 m) Comp Range or R_B (Corr) 30,770 m	Firing Table Entry Height of Burst (10 m) HOB rel to Lchr or H_B +1390 m

Alt of Lchr 451 m	Az of Fire 6273 mil	Latitude of Lchr (10°) 30 (N)/S	Df Corr (L)/R (Adden) 3 mil

Initial Laying Data*	
*Az of OL	1721 mil
+6400 (if nec)	+ 6400 mil
Sum	= 8121 mil
*Az of Fire	− 6273 mil
Difference	= 1848 mil
−3200 (if nec)	− mil
*Orienting Angle	= 1848 mil
*QE (Trial) (1 mil)	641 mil

Computations (QE (Trial), TF (Trial), and Surface Pressure):

QE
640.1 + (90/100)(2.5) = 640.10 + 2.25 = 642.35
642.35 + (−30/100)(3.4) = 642.35 − 1.02 = 641.33 = 641.3

TF
76.68 + (90/100)(−0.07) = 76.680 − 0.063 = 76.617
76.617 + (−30/100)(0.43) = 76.617 − 0.129 = 76.488 = 76.49

Surface Pressure = 961 mb = 94.8 %

Alt Lchr (10 m)	450 m
Alt MDP (10 m)	− 360 m
Lchr above/below MDP	+ 90 m
Az of Wind (100 mil)	5700 mil
+6400 (if nec)	+ 6400 mil
Sum	= 12100 mil
Az of Fire (100 mil)	− 6300 mil
Chart Dir of Wind	= 5800 mil

Met Station			Use	Type	Oct	Latitude			Longitude		
M	E	T	B	3	1	3	4	4	9	8	2
Day		B. Time		E. Time		Altitude MDP			Sur. Press. (MDP)		
3	1	1	7	0	0	0	3	6	9	5	9
Line Nr		Wind Az		Wind Vel		Temperature			Density		
1	0	5	7	3	0	0	2	8	9	4	9
Density-Temperature Corr						−	0	2	−	0	9
Corrected Values					1	0	2	6	9	4	0

CROSS WIND (L)/R .56 x 30 = (L)/R 17 x .68 = (L)/R 12 mil (Comp, Vel, Unit Corr)

RANGE WIND (H)/T .83 x 30 = (H)/T 25 Kn/mph (Comp, Vel)

BALLISTIC FACTORS	Std	Known	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant	57 °	Decrease	20.50					1.640	
Temperature	77°F	19	0.47		+0.47	(D)I 1	+.034	0.034	
Propellant Weight	lb	−11.3	10.17		+0.90	(D)I 11.3	+.073	0.825	
Surface Pressure	100% ~~1013 mb~~	94.8		4.11	−0.79	(D)I 5.2	−.064		0.333
Density	100%	94.0		45.96	−7.66	(D)I 6.0	−.750		4.500
Air Temperature	100% ~~59°F~~	102.6	7.12		+2.74	D(I) 2.6	+.230	0.598	
Empty Weight	2630 lb	2656	6.24		+0.24	D(I) 26	+.015	0.390	
Range Wind	0 Kn 0 mph	H 25	21.50		+0.86	(H)T 25	+.102	2.550	
			66.00	50.07				6.037	4.833

DEFLECTION	L	R		Met Corr to QE & TF	
Df Corr (Adden)	3		50.07		4.833
			15.93		1.204

	L	R	QUAD ELEV +	QUAD ELEV −		FUZE SETTING +	FUZE SETTING −
Cross Wind Corr	12						
Rotation Corr	1						
Drift Corr		7	15.9		Met Correction	1.20	
	16	7	0.9		Rotation Correction	0.00	
	7						
Total Df Corr	9		16.8		Total QE & TF Correction	1.20	

LLW CORR — CROSS (Df) L/(R) 8 x 3.52 = L/(R) 28 (Vel, Unit Corr, LLW) — RANGE (QE) (H)+ T− 4 x 1.72 = (+) − 6.9 (Vel, Unit Corr, LLW)

Aiming Point Df	1437	QE (Trial) (0.1 mil)	641.3	TF (Trial) (0.01)	76.49
Df Correction	(L)R 9	QE Correction	(+) 16.8	TF Correction	(+) 1.20
Df (Corrected)	1446	QE (Corrected)	658.1	TF (Corrected) (.1)	77.7
Low Level Wind	L(R) 28	Low Level Wind	(+) 6.9	Fuze Corr	(+) 0.2
Df FIRED	1418	QE FIRED	665.0	FS FIRED	77.9

Figure 3-4②. Computer's record data correction sheet (Free Rocket), DA Form 6-56 (reverse) (sample mission 2).

(*a*) Determine the height of target relative to the launcher (H_T). Subtract the altitude of the launcher (451 meters) from the altitude of the target (601 meters) to obtain the height of target relative to the launcher (+150 meters). Record this value in both spaces ((1m) and (10m)) in the Ht of Tgt rel Lchr-H_T block, since in this case the height of target relative to the launcher is already expressed to the nearest 10 meters.

(*b*) Determine the trial range to burst (R_B (trial)) by interpolation in table B. From page 120 (launcher-target range 31,400 meters), interpolation is made in column 3 between heights of target relative to launcher, column 2, for a HIGH height of burst relative to target, column 1. Interpolate between +100 meters and +200 meters as follows:

	H_T			R_B	
100	200			30945	−5
	150	50	X	?	
	100			30950	

$$\frac{50}{100} = \frac{X}{-5} \text{ or } X = -5\left(\frac{50}{100}\right) = -2.5$$

Therefore, the R_B corresponding to H_T +150 meters and range 31,400 meters = 30,950.0 − 2.5 = 30,947.5 meters. Since this value was obtained at an entry range of 31,400 meters, a change must be computed for the −100 meters of range. This is accomplished by use of the m/100m factor in column 4 of table B. Enter the table at the nearest 100-meter H_T (+200 meters) and obtain the corresponding m/100m factor (+103 meters). This factor represents the number of meters necessary to change the R_B for a 100-meter change in launcher-target range. Compute the change in R_B corresponding to the −100 meters of range as follows −100/100 × 103 = −103.0 meters. Algebraically add this value to the R_B already computed for range 31,400 meters and H_T +150 meters (30,947.5 meters) and obtain the trial R_B of 30,844 meters (30,947.5 − 103.0 = 30,844.5 or 30,844 meters). Enter this value in the R_B (trial) space of the ADDENDUM COMPUTATIONS section.

(*c*) The height of burst relative to the launcher (H_B) is determined from the same page as trial R_B. Interpolation is made in column 5 between heights of target relative to launcher, column 2, for a HIGH height of burst relative to target, column 1. Interpolate between +100 meters and +200 meters as follows:

	H_T			H_B	
100	200			1438	100
	150	50	X	?	
	100			1338	

$$\frac{50}{100} = \frac{X}{100} \text{ or } X = 100\left(\frac{50}{100}\right) = 50$$

Therefore, the H_B corresponding to H_T of +150 meters = 1338 + 50 = 1,388 meters. Enter this value in the H_B space of the ADDENDUM COMPUTATIONS section.

(*d*) The height of burst above target must now be computed in order to determine the applicable line of the met message. Algebraically subtract H_T (1m) (+150 meters) from H_B (+1,388 meters) to obtain the height of burst above target (+1,238 meters). Enter this value in the HOB above Tgt space of the ADDENDUM COMPUTATIONS section.

(*e*) Determine the applicable line number of the met message by entering table A, page 7, with the height of burst above target (+1,238 meters). The line number is 03, and the data from line 03 in the current met message are 03 49 14 019 945. Enter these data in the Line Nr. Wind Az, Wind Vel, Temperature, and Density spaces of the ADDENDUM COMPUTATIONS section.

(*f*) Determine the height of the target with reference to the MDP. From group 4 of the introduction of the current met message, determine the altitude of the meteorological datum plane (MDP) to be 360 meters. Subtract the altitude of the MDP from the altitude of the target (+601 meters) to obtain the height of the target with reference to the MDP (+241 meters). Enter this value in the Alt Diff space of the ADDENDUM COMPUTATIONS section.

(*g*) Correct the air density from line 03 of the met message for the difference in altitude between the target and the MDP. Enter the Air Density Corrections table on page 3 with the height of the target with reference to the MDP expressed to the nearest 10 meters (+240 meters) and determine the air density correction to be −2.4 percent. Enter this value in the Density Correction space and subtract the value from the density (94.5 percent) to obtain the corrected density (92.1 percent). Enter this value in the

Corrected Value space of the ADDENDUM COMPUTATIONS section.

(*h*) Determine the chart direction of the wind by subtracting the azimuth of fire from the azimuth of the ballistic wind, adding 6,400 mils if necessary. Enter the computations in the appropriate spaces in the ADDENDUM COMPUTATIONS section.

Azimuth of ballistic wind (nearest 100 mils)	4,900 mils
	6,400 mils
	11,300 mils
Azimuth of fire (nearest 100 mils)	− 6,300 mils
Chart direction of ballistic wind	5,000 mils

(*i*) Convert the ballistic wind data to range and cross wind components. Enter the Correction Components of a One Knot Wind table on page 2 with the chart direction of the wind (5,000 mils) to obtain—

Cross wind correction component = L.98
Range wind correction component = H.20

The ballistic cross and range winds are the products of the wind velocity from line 03 of the met message (14 knots) and the correction components just determined. Hence,

Ballistic cross wind = L.98 × 14 = L14 knots
Ballistic range wind = H.20 × 14 = H3 knots

Enter these computations in the CROSS WIND and RANGE WIND blocks of the ADDENDUM COMPUTATIONS section.

(*j*) A correction to azimuth (deflection) must be applied to compensate for the ballistic cross wind. Enter table B (launcher-target range = 31,400 meters, height of burst relative to target = HIGH, and H_T = +200 meters) and determine the correction for a ballistic cross wind of 1 knot (colm 10) to be 0.23 mil. The correction for a cross wind of L14 is L14 × 0.23 = L3 mils. Enter the correction in the Df Corr space of the CROSS WIND block. This correction must be included in the total correction in computing the deflection to be fired.

(*k*) Determine the met corrections to trial R_B to compensate for nonstandard conditions of ballistic air density and ballistic range wind. Compare the known conditions of ballistic air density and ballistic range wind with the standard conditions to determine the variations from standard. Enter columns 6 and 8 of table B (launcher-target range = 31,400 meters, height of burst relative to target = HIGH, and H_T = +200 meters) to determine the unit correction factors. Then multiply the factors by the variations from standard and algebraically sum the products to determine the total correction to trial R_B. Enter the computations in the appropriate spaces in the BALLISTIC FACTORS block as shown in figure 3-5.

(*l*) Determine the corrected range to burst (R_B (corr)). Algebraically add the met correction to R_B (−71 meters) to the R_B (trial) (30,844 meters) to obtain the corrected range to burst (30,773 meters). Enter this value to the nearest meter in the (1m) space and to the nearest 10 meters in the (10m) space of the R_B (corr) block.

Note: All subsequent computations are made on the reverse side of DA Form 6-56. At tht top of the form, enter the following values that were computed on the front side of the form:

Firing table entry range (R_n (corr)) (nearest 10 meters)	30,770 meters
Firing table entry height of burst (H_n) (nearest 10 meters)	+1,390 meters
Altitude of launcher	451 meters
Azimuth of fire	6,273 mils
Latitude of launcher (nearest 10°)	30° N
Deflection correction (adden)	L3 mils

(5) *Orienting angle.* In the INITIAL LAYING DATA block, enter the azimuth of the

BALLISTIC FACTORS	Std	Known	Variation from Std	Unit Corr	Rg Corr +/−
Density	100%	92.1	(D) I 7.9	−12.3	−97.2
Range Wind	0 Kn	H3	(H) T 3	+8.8	+26.4
Met Corr to R_B (Trial) +/(−)					70.8

Figure 3-5. Meteorological corrections to trial range to burst (sample mission 2).

orienting line (1,721 mils), add 6,400 mils, subtract the azimuth of fire (6,273 mils), and obtain the value of the orienting angle (1,848 mils).

g. The trial QE is determined by entering table G of FTR 762–G–1 with the range to the nearest 200 meters and obtaining the elevation from column E2 corresponding to the firing table entry height of burst (H_B) in column E1.

(1) In this example, to obtain the elevation (colm E2) corresponding to the launcher-target range of 30,770 meters, enter table G at range 30,800 meters and HOB relative to launcher +1,300 meters (colm E1). The elevation for an HOB of +1,300 meters is 640.1 mils. To find the elevation for an HOB of +1,390 meters, interpolate between +1,300 meters and +1,400 meters HOB as follows:

	HOB			EL	
100	1400			642.6	2.5
	1390	90	X	?	
	1300			640.1	

$$\frac{90}{100} = \frac{X}{2.5} \text{ or } X = 2.5\left(\frac{90}{100}\right) = 2.25$$

Therefore, the elevation corresponding to HOB +1,390 meters and range 30,800 meters = 640.10 + 2.25 = 642.35 mils.

(2) Since this elevation was obtained at an entry range of 30,800 meters, an elevation change must be computed for the −30 meters of range. This is accomplished by use of the c factor in column E3 of table G. Enter the table at the nearest 100-meter HOB (+1400) and obtain the corresponding c factor (+3.4). Compute the elevation change corresponding to the −30 meters of range as follows: −30/100 × 3.4 = −1.02 mils. Subtract this value from the elevation already computed for range 30,800 meters and HOB +1,390 meters (642.35) and obtain the trial QE of 641.3 mils (642.35 − 1.02 = 641.33 or 641.3 mils). Enter this value to the nearest mil in the QE (trial) space of the INITIAL LAYING DATA block and to the nearest tenth mil in the QE (trial) space at the bottom center of the form.

(3) Transmit the initial laying data to the firing section:

(*a*) Azimuth of the orienting line	1,721 mils
(*b*) Azimuth of fire	6,273 mils
(*c*) Orienting angle	1,848 mils
(*d*) Trial QE	641 mils

h. The trial time of flight (TF) is determined in the same manner as the trial QE.

(1) Enter table H of the firing table with the same range (30,800) and HOB (+1300). Determine the time of flight corresponding to 30,800 meters and HOB +1,390 meters by interpolation as follows:

	HOB			TP	
100	1400			76.61	−0.07
	1390	90	X	?	
	1300			76.68	

$$\frac{90}{100} = \frac{X}{-0.07} \text{ or } X = -0.07\left(\frac{90}{100}\right) = -0.063$$

Therefore, the time of flight corresponding to HOB +1,390 meters and range 30,800 meters is 76.617 seconds (76.680 − 0.063 = 76.617 seconds).

(2) As with the trial QE, a time of flight change must be computed for the decrease of 30 meters in range. This is accomplished by use of the t factor in column T3 of table H. Enter the table at the nearest 100-meter HOB (+1400) and obtain the corresponding t factor (.43). Compute the time of flight change corresponding to the decrease of 30 meters as follows: −30/100 × 0.43 = −0.129 seconds. Subtract this value from the time of flight computed in (1) above (76.617) to obtain the trial time of flight of 76.49 seconds (76.617 − 0.129 = 76.488 or 76.49 seconds). Enter this value in the TF (Trial) space in the lower right-hand corner of the form.

i. The data from the met message must be reduced to a form that can be used in computing corrections to trial QE, trial TF, and deflection to compensate for nonstandard meteorological conditions.

(1) Enter the data from the heading of the met message in the appropriate spaces on the form.

(2) Enter table A with the trial QE of 641 mils and find the line number applicable to this particular fire mission (10).

(3) The data from line 10 (uncorrected for the difference in altitude between the launcher and the MDP) are 10 57 30 102.8 94.9. Enter these data in the appropriate spaces on the form.

(4) Correction must be applied to compensate for the difference in altitude between the launcher and the MDP. First determine the dif-

ference in altitude between the launcher and the MDP, using the spaces on the left side of the form directly beneath the QE (Trial) space.

Altitude of launcher (451) to nearest 10 meters	450 meters
Minus altitude of MDP	−360 meters
Difference (launcher above MDP)	= + 90 meters

Next enter table B at the height of the launcher with reference to the MDP (+90 meters) to obtain a correction to air temperature of −.2 percent and a correction to air density of −.9 percent. Apply these corrections to the air temperature and density recorded from line 10 of the met message.

	Temperature	*Density*
	102.8	94.9
	− 0.2	− 0.9
Corrected	102.6	94.0

Record the corrected data in the appropriate spaces on the form.

j. Surface air pressure measured with a barometer at the firing position (961 millibars) must now be converted to a percent of standard air pressure. Enter table C with 961 millibars to obtain 94.8 percent.

k. The met message is now applicable to the firing problem being solved; but, before actual corrections can be determined for existing meteorological conditions, the ballistic wind data must be reduced to cross wind and range wind components.

(1) Determine the chart direction of the ballistic wind by subtracting the azimuth of fire from the azimuth of the ballistic wind, adding 6,400 mils if necessary.

Azimuth of ballistic wind	5,700 mils
	+ 6,400 mils
	=12,100 mils
Azimuth of fire (6273 to nearest 100 mils)	− 6,300 mils
Chart direction of ballistic wind	= 5,800 mils

(2) Using this chart direction, enter the "Correction" Components of a Unit Wind table (table E, page 14) to obtain—

Cross wind correction component = L.56
Range wind correction component = H.83

The ballistic cross and range winds are the products of the wind velocity from line 10 of the met message (30 knots) and the correction components just determined. Hence,

Ballistic cross wind = L.56 × 30 = L17 knots
Ballistic range wind = H.83 × 30 = H25 knots

(3) A correction to deflection must be applied to compensate for the ballistic cross wind. Enter table F (range = 31,000 meters) and determine the unit correction factor for a ballistic cross wind of 1 knot (colm 11) to be 0.68 mil. The correction for a cross wind of L17 is L17 × 0.68 = L12 mils.

l. Corrections to QE and TF must be applied to compensate for nonstandard conditions of materiel and weather.

(1) First, compute variations from standard of all met and ammunition data and enter the variations from standard in the Variation from Std column of the BALLISTIC FACTOR block of the form as shown in figure 3–6.

BALLISTIC FACTORS	Std		Known	Variation from Std
Propellant Temperature	57 ° Decrease			(D) 57
	77°F		19	(D)I 1
Propellant Weight		lb	-11.3	(D)I 11.3
Surface Pressure	100%	~~1013mb~~	94.8	(D)I 5.2
Density	100%		94.0	(D)I 6.0
Air Temperature	100%	~~59°F~~	102.6	D(I) 2.6
Empty Weight	2630 lb		2656	D(I) 26
Range Wind	0Kn	~~0mph~~	H25	(H)T 25

Figure 3–6. Ballistic factors and variations from standard (sample mission 2).

Note: In this sample mission the propellant temperature is in the range 20° F to −30° F (observed temperature 19° F). Because of the large decrease from the standard temperature of 77° F, a different procedure for determining the correction for propellant temperature is required. This procedure is explained in (4) below.

(2) Next, determine the unit corrections to QE and TF by entering the tables G and H at range 30,800 meters and height +1,400 meters. The column chosen to obtain a unit correction for a variation from standard conditions depends on whether the variation is an *increase* or a *decrease*. Record each unit correction in the appropriate column of the BALLISTIC FACTORS block.

(3) Multiply each unit factor ((2) above) by the corresponding variation from standard ((1) above) and record each product in the appropriate column (+ or −) of the BALLISTIC FACTORS block. Algebraically sum the products to determine the total met corrections to QE and TF. Sample computations are shown in figure 3–7.

(4) The procedure for determining the corrections for the decrease in propellant temperature is as follows:

(*a*) First, enter columns E5 of table G and T5 of table H to obtain the corrections to QE (+20.50 mils) and TF (+1.640 seconds) to compensate for a 57° F decrease in propellant temperature from 77° F to 20° F.

(*b*) Next, enter columns E6 of table G and T6 of table H to obtain the unit corrections applicable in the range 20° F to −30° F. Use these corrections in the usual manner to obtain corrections for the decrease in propellant temperature from 20° F to the observed value.

(*c*) Finally, add the corrections determined in (*a*) and (*b*) above to determine the total corrections to be applied to QE (+20.50 mil + 0.47 mil) and TF (+1.640 seconds +0.034 second) for the decrease from 77° F to the observed propellant temperature (19° F).

(5) Record the QE correction (+15.93) to the nearest tenth mil (+15.9) in the appropriate column of the QUAD ELEV block and the TF correction (+1.204) to the nearest hundredth second (+1.20) in the FUZE SETTING block.

m. Corrections to deflection must be applied to compensate for rotation of the earth and drift of the rocket during burning phase.

(1) Enter table I with the latitude to the nearest 10° (30° N), azimuth of fire to the nearest 400 mils (0/6,400 mils), and range to the nearest 2,000 meters (30,000 meters). The correction for rotation of the earth is L1 mil.

(2) Enter table J with the range to the nearest 1,000 meters (31,000 meters) and propellant temperature to the nearest 10° (20° F). The drift correction is R7 mils.

(3) Assuming an aiming point deflection of 1,437 mils and combining the addendum deflec-

BALLISTIC FACTORS	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant Temperature	20.50			(D) 57		1.640	
	0.47		+0.47	(D)I 1	+.034	0.034	
Propellant Weight	10.17		+0.90	(D)I 11.3	+.073	0.825	
Surface Pressure		4.11	−0.79	(D)I 5.2	−.064		0.333
Density		45.96	−7.66	(D)I 6.0	−.750		4.500
Air Temperature	7.12		+2.74	D(I) 2.6	+.230	0.598	
Empty Weight	6.24		+0.24	D(I) 26	+.015	0.390	
Range Wind	21.50		+0.86	(H)T 25	+.102	2.550	
	66.00	50.07				6.037	4.833
	50.07		Met Corr to QE & TF			4.833	
	15.93					1.204	

Figure 3–7. Meteorological corrections to quadrant elevation and time of flight (sample mission 2).

tion correction (L3 mils) (*f*(4) above) and the correction for a cross wind (L12 mils) (*k* (3) above) with the corrections for rotation of the earth (L1 mil) and drift (R7 mils), the corrected deflection is 1,446 mils (1437 + 3 + 12 + 1 − 7 = 1,446 mils).

n. Corrections must be applied to QE and TF to compensate for the rotation of the earth.

(1) Enter table K at range 30,000 meters and azimuth 6,200 mils and extract the QE correction of +1 mil and TF correction of 0 seconds.

(2) Multiply the corrections by the correction factor for 30° N latitude.

QE correction = +1 × 0.87 = 0.87 or 0.9 mil
TF correction = 0 × 0.87 = 0 seconds

(3) Record the QE correction in the QUAD ELEV block and the TF correction in the FUZE SETTING block.

o. The total corrections to QE and TF are the sums of the corrections for nonstandard conditions of weather and materiel and the corrections for rotation. Thus, the total QE correction = +15.9 (met correction) +0.9 (rotation correction) = +16.8 mils; the total TF correction = +1.20 (met correction) + 0 (rotation correction) = +1.20 seconds. Add these corrections to the trial QE and the trial TF to determine the corrected QE and corrected TF.

Corrected QE = 641.3 + 16.8 = 658.1 mils
Corrected TF = 76.49 + 1.20 = 77.69 or 77.7 seconds

p. A correction to TF must be applied to compensate for a bias in the M421 timer. Add the correction shown in table L (+0.2 second) to the corrected TF to determine the fuze setting to be fired (77.7 + 0.2 = 77.9 seconds). The following fire commands can now be sent to the firing section:

Deflection	1,446	mils
Time	77.9	seconds
Quadrant elevation	658.1	mils

q. Corrections to deflection and quadrant elevation must be applied to compensate for low-level winds. The cross wind (R8 mph) and range wind (H4 mph) are obtained from the wind speed indicator of the wind measuring set.

(1) Since the conditions are ALL OTHER THAN NIGHTTIME, table M-1 is used for determining the correction factors. The corrected QE to the nearest mil (658) is not listed in table M-1; therefore, the correction factors must be determined by interpolation between QE 650 and QE 660.

(*a*) By interpolation, determine the deflection correction factor of 3.52. To determine the deflection correction, multiply the correction factor by the cross wind: 3.52 × R8 = R28.16 or R28 mils.

(*b*) By interpolation, determine the elevation (head wind) correction factor of +1.73. To determine the elevation correction, multiply the correction factor by the range wind: +1.73 × H4 = +6.92 or +6.9 mils.

(2) To determine the deflection and QE to be fired, add the low-level wind corrections to the corrected deflection and corrected QE.

Deflection fired = 1,446 + (−28) = 1,418 mils
QE fired = 658.1 + 6.9 = 665.0 mils

3-7. Sample Mission 3: MGR-1A Rocket With M144 Warhead

In this sample mission, an MGR-1A rocket with M144 HE warhead is to be fired from an M386 launcher. This combination requires the use of FTR 762-F-1 and FTR 762-ADD-A-1 for manual firing data computations. The propellant temperature is in the range 77° F to 120° F, the low-level wind is measured with an AN/PMO-6 windset, the conditions are ALL OTHER THAN NIGHTTIME, and the surface pressure is measured with a barometer at the firing site.

a. The following call for fire is received in the FDC:

THIS IS FIREPOWER 3
FIRE MISSION
LONG SHOT
ONE LAUNCHER
FIRING POSITION NUMBER 4
TARGET NUMBER NA2127
TARGET GRID NP3156439611
TARGET ALTITUDE 393 METERS
ROCKET MGR-1A
WARHEAD M144
FUZE TIME/HEIGHT OF BURST LOW
ONE ROCKET
TIME ON TARGET 2330
TIME ON TARGET NO LATER THAN 2350

b. The S3 issues the following fire order:

LONG SHOT BRAVO
LAUNCHER NUMBER 3
FIRING POSITION NUMBER 4
TARGET NUMBER NA2127

c. The following warning order, based on the call for fire and the S3's fire order, is sent to the firing section:

LAUNCHER NUMBER 3
FIRING POSITION NUMBER 4
ROCKET MGR–1A
WARHEAD M144
FUZE TIME
ONE ROUND, AT MY COMMAND
TIME ON TARGET 2330

d. All known values are entered on the Computer's Record Data Correction Sheet, DA Form 6–56 (fig 3–8 ① and ②).

(1) Target coordinates NP3156439611.

(2) Target altitude 393 meters.

(3) Launcher coordinates NP4884235369.

(4) Launcher altitude 448 meters.

(5) Azimuth of orienting line 1,258 mils.

(6) Empty weight 3,840 pounds.

(7) Propellant weight 2,049 pounds.

(8) Propellant temperature 78° F.

(9) Latitude of launcher 34° N.

(10) Surface air pressure (barometer) 988 millibars.

(11) Launcher aiming point deflection 1,462 mils.

e. The FDC receives the following ballistic met message:

METB31	344982
010400	036972
000320	973000
010233	971001
026429	970004
036436	967003
046337	967003
056234	967002
066034	966002
075933	965999
086033	963999
096032	961997
105936	961993

f. Initial data to lay the launcher are computed and recorded on the computer's record data sheet.

(1) *Bearing.* Compute and record the bearing as outlined in paragraphs 3–5*f*(1) and 3–6*f*(1): 1,354.8 mils.

(2) *Azimuth of fire.* Compute and record the azimuth of fire as outlined in paragraphs 3–5*f*(2) and 3–6*f*(2): 5,045 mils.

(3) *Launcher-target range.* Compute and record the launcher-target range as outlined in paragraphs 3–5*f*(3) and 3–6*f*(3): 17,791 meters.

(4) *Second trajectory (ADDENDUM) computations.* Since this example includes second trajectory computations, FTR 762–ADD–A–1 is used to determine the corrected range to burst (R_B (corr)), the height to burst relative to the launcher (H_B), and the addendum deflection correction (df corr (adden)).

(*a*) Determine the height of target relative to the launcher (H_T). Subtract the altitude of the launcher (448 meters) from the altitude of the target (393 meters) to obtain the height of target relative to the launcher (−55 meters). Enter this value to the nearest meter in the (1m) space and to the nearest 10 meters (−60 meters) in the (10m) space of the Ht of Tgt Rel Lchr = H_T block.

(*b*) Determine the trial range to burst (R_B (trial)) by interpolation in table B. From page 86 (launcher-target range 17,800 meters), interpolation is made in column 3 between heights of target relative to launcher, column 2, for a LOW height of burst relative to target, column 1. Interpolate between −100 meters and 0 meters as follows:

	H_T			R_B	
100	0			17045	−8
	−60	40	X	?	
	−100			17053	

$$\frac{40}{100} = \frac{X}{-8} \text{ or } X = -8\left(\frac{40}{100}\right) = -3.2$$

Therefore, the R_B corresponding to H_T −60 meters and range 17,800 meters = 17,053.0 − 3.2 = 17,049.8 meters. Since this value was obtained at an entry range of 17,800 meters a change must be computed for the −10 meters of range. This is accomplished by use of the m/100m factor in column 4 of table B. Enter the table at the nearest 100-meter H_T (−100 meters) and obtain the corresponding m/100m factor (+103 meters). Compute the change in R_B corresponding to the −10 meters in range as follows: −10/100 × 103 = −10.3 meters. Algebraically add this value to the R_B already computed for range 17,800 meters and H_T −60 meters (17,049.8 meters) and obtain the trial R_B of 17,040 meters (17,049.8 − 10.3 = 17,039.5 or 17,040 meters). Enter this value in the R_B (Trial) space of the ADDENDUM COMPUTATIONS section.

COMPUTER'S RECORD DATA CORRECTION SHEET *(FREE ROCKET)*

For use of this form, see FM 6-40-1, the proponent agency is U.S. Continental Army Command.

UNIT	Lchr Lat	Time and Date Fired	Min QE	FPC / FDC	Tgt Nr / Rkt Mtr SN
3/2	34 °(N)/S	2330 31 AUG 70		FPC 201 ⨯; FDC 263 ⨯	Tgt Nr NA 2127; Rkt Mtr SN 1672

FIRE MISSION

FIREPOWER 3, FM, Unit to Fire 3/2, Lchr (s) to Fire 1, FP Nr 4, Tgt Nr NA2127, Tgt Grid NP 31564 39611, Tgt Alt 393 m, Type Rkt MGR-1A, Whd M144, Fz/HOB TI/LOW, Total Nr Rkts 1, TOT 2330, TOT NLT 2350, Remarks ______

FIRE ORDER

Unit to Fire B/3/2, Lchr Nr 3, FP Nr 4, Tgt Nr NA2127

WARNING ORDER

Lchr Nr ____, FP Nr ____, Tgt Nr ____, Type Rkt ____, Whd ____, Fz/HOB ____, TOT ____, Pred. TOF ____, Az ____, Nr Rkts per Lchr ____

SEE DA FORM 2257-R

COMPUTATION OF RANGE AND BEARING

Tgt Coord	31564	39611
Lchr Coord	48842	35369
	dE (−) 17278	dN (+) 4242

BEARING	
Log dE	4.237493
Log dN	− 3.627571
Log Tan Bearing	0.609922
Bearing	1354.8 ⨯

RANGE	
dE Greater than dN	
Log dE	4.237493
Log Sin B	− 9.987293
Log Rg	4.250200
Range	17,791 m
dN Greater than dE	
Log dN	
Log Cos B	−
Log Rg	
Range	m

Computation ** Range (10 m) 17,790 m

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

AZIMUTH

0 / 3200 / 6400	6400 ⨯
Bearing	(−) 1355 ⨯
Az of Fire	5045 ⨯

HOB REL TO LCHR

Tgt Alt	m
HOB rel to Tgt **	+ m
Alt of Burst	= m
Alt of Lchr	− m
HOB rel to Lchr	= m
HOB rel to Lchr (10 m)	m

ADDENDUM COMPUTATIONS

Alt Tgt	393 m
Alt Lchr	−448 m
Ht of Tgt rel Lchr—H_T (1 m)	= −55 m
Ht of Tgt rel Lchr—H_T (10 m)	= −60 m

H_B	+1185 m
H_T (1m)	− −55 m
HOB above Tgt	= +1240 m

R_B (Trial)	17040 m
Met Corr to R_B	(+) 80 m
R_B (Corr) (1m)	= 17120 m
R_B (Corr) (10 m)	= 17120 m

Line Nr		Wind Az		Wind Vel		Temperature			Density		
0	3	6	4	3	6	9	6	7	0	0	3

Alt Tgt	393 m	Density Correction	—	0	3
Alt MDP	−360 m	Corrected Value	1 0	0	0
Alt Diff	+33 m				

Wind Az (100 ⨯)	6400 ⨯
+6400 (if nec)	+ ⨯
Sum	= 6400 ⨯
Az of Fire (100 ⨯)	−5000 ⨯
Chart Dir of Wind	= 1400 ⨯

CROSS WIND: L/(R) .98 (Comp) x 36 (Vel) = L/(R) 35 x .53 (Unit Corr) = L/(R) 19 ⨯ (Df Corr)

RANGE WIND: (H)/T .20 (Comp) x 36 (Vel) = (H)/T 7 Knots

Computations:

BALLISTIC FACTORS	Std	Known	Variation from Std	Unit Corr	Rg Corr +/−
Density	100%	100.0	D I 0.0		
Range Wind	0 Kn	H 7	(H) T 7	+11.4	+79.8
Met Corr to R_B (Trial)				(+)/−	79.8

R_B (Trial)

17053 + (40/100)(−8) = 17053.0 − 3.2 = 17049.8

17049.8 + (−10/100)(103) = 17049.8 − 10.3 = 17039.5 = 17040

H_B

1145 + (40/100)(100) = 1145 + 40 = 1185

**See FM 6-40-1A

DA FORM 1 FEB 69 6-56 REPLACES EDITION OF 1 JUL 61, AND DA FORM 2256-1-R, 1 JAN 62, WHICH ARE OBSOLETE

Figure 3-8①. Computer's record data correction sheet (Free Rocket), DA Form 6-56 (front) (sample mission 3).

Firing Table Entry Range (10 m) Comp Range or R_B (Corr) 17120 m	Firing Table Entry Height of Burst (10 m) HOB rel to Lchr or H_B +1180 m

Alt of Lchr 448 m	Az of Fire 5045 mil	Latitude of Lchr (10°) 30 Ⓝ/S	Df Corr L/Ⓡ (Adden) 19 mil

Initial Laying Data*	
*Az of OL	1258 mil
+6400 (if nec)	+6400 mil
Sum	= 7658 mil
*Az of Fire	− 5045 mil
Difference	= 2613 mil
−3200 (if nec)	− mil
*Orienting Angle	= 2613 mil
*QE (Trial) (1 mil)	524 mil

Computations (QE (Trial), TF (Trial), and Surface Pressure):

QE

518.0 + (80/100)(6) = 518.00+4.80 = 522.80

522.80+(20/100)(3.5) = 522.80+0.70 = 523.50 = 523.5

TF

42.40 + (80/100)(0.0) = 42.400+0.000 = 42.400

42.400+(20/100)(0.41) = 42.400+0.082 = 42.482 = 42.48

Surface Pressure = 988 mb = ____ %

Alt Lchr (10m)	450 m
Alt MDP (10m)	− 360 m
Lchr (above)/below MDP	+ 90 m
Az of Wind (100 mil)	6000 mil
+6400 (if nec)	+ mil
Sum	= 6000 mil
Az of Fire (100 mil)	− 5000 mil
Chart Dir of Wind	= 1000 mil

Met Station			Use	Type	Oct	Latitude			Longitude		
M	E	T	B	3	1	3	4	4	9	8	2
Day		B. Time		E. Time		Altitude MDP			Sur. Press. (MDP)		
0	1	0	4	0	2	0	3	6	9	7	2
Line Nr		Wind Az		Wind Vel		Temperature			Density		
0	6	6	0	~~3~~	~~4~~	9	6	6	0	0	2
Density-Temperature Corr						−	0	2	−	0	9
Corrected Values 39 MPH						~~9~~ 4	~~6~~ 0	~~4~~ °F	9	9	3

CROSS WIND Ⓡ.83 x 39 = Ⓡ32 x .40 = Ⓡ13 mil (Comp, Vel, Unit Corr)

RANGE WIND Ⓗ/T .56 x 39 = Ⓗ/T 22 ~~kn~~/mph (Comp, Vel)

BALLISTIC FACTORS	Std	Known	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant	____ °	Decrease							
Temperature	77°F	78		0.39	−0.39	DⒾ 1	−0.016		0.016
Propellant Weight	2050 lb	2049	0.42		+0.42	ⒹI 1	+0.026	0.026	
Surface Pressure	~~100%~~ 1013mb	988		1.62	−0.065	ⒹI 25	−0.0042		0.105
Density	100%	99.3		2.18	−3.11	ⒹI 0.7	−0.266		0.186
Air Temperature	~~100%~~ 59°F	40		2.66	−0.14	ⒹI 19	−0.009		0.171
Empty Weight	3850 lb	3840		1.10	−0.11	ⒹI 10	−0.006		0.060
Range Wind	~~0Kn~~ 0mph	H 22	7.92		+0.36	ⒽT 22	+0.040	0.880	
			8.34	7.95	Met Corr to QE & TF			0.906	0.538
			7.95					0.538	
			0.39					0.368	

DEFLECTION	L	R	QUAD ELEV +	QUAD ELEV −		FUZE SETTING +	FUZE SETTING −
Df Corr (Adden)		19					
Cross Wind Corr		13					
Rotation Corr	1						
Drift Corr			0.4		Met Correction	0.37	
	1	32	1.7		Rotation Correction	0.00	
		1					
Total Df Corr		31	2.1		Total QE & TF Correction	0.37	

LLW CORR — CROSS (Df) Ⓛ/R 37 x 6.00 = Ⓛ/R 222 (Vel, Unit Corr, LLW); RANGE (QE) H+/T− 1 x 2.38 = ⊖/+ 2.4 (Vel, Unit Corr, LLW)

Aiming Point Df	1462	QE (Trial) (0.1 mil)	523.5	TF (Trial) (0.01)	42.48
Df Correction	L/Ⓡ 31	QE Correction	⊕ 2.1	TF Correction	⊕ 0.37
Df (Corrected)	1431	QE (Corrected)	525.6	TF (Corrected) (.1)	42.8
Low Level Wind	Ⓛ/R 222	Low Level Wind	± 2.4	Fuze Corr	⊕ 0.2
Df FIRED	1653	QE FIRED	523.2	FS FIRED	43.0

Figure 3-8②. Computer's record data correction sheet (Free Rocket), DA Form 6-56, (reverse) (sample mission 3).

(*c*) The height of burst relative to launcher (H_B) is determined from the same page as trial R_B. Interpolation is made in column 5 between heights of target relative to launcher, column 2, for a LOW height of burst relative to target, column 1. Interpolate between −100 meters and 0 meters as follows:

$$100\left[\begin{matrix} H_T \\ 0 \\ -60 \\ -100 \end{matrix}\right]40 \qquad X\left[\begin{matrix} H_B \\ 1245 \\ ? \\ 1145 \end{matrix}\right]100$$

$$\frac{40}{100} = \frac{X}{100} \text{ or } X = 100\left(\frac{40}{100}\right) = 40$$

Therefore, the H_B corresponding to H_T of −60 meters = 1145 + 40 = 1,185 meters. Enter this value in the H_B space of the ADDENDUM COMPUTATIONS section.

(*d*) The height of burst above target must now be computed in order to determine the applicable line of the met message. Algebraically subtract the H_T (1m) (−55 meters) from H_B (+1,185 meters) to obtain the height of burst above target (+1,240 meters). Enter this value in the HOB above Tgt space of the ADDENDUM COMPUTATIONS section.

(*e*) Determine the applicable line number of the met message by entering table A, page 7, with the height of burst above target (+1,240 meters). The line number is 03, and the data from this line in the current met message are 03 64 36 967 003. Enter these data in the Line Nr. Wind Az, Wind Vel, Temperature, and Density spaces of the ADDENDUM COMPUTATIONS section.

(*f*) Determine the height of the target with reference to the MDP. From group 4 of the introduction of the current met message, determine the altitude of the meteorological datum plane (MDP) to be 360 meters. Subtract the altitude of the MDP from the altitude of the target (+393 meters) to obtain the height of the target with reference to the MDP (+33 meters). Enter this value in the Alt Diff space of the ADDENDUM COMPUTATIONS section.

(*g*) Correct the air density from line 03 to the met message for the difference in altitude between the target and the MDP. Enter the Air Density Corrections table on page 3 with the height of the target with reference to the MDP expressed to the nearest 10 meters (+30 meters) and determine the air density correction to be −0.3 percent. Enter this value in the Density Correction space and subtract the value from the density (100.3 percent) to obtain the corrected density (100.0 percent). Enter this value in the Corrected Value space of the ADDENDUM COMPUTATIONS section.

(*h*) Determine the chart direction of the wind by subtracting the azimuth of fire from the azimuth of the ballistic wind, adding 6,400 mils if necessary. Enter the computations in the appropriate spaces in the ADDENDUM COMPUTATIONS section.

Azimuth of ballistic wind (nearest 100 mils)	6,400 mils
Azimuth of fire (nearest 100 mils)	−5,000 mils
Chart direction of ballistic wind	1,400 mils

(*i*) Convert the ballistic wind data to range and cross wind components. Enter the Correction Components of a One Knot Wind table on page 2 with the chart direction of the wind (1,400 mils) to obtain—

Cross wind correction component = R.98
Range wind correction component = H.20

The ballistic cross and range winds are the products of the wind velocity from line 03 of the met message (36 knots) and the correction components just determined. Hence,

Ballistic cross wind = R.98 × 36 = R35 knots

Ballistic range wind = H.20 × 36 = H7 knots

Enter these computations in the CROSS WIND and RANGE WIND blocks of the ADDENDUM COMPUTATIONS section.

(*j*) A correction to azimuth (deflection) must be applied to compensate for the ballistic cross wind. Enter table B (launcher-target range = 17,800 meters, height of burst relative to target = LOW, and H_T = −100 meters) and determine the correction for a ballistic cross wind of 1 knot (colm 10) to be 0.53 mils. The correction for a cross wind of R35 is R35 × 0.53 = R19 mils. Enter the correction in the Df Corr space of the CROSS WIND block. This correction to deflection must be included in the total deflection correction in computing the deflection to be fired.

(*k*) Determine the met corrections to trial R_B to compensate for nonstandard conditions of ballistic air density and ballistic range wind.

BALLISTIC FACTORS	Std	Known	Variation from Std	Unit Corr	Rg Corr +/-
Density	100%	100.0	D I 0.0		
Range Wind	0 Kn	H 7	Ⓗ T 7	+11.4	+79.8
Met Corr to R_B (Trial) ⊕					79.8

Figure 3–9. Meteorological corrections to trial range to burst (sample mission 3).

Compare the known conditions of ballistic air density and ballistic range wind with the standard conditions to determine the variations from standard. Enter column 8 of table B (launcher-target range = 17,800 meters, height of burst relative to target = LOW, and H_T = −100 meters) to determine the unit correction factor for ballistic range wind. (No correction is required for ballistic air density since the variation from standard is 0.) Then multiply the factor by the variation from standard to determine the correction to trial R_B. Enter the computations in the appropriate spaces in the BALLISTIC FACTORS block as shown in figure 3–9.

(*l*) Determine the corrected range to burst (R_B (corr)). Algebraically add the met correction to R_B (+80 meters) to the R_B (trial) (17,040 meters) to obtain the corrected range to burst (17,120 meters). Enter this value in both spaces ((1m) and (10m)) of the R_B (corr) block, since in this case the corrected range to burst is already expressed to the nearest 10 meters.

Note: All subsequent computations are made on the reverse side of DA Form 6-56. At the top of the form, enter the following values that were computed on the front side of the form:

Firing table entry range (R_B (corr) (nearest 10 meters)	17,120 meters
Firing table entry height of burst (H_B) (nearest 10 meters)	+1,180 meters
Altitude of launcher	448 meters
Azimuth of fire	5,045 mils
Latitude of launcher (nearest 10°)	30° N
Deflection correction (adden)	R19 mils

(5) *Orienting angle.* In the Initial Laying Data block, enter the azimuth of the orienting line (1,258 mils), add 6,400 mils, subtract the azimuth of fire (5,045 mils), and obtain the value of the orienting angle (2,613 mils).

g. Compute and record the trial quadrant elevation.

(1) Enter table C, FTR 762–F–1, and interpolate as follows:

	HOB			EL	
100	1200			524	6
	1180	80	X	?	
	1100			518	

$$\frac{80}{100} = \frac{X}{6} \text{ or } X = 6\left(\frac{80}{100}\right) = +4.80$$

Therefore, the elevation corresponding to HOB +1,180 meters and range 17,100 meters = 518.00 + 4.80 = 522.80 mils. Obtain the c factor (colm E3) at height +1,200 meters and range 17,100 meters and determine the trial QE: Trial QE = 522.80 + (20/100) (3.5) = 522.80 + 0.70 = 523.50 or 523.5 mils.

(2) Transmit the initial laying data to the firing section.

(*a*) Azimuth of the orienting line	1,258 mils
(*b*) Azimuth of fire	5,045 mils
(*c*) Orienting angle	2,613 mils
(*d*) Trial QE	524 mils

h. Compute and record the trial time of flight. Enter table D and interpolate as follows:

	HOB			TF	
100	1200			42.4	0
	1180	80	X	?	
	1100			42.4	

$$\frac{80}{100} = \frac{X}{0} \text{ or } X = 0\left(\frac{80}{100}\right) = 0.000$$

Therefore, the time of flight corresponding to HOB + 1,180 meters and range 17,100 meters = 42.400 + 0.000 = 42.400 seconds. Obtain the t factor (colm T3) at HOB +1,200 meters and range 17,100 meters and determine the trial TF: Trial TF = 42.400 + (20/100) (0.41) = 42.400 + 0.082 = 42.482 or 42.48 seconds.

i. All MGR-1A firing tables are based on the ordnance standard (US) met and the ICAO atmosphere. Therefore, conversion of the ballistic met to the US format is required before continuing computations. All firing tables (and changes) contain the tables required for this conversion. The procedure, using change 3 to FTR 762-F-1, is as follows:

(1) Enter the Line Number of Ballistic Meteorological Message table (page 16, change 3) with trial QE 524 to determine the line number applicable to this particular fire mission (06).

(2) The data from line 06 of the ballistic message are 06 60 34 966 002.

(3) The wind direction (6,000 mils) from the ballistic met message is used without conversion.

(4) The wind speed (34 knots) must be converted to miles per hour. Enter the Conversion of Knots to Miles Per Hour table (page 16.1, change 3) to perform this conversion: 34 knots = 39 mph.

(5) The ballistic air temperature percent of standard (96.6 percent of the ballistic met message must be converted to degrees Fahrenheit. First, correct the air temperature percent of standard to compensate for the difference in altitude between the launcher and the MDP. The difference is +90 meters (450 − 360 = +90 meters). Enter the Air Temperature, Air Density, and Surface Air Pressure Corrections table (page 15, change 3) with this difference. In this case, the air temperature correction is −0.2 percent. Algebraically add the temperature correction to the air temperature percent of standard. The corrected value is 96.4 percent (96.6 − 0.2 = 96.4). Next, enter the Conversion of Percent Standard Temperature to Degrees Fahrenheit table (page 16.2, change 3) to convert 96.4 percent of standard to degrees Fahrenheit: 96.4 percent = 40° F.

(6) The ballistic air density percent of standard (100.2 percent) of the ballistic met message must be corrected. Again enter the Air Temperature, Air Density, and Surface Air Pressure Corrections table (page 15, change 3) with the height of the launcher with reference to the MDP (+90 meters). The air density correction is −0.9 percent. Algebraically add this correction to the air density percent of standard. The corrected value is 99.3 percent (100.2 − 0.9 = 99.3). No further conversion is required.

(7) Record the corrected data in the appropriate spaces on the form.

j. Since all MGR-1A firing tables are based on the ordnance standard (US) met and the ICAO atmosphere, the surface air pressure of 988 millibars measured with a barometer at the launcher does not require conversion to a percent of standard surface air pressure. Enter this value (988) in the appropriate spaces of the Computations space and BALLISTIC FACTORS block on DA Form 6-56.

k. Before corrections can be determined for existing meteorological conditions, the ballistic wind data must be reduced to cross wind and range wind components.

(1) Determine the chart direction of the wind by subtracting the azimuth of fire from the azimuth of the ballistic wind. (In this sample mission, it is not necessary to add 6,400 mils.)

Azimuth of ballistic wind (nearest 100 mils)	6,000 mils
Azimuth of fire (nearest 100 mils)	−5,000 mils
Chart direction of ballistic wind	1,000 mils

(2) Using this chart direction, enter the "Correction" Components of a One Mile Per Hour Wind table (page 12) to obtain

Cross wind correction component = R.83
Range wind correction component = H.56

The ballistic cross and range winds are the products of the wind velocity from line 03 of the met message (39 mph) and the correction components just determined. Hence,

Ballistic cross wind = R.83 × 39 = R32 mph
Ballistic range wind = H.56 × 39 = H22 mph

(3) A correction to deflection must be applied to compensate for the ballistic cross wind. Enter table A (range = 17,000 meters) and determine the unit correction factor for a ballistic cross wind of 1 mile per hour to be 0.40 mil. The correction for a cross wind of R32 miles per hour is R13 mils.

Ballistic Cross Wind	R32 mph
Multiplied by Correction Factor	× 0.40
Equals Cross Wind Correction	= R12.8 or R13 mils

l. Determine and record the corrections to QE and TF to compensate for nonstandard conditions of materiel and weather.

(1) Enter the known value for each ballistic factor and compute the variations from standard as shown in figure 3-10.

BALLISTIC FACTORS	Std		Known	Variation from Std
Propellant Temperature	____° Decrease			
	77°F		78	D(I) 1
Propellant Weight	2050 lb		2049	(D)I 1
Surface Pressure	~~100%~~	1013mb	988	(D)I 25
Density	100%		99.3	(D)I 0.7
Air Temperature	~~100%~~	59° F	40	(D)I 19
Empty Weight	3850 lb		3840	(D)I 10
Range Wind	~~0Kn~~	0mph	H22	(H)T 22

Figure 3–10. Ballistic factors and variations from standard (sample mission 3).

BALLISTIC FACTORS	+	−	Unit Corr to QE	Variation from Std	Unit Corr to TF	+	−
Propellant Temperature							
		0.39	−0.39	D(I) 1	−0.016		0.016
Propellant Weight	0.42		+0.42	(D)I 1	+0.026	0.026	
Surface Pressure		1.62	−0.065	(D)I 25	−0.0042		0.105
Density		2.18	−3.11	(D)I 0.7	−0.266		0.186
Air Temperature		2.66	−0.14	(D)I 19	−0.009		0.171
Empty Weight		1.10	−0.11	(D)I 10	−0.006		0.060
Range Wind	7.92		+0.36	(H)T 22	+0.040	0.880	
	8.34	7.95				0.906	0.538
	7.95					0.538	
	0.39		Met Corr to QE & TF			0.368	

Figure 3–11. Meteorological corrections to quadrant elevation and time of flight (sample mission 3).

(2) Enter tables C and D, part 2, with the range and height of burst relative to the launcher to the nearest 100 meters (range 17,100 meters and HOB +1,200 meters) and obtain the unit corrections to QE and TF for each variation from standard. Multiply each unit correction by the corresponding variation and compute the algebraic sums of these products. These sums are the corrections to QE and TF for the non-standard conditions of weather and materiel. The computations are shown in figure 3–11.

m. Determine and record the corrections to deflection, TF, and QE to compensate for the rotation of the earth.

Deflection (table B)	L1
Time of flight (table F)	0 (0.0 × 0.87)
Quadrant elevation (table F)	+1.7 (+2 × 0.87)

n. Compute the total corrections to deflection, quadrant elevation, and time of flight and the corrected deflection, quadrant elevation, and time of flight shown in figure 3–12.

o. A correction to TF must be applied to compensate for a bias in the M421 fuze. Add the correction shown in table J, part 2 (+0.2 second), to the corrected TF to determine the fuze setting to be fired (42.8 seconds + 0.2 = 43.0 sec-

DEFLECTION	L	R	QUAD ELEV			FUZE SETTING	
Df Corr (Adden)		19					
Cross Wind Corr		13					
Rotation Corr	1		+	−		+	−
Drift Corr			0.4		Met Correction	0.37	
	1	32	1.7		Rotation Correction	0.00	
		1					
Total Df Corr		31	2.1		Total QE & TF Correction	0.37	

Aiming Point Df	1462	QE (Triol) (0.1m)	523.5	TF (Triol) (0.01)	42.48
Df Correction	L(R) 31	QE Correction	(+) 2.1	TF Correction	(+) 0.37
Df (Corrected)	1431	QE (Corrected)	525.6	TF (Corrected) (.1)	42.8

Figure 3-12. Computation of corrected deflection, quadrant elevation, and time of flight.

onds). The following fire commands can now be sent to the firing section:

Deflection	1,431 mils
Time	43.0 seconds
Quadrant elevation	525.6 mils

p. Corrections to deflection and QE must be applied to compensate for low-level winds. The cross wind (L37 mph) and range wind (T1 mph) are obtained from the wind speed indicator of the wind measuring set.

(1) Since the conditions are ALL OTHER THAN NIGHTTIME, table E-1, part 2, change 3, is used for determining the correction factors. The corrected QE to the nearest mil (526 mils) is not listed; therefore the correction factors are determined by interpolation.

(*a*) By interpolation, determine a deflection correction factor of 6.00. The deflection correction = 6.00 × L37 = L222 mils.

(*b*) By interpolation, determine an elevation (tail wind) correction factor of −2.38. The elevation correction = −2.38 × T1 = −2.38 or −2.4 mils.

(2) Determine the deflection to be fired and the QE to be fired by adding the low-level wind corrections to the corrected deflection and corrected QE.

Deflection fired = 1431 + 222 = 1,653 mils
QE fired = 525.6 + (−2.4) = 523.2 mils

Section III. PROCEDURES FOR UNUSUAL CONDITIONS

3-8. Surface Air Pressure When Barometer is Not Available

If there is no properly functioning barometer available, the heading of the met message and any MGR-1B firing table can be used to determine surface air pressure. The following example illustrates this method of determining surface air pressure:

a. Known data are as follows:

(1) Type of rocket	MGR-1B
(2) Altitude of launcher	450 meters
(3) Height of launcher above the MDP	+80 meters
(4) Heading of the met message	METB31 344982 141200 037990

b. Since the heading of the met message gives the surface air pressure at the MDP, a correction must be applied to compensate for the difference in altitude between the launcher and the MDP. Enter table B with the height of the launcher above the MDP (+80 meters) and extract the surface air pressure correction (−0.9). Algebraically add the correction to the surface air pressure at the MDP to determine the surface air pressure at the launcher altitude.

Surface air pressure at the MDP	99.0 percent
Plus surface air pressure correction	− 0.9 percent
Surface air pressure at the launcher altitude	=98.1 percent

Note: When the MGR–1A rocket is fired, enter table C to convert the surface air pressure expressed as a percent of standard to millibars; for example, 93.6 percent = 948 millibars.

3–9. Low-Level Wind Data When Windset is Not Available

If there is no properly functioning windset available, a pilot balloon technique may be used to determine low-level winds. If there is neither a windset nor a pilot balloon available, line 01 of the met message may be used to determine low-level winds.

a. Single Theodolite Pilot Balloon Method. Low-level winds may be measured by using a standard theodolite (ML–247 with tripod ML–79 or ML–474–GM with tripod ML–79 or MT–1309–GM) and a 30-gram pilot balloon. In the single theodolite method, a standard rate of rise is assumed for the 30-gram balloon. This assumption is subject to gross error. Consequently, this method is recommended as a secondary means or backup for the windset. The corrections obtained in this manner ordinarily will not be as reliable as windset corrections weighted for profile conditions. The procedure for determining corrections by this method is outlined in (1) through (5) below. The computations required are illustrated in figure 3–13.

(1) *Location of theodolite.* The theodolite should be located near the launcher, approximately 50 meters upwind.

(2) *Orientation of theodolite.* The theodolite must be oriented in the direction of fire; that is, the azimuth reading must be zero when the operator's line of sight through the right-angle telescope is in the direction of fire. This can be accomplished by either the orienting angle method or the aiming circle method.

(*a*) *Orienting angle method.* The orienting angle method is recommended as the primary method for orienting the theodolite, since it produces the most accurate solution with minimum effort by the launcher crew. A theodolite stake (location) must be emplaced and an orienting line (line of known direction) must be established in the firing position by the unit survey section. The orienting angle, which is based on the azimuth of fire, is computed by the fire direction center in a manner similar to that of computing the orienting angle for the launcher. The exception is that the theodolite orienting angle must be computed in degrees (to the nearest tenth of a degree). The procedure for the theodolite crew is as follows:

1. Set up and level the theodolite (TM 11–6675–200–10) over the theodolite stake.

2. Obtain the orienting angle from the launcher section commander.

3. Disengage the azimuth and tracking control and set the orienting angle on the azimuth scale.

4. Engage the azimuth tracking control and loosen the azimuth calibration clamp.

5. Approximately orient the theodolite by sighting on the far end of the orienting line (through the telescope), using the fast motion.

6. Tighten the azimuth calibration clamp and precisely orient the theodolite by using the azimuth calibration adjustment.

(*b*) *Aiming circle method.* The aiming circle must be oriented in the direction of fire. After the aiming circle has been oriented, the following procedures should be used:

1. Set up and level the theodolite.

2. Sight on the telescope of the theodolite with the aiming circle and determine the instrument reading (not the deflection).

3. Convert this reading to degrees (nearest tenth of a degree) and relay the information to the theodolite operator.

4. Disengage the azimuth tracking control and set the reading obtained from the aiming circle on the azimuth scale of the theodolite. Engage the azimuth tracking control.

5. Loosen the azimuth calibration clamp on the theodolite.

6. Plunge the theodolite telescope.

7. Sight the theodolite on the aiming circle, using the fast motion.

8. Tighten the azimuth calibration clamp on the theodolite and sight exactly on the aiming circle, using the azimuth calibration adjustment.

9. Plunge the telescope back to 0° elevation. The theodolite is now oriented.

(3) *Inflation procedures.* Inflate the 30-gram balloon, using the procedures prescribed in FM 6–15 and TM 11–6660–222–12. The balloon must be inflated while in an enclosed shelter to protect it from the wind. Errors in the rate of rise will result from improper inflation. A ¾-ton or 2½-ton truck with canvas installed may be used as a shelter.

(4) *Determination of low-level wind components.* The wind measurement is accomplished by a single observation of the pilot balloon. The time of the observation depends on the quadrant ele-

LOW LEVEL WIND CORRECTIONS, SINGLE THEODOLITE PILOT BALLOON TECHNIQUE

1. Weather conditions:
   - A. Nighttime ______
   - B. All other than nighttime __X__
2. Theodolite orienting data:
   - A. Azimuth orienting line __196.1__ degrees
   - B. Azimuth of fire __260.3__ degrees
   - C. Orienting angle __295.8__ degrees
3. Time of flight for balloon __32__ seconds
4. Vertical angle to balloon __48.7__ degrees
5. Azimuth reading to balloon __241__ degrees
6. Total corrections low level winds:
   - A. Cross wind correction:
     Deflection: __7.3__ (wd speed) mph X R(L) __0.87__ (wd comp) = R(L) __6.4__ (cross wd) mph X __4.60__ (unit corr DF) mil = R(L) __29__ mil
   - B. Range wind correction:
     Quadrant elevation __7.3__ (wd speed) mph X (H)T __0.48__ (wd comp) = (H)T __3.5__ (range wd) mph X __+1.52__ (unit corr QE) mil = (+) __5.3__ mil
7. Final firing data:
   - A. Deflection (corrected) __2814__ mil
     Low level wd corr DF: R(L) __29__ mil
     FINAL DEFLECTION __2843__ mil
   - B. QE (corrected) __403.8__ mil
     Low level wd corr QE(+) __5.3__ mil
     FINAL QE __409.1__ mil

4. ______ degrees
5. ______ degrees
6A. ____mph X R L ______ = R L ______ mph
6B. ____mph X R L ______ = R L ______ mph

Use this box for data at firing time.

Figure 3–13. Low-level wind corrections, single theodolite and pilot balloon technique.

vation (corrected) and the existing wind profile. Both a vertical reading and a horizontal reading are obtained at the time of observation. The measured vertical angle is used to determine the wind speed. The measured horizontal angle is the basis for determining correction components used to resolve the indicated wind into range and cross wind components. The following example illustrates the procedures used to determine low-level wind components by the pilot balloon method.

(*a*) Known conditions are—

1. Rocket MGR–1A (FTR 762–F–1).

2. Quadrant elevation (corrected) 403.8 mils.

3. Existing wind profile ALL OTHER THAN NIGHTTIME.

(*b*) Determine the time to read the vertical and horizontal angles to the balloon from table B–14, appendix B. Enter the table with the quadrant elevation to the nearest listed value (400) and the existing wind profile (ALL OTHER THAN NIGHTTIME CONDITIONS) and extract the time: 32 seconds.

Note: If the quadrant elevation is less than the minimum value listed, use the minimum time listed.

(*c*) Read and record the vertical and horizontal angles to the pilot balloon 32 seconds after release. Determine the vertical angle to the nearest tenth of a degree and the horizontal angle to the nearest degree.

Vertical angle 48.7°
Horizontal angle 241°

(*d*) Enter table B–15, appendix B with the measured vertical angle (48.7°) and extract the wind speed: 7.3 miles per hour.

(*e*) Enter table B–16, appendix B, with the measured horizontal angle (241°) and extract the wind correction components.

Range wind correction component H.48
Cross wind correction component L.87

(*f*) Multiply the indicated wind speed by the correction components to determine the cross wind and range wind components in miles per hour.

Cross wind = 7.3 × L0.87 = L6 mph
Range wind = 7.3 × H0.48 = H4 mph

(5) *Determination of low-level wind corrections.* Wind profile corrections are not required when the pilot balloon method is used. The profile condition considered in determining the ob-

servation time is ignored, and unit corrections for a 1-mile-per-hour range or cross wind are determined from the Pilot Balloon or Met Line 0 correction table. The total correction to deflection or elevation to compensate for the low-level wind effects is the product of the wind component ((4) above) and the unit correction from the firing table. Continuing the example from (4) above, the procedure is as follows:

(*a*) Enter table E-3 (FTR 762-F-1) with the corrected quadrant elevation 404 mils (nearest mil) and determine the unit correction factors by interpolation for a 1-mile-per-hour low-level cross wind and head wind:

Cross wind unit correction factor	4.60
Head wind unit correction factor	+1.52

Note: The direction of the cross wind correction is determined from the letter preceding the cross wind component. The direction of the range wind correction is indicated by the sign of the unit correction.

(*b*) Multiply the unit correction factors by the appropriate wind component from (4)(*f*) above.

Cross wind (df): 4.60 × L6 = L28 mils
Range wind (QE): +1.52 × H4 = +6.1 mils

(*c*) Apply the corrections computed in (*b*) above to the corrected deflection and quadrant elevation. A correction to time of flight for the effects of low-level winds is not computed.

b. Met Message Line 01 Method. As a last resort, the surface winds may be estimated from line 01 of the ballistic or computer met message. Whether or not the values in line 01 approximate the surface winds the rocket will encounter depends on how old the measurement is, how far away the met station is, and how much difference exists between the terrain at the firing point and the terrain at the met station. Wind profile corrections are not required when the line 01 method is used. Unit corrections for a 1-mile-per-hour range or cross wind are determined from the Pilot Balloon or Met Line 0 correction table. The following example illustrates this method of determining low-level wind data:

Note: Met Line 0 was formerly recommended for this method because it was determined from data recorded from the first few seconds of balloon flight. Now, however, line 0 measurements are made on the surface with a handheld anemometer. Therefore, line 01 is a more accurate approximation of the rocket flight environment and is used with the Pilot Balloon or Met Line 0 correction table to compute low-level wind corrections.

(1) *Known conditions.*

(*a*) Rocket MGR-1B (FTR 762-G-1).

(*b*) Azimuth of fire 4,784 mils.

(*c*) Line 01 of met message 014309 029957.

(*d*) Quadrant elevation (corrected) 405.6 mils.

(2) *Determination of low-level wind components.* Calculate the chart direction of the wind, using the wind direction (azimuth) from line 01 of the met message.

Azimuth of wind (100 mils)	4,300 mils
Plus 6,400 mils (if necessary)	+ 6,400 mils
Sum	=10,700 mils
Minus azimuth of fire (nearest 100 mils)	− 4,800 mils
Equals chart direction of wind	= 5,900 mils

Using this chart direction of wind, enter the "Correction" Components of a Unit Wind table (table E, part 2) and obtain—

Range wind correction component	=H.88
Low-level cross wind correction component	=R.47

The line 01 wind velocity is 9 knots, which must be converted to miles per hour for use with wind table M-3. The conversion factor is 1.1508: 9 knots × 1.1508 = 10 mph. Hence, the range and cross wind components of the low-level wind are—

10 × H.88 = H9 mph
10 × R.47 = R5 mph

(3) *Determination of low-level wind corrections.* Finally, determine the QE and deflection corrections by multiplying these low-level wind components by the appropriate correction factor from table M-3 (Pilot Balloon or Met Line 0). Enter table M-3 with QE = 406 mils and interpolate. The final corrections are—

QE correction = H9 × 0.79 = +7.1 mils
Deflection correction = R5 × 2.32 = R12 mils

Section IV. DETERMINATION OF MINIMUM QUADRANT ELEVATIONS, MAXIMUM QUADRANT ELEVATION, AND CREST CLEARANCE

3-10. Determination of Minimum Quadrant Elevations

Three minimum quadrant elevations must be determined for the Honest John rocket system.

a. Launcher-rocket (firing platoon commander's) minimum quadrant elevation (MIN QE FPC).

b. Piece-crest minimum quadrant elevation (fig 3–14).

c. Intermediate crest minimum quadrant elevation (fig 3–14).

3–11. Launcher-Rocket Minimum Quadrant Elevation

a. General. The firing platoon (section) commander must compute the position-launcher-rocket minimum quadrant elevation and report it to the FDC. To determine this minimum QE, he must consider three factors:

(1) Rocket qualification quadrant elevation.

(2) Launcher-beam separation angle.

(3) Launcher emplacement angle.

b. Rocket Qualification Quadrant Elevation. The rocket qualification QE is the lowest QE for which safe results may be obtained when a particular rocket is fired. This restriction is imposed by the necessity of overcoming the force of gravity and varies with the mass of the rocket and the thrust developed by the rocket. *It is independent of the launcher position or launcher used.* Regardless of any other factor, a rocket may *never* be fired at a QE less than the qualification QE for that rocket. Rocket qualification QE's are as follows:

Rocket	*Qualification quadrant elevation*
MGR–1A	178 mils
MGR–1B	72 mils

c. Launcher-Beam Separation Angle. The launcher-beam separation angle is that minimum angle which is formed between the longitudinal axis of the launcher bottom carriage and the launcher rail (beam) to allow full traverse capabilities and to insure that the complete rocket will safely clear any part of the launcher when the rocket is fired. This angle is dependent on the launcher and rocket configurations. It varies with each launcher-rocket combination. The launcher-beam separation angles are as follows:

Launcher	*Rocket*	*Launcher-beam separation angle*
M289	MGR–1A	178 mils
	MGR–1B	178 mils
M386	MGR–1A	118 mils
	MGR–1B	72 mils
M33	MGR–1A	178 mils
	MGR–1B	72 mils

d. Launcher Emplacement Angle. The launcher emplacement angle is the slope of the launcher position in the direction of fire. The maximum emplacement angle for all launchers is ±178 mils (reverse slope of +178 mils and forward slope of −178 mils). The actual emplacement angle for all launchers except the M289 is determined by measuring the elevation of the launcher rail when it is locked in the traveling position. The launcher rail of the M289 launcher is separated from the truck chassis by 88 mils when the launcher rail is locked in the traveling position. To determine the emplacement angle for the M289 launcher, measure the beam elevation with the launcher emplaced and the beam locked in the traveling position and algebraically add −88 mils to the measured beam elevation. The sum is the launcher emplacement angle.

Example:

Measured beam elevation	+30 mils
Plus traveling position separation	−88 mils
Equals launcher emplacement angle	= −58 mils

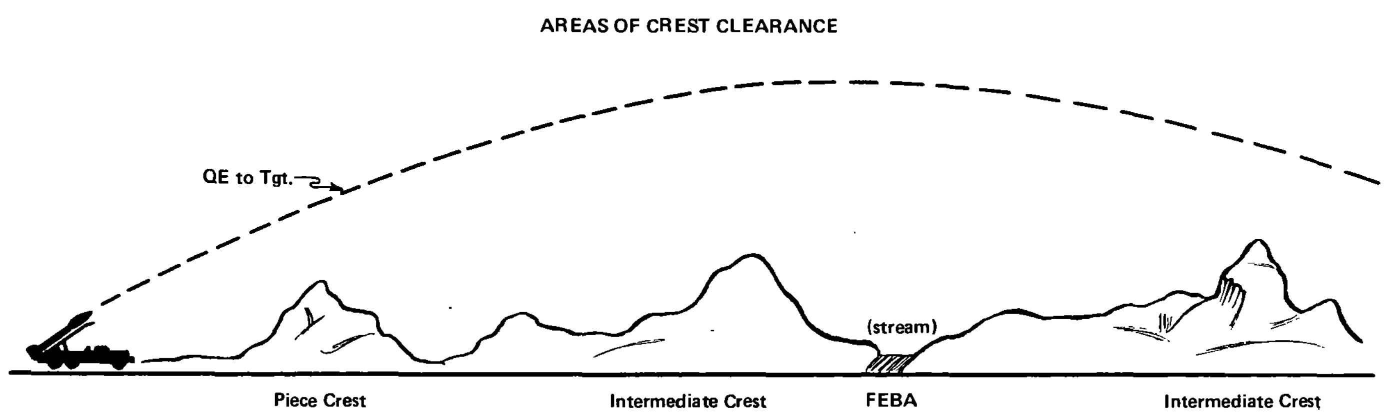


Figure 3–14. Areas of crest clearance.

e. Determination of Launcher-Rocket Minimum Quadrant Elevation. The procedure for determining launcher-rocket minimum quadrant elevation is as follows:

(1) Determine the emplacement angle.

(2) Enter table B–1, appendix B, with the launcher-rocket combination in use. In the Emplacement Angle columns of the Launcher-Rocket Minimum Elevation Calculations section, find the values within which the measured emplacement angle falls.

(3) If the emplacement angle falls between the two upper values shown for the launcher-rocket entry combination, extract the minimum QE from the Launcher-Rocket Minimum Elevation column.

(4) If the emplacement angle falls between the two lower values shown for the rocket-launcher entry combination, calculate the minimum QE by algebraically adding the lower value shown in the Launcher-Rocket Minimum Elevation column to the emplacement angle.

Example:

(*a*) Known conditions are—

Launcher	M386
Rocket	MGR–1A

(*b*) Determine and record the emplacement angle: +65 mils

(*c*) Enter table B–1 and determine that the emplacement angle falls between the two lower values shown on the M386–MGR–1A line. The minimum QE is, therefore, the algebraic sum of the lower value shown in the Launcher-Rocket Minimum Elevation column (118) and the emplacement angle (+65 mils): 118 + 65 = 183 mils.

3–12. Piece-Crest Minimum Quadrant Elevation

In addition to computing and reporting the launcher-rocket minimum quadrant elevation, the firing platoon commander must also report to the FDC the measured angle of site to crest and the piece-crest range. The piece crest is defined as the highest crest in front of, and visible from, the firing position. The piece-crest range may be determined from a map or may be estimated. The computation of the piece-crest minimum quadrant elevation is the responsibility of the S3 at the battalion or the fire direction officer at the battery. Four factors, expressed as angles, are added to produce the piece-crest minimum quadrant elevation (fig 3–15): the angle of site to crest; 60 meters vertical clearance at the crest converted to mils at the computational range by using the mil relation (when applicable as outlined in *a* and *b* below); 5.8 range probable errors (PE_r) at the computational range, converted to mils by using the meters-per-mil factor from the Ground Data table; and the elevation corresponding to the computational range. The computational range is the piece-crest range expressed to the nearest 100 meters.

Tables B–2 through B–13 in appendix B are piece-crest minimum quadrant elevation tables which include in the quadrant elevations the latter two angles when the computational range is 2,600 meters or less and the latter three angles when the computational range is greater than 2,600 meters. Enter tables B–2 through B–13 with the piece-crest range.

a. To calculate the piece-crest minimum QE

MINIMUM QUADRANT ELEVATION—PIECE CREST

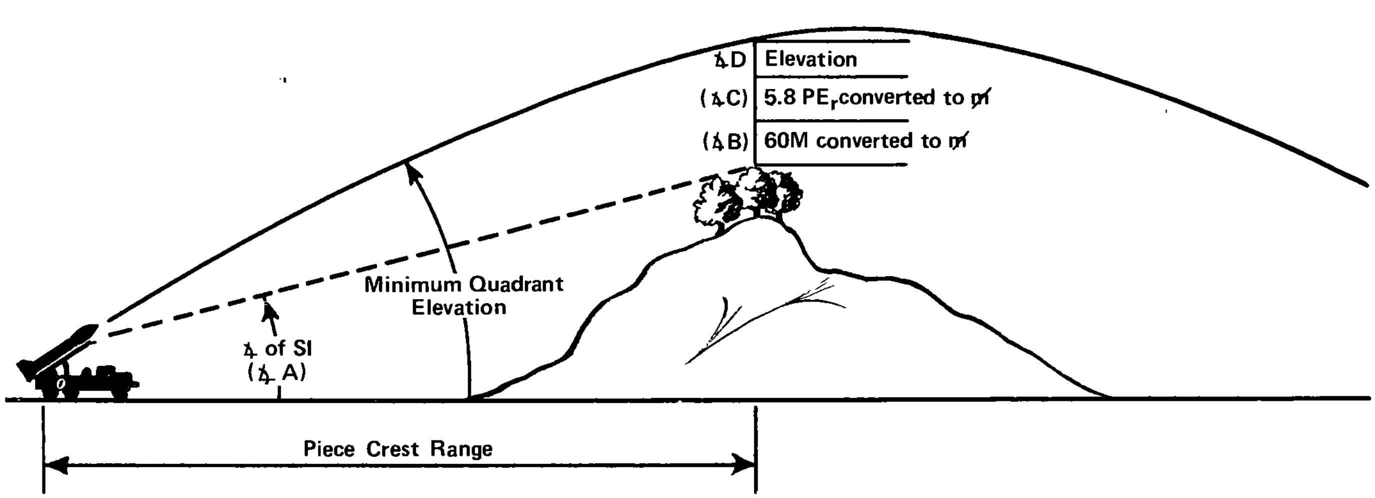


Figure 3–15. Piece-crest minimum quadrant elevation.

for all computational ranges and situations except as outlined in *b* below, enter the appropriate piece-crest minimum quadrant elevation table in appendix B, extract the piece-crest QE, and add this QE to the measured angle of site to crest reported by the firing platoon commander. The following example illustrates this procedure:

(1) Known conditions are—

Terrain in front of the launcher	not occupied
Piece-crest range	1,560 meters
Angle of site to crest	+50 mils
Rocket	MGR-1A
Firing table	FTR 762-F-1

(2) Record the measured angle of site reported by the firing platoon commander (angle A): +50 mils.

(3) Enter table B-7, appendix B, with the range to crest (1,560 meters) and determine that the piece-crest QE is 130 mils.

(4) Add the measured angle of site reported by the firing platoon commander to the value from the table: 130 + 50 = 180 mils.

(5) Record this sum as the piece-crest minimum quadrant elevation.

b. To calculate the piece-crest minimum QE when the computational range is 2,600 meters or less, the terrain immediately in front of the launcher (up to 2,600 meters) is occupied, and the commander wishes to follow the recommendations of AR 385-62, enter the appropriate piece-crest minimum quadrant elevation table in appendix B, extract the piece-crest QE, add this QE to the measured angle of site to crest reported by the firing platoon commander, and add this sum to the value of 60 meters vertical clearance at the crest converted to mils. The following example illustrates this procedure:

(1) Known conditions are:

Terrain in front of the launcher	occupied
Piece-crest range	1,220 meters
Angle of site to crest	+62 mils
Rocket	MGR-1B
Firing table	FTR 762-G-1

(2) Record the measured angle of site reported by the firing platoon commander (angle A): +62 mils.

(3) Enter table B-8, appendix B, with the range to crest (1,220 meters) and determine that the piece-crest QE is 96 mils.

(4) Add the measured angle of site reported by the firing platoon commander to the value from the table: 96 + 62 = 158 mils.

(5) Convert 60 meters to mils, using the mil relation, at a computational range equal to the range to crest expressed to the nearest 100 meters: $\not m = W/R = \not m = 60/1.2 = \not m = 50.0$.

(6) Add this value to the sum determined in (4) above: 158 + 50 = 208 mils.

(7) Record this sum as the piece-crest minimum quadrant elevation.

3-13. Intermediate Crest Minimum Quadrant Elevation

An intermediate crest is defined as a crest not visible from the firing position, lying between the firing position and the target (fig 3-16). Location of intermediate crest is based on a continuing study (usually by map) of the terrain within the unit's sector of fire.

a. The normal procedure for computing an intermediate crest minimum quadrant elevation is as follows:

(1) Compute the elevation to a point at the crest range and the height of crest with respect to the launcher plus 60 meters. Since the height of crest is known, the 60-meter vertical clearance can be added to it and the resulting sum can be used as the height argument for entry into the firing table. (When firing an M27, M47, or M48 warhead, see FM 6-40-1A for possible additional requirements.)

(2) Determine the value of 6 PE_r at the crest range and convert this value to mils, using the meters-per-mil factor. Interpolate in the Ground Data table at the crest range (nearest 100 meters) to determine the value of the PE_r and the meters-per-mil factor.

Note: The value of 6 probable errors is specified to give a very high assurance of clearing crests for peacetime conditions. For wartime conditions, this value can be relaxed to 4 probable errors and still achieve 99.65 percent assurance of clearing any intermediate crest. The 60-meter safety clearance value may also be ignored for unoccupied crests or for crests lying in enemy terrain, provided the commander is willing to accept less assurance of accomplishing the mission.

(3) The sum of the elevation to the point 60 meters above the crest ((1) above) plus the elevation change equivalent to 6 PE_r ((2) above) is the intermediate crest minimum quadrant elevation.

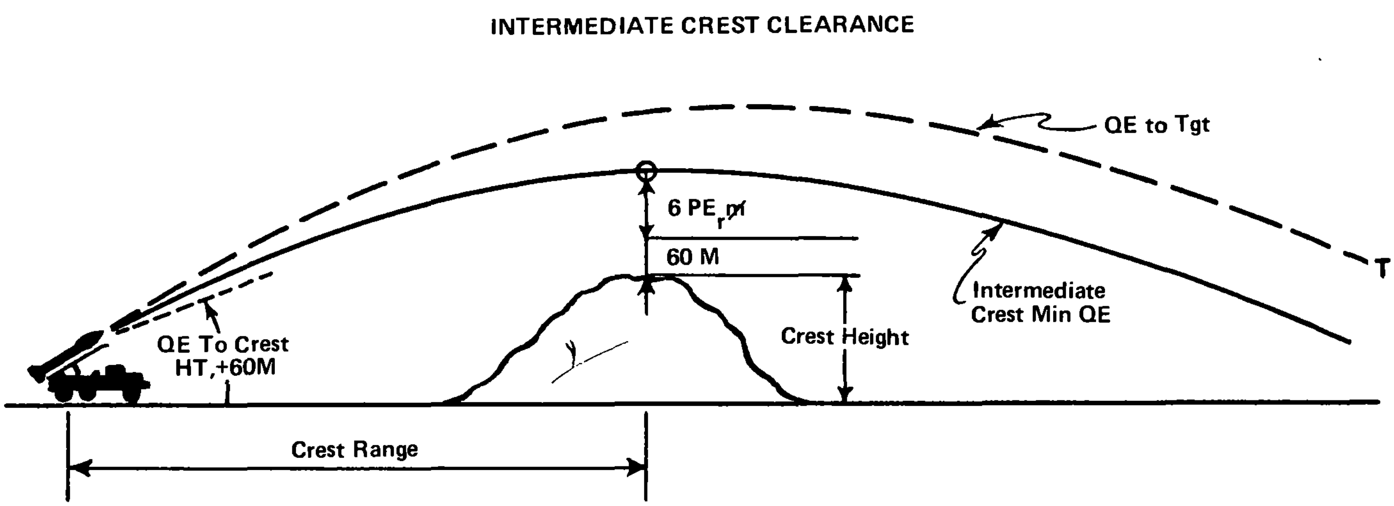


Figure 3–16. Intermediate crest clearance.

(4) The computational procedures are the same for all Honest John rockets. The following examples illustrate these procedures:

Example 1:

(*a*) Known conditions are—

Crest range	6,300 meters
Crest height (above launcher)	+520 meters
Rocket MGR–1B	FTR 762–H–1

(*b*) Add 60 meters to the crest height: 520 + 60 = +580 meters.

(*c*) Compute the elevation corresponding to crest range 6,300 meters and height +580 meters. Enter table G with the crest range to the nearest 100 meters and height to the nearest 10 meters (interpolate).

Note: Since the MGR–1B firing tables present data at 200-meter range increments, it is necessary to determine the elevation to this height at range 6,400 meters and then apply the elevation correction corresponding to a decrease of 100 meters to range 6,300 meters.

Range—6400	*Height*	*Elevation*
	600	217.6
	580	214.5
	500	202.1
Elevation at range 6,400 meters		214.5 mils
Minus c factor (determine at height +600 meters)		−(−0.6) mils
Elevation to a point 60 meters above the crest		215.1 mils

(*d*) Convert 6 PE_r at the crest range (6,300 meters) to mils, using the meters-per-mil factor. Determine the following from the Ground Data table (table F, part 2):

Meters-per-mil factor (colm 4) = 122 meters per mil (by interpolation)

PE_r (colm 6) = 414 meters (by interpolation)

Therefore, the elevation change corresponding to 6 PE_r is

$$\frac{(6 \times 414)}{122} = 20.4 \text{ mils}$$

(*e*) Add the values determined in (*c*) and (*d*) above and record the sum, to the nearest mil, as the intermediate crest minimum quadrant elevation.

215.1 + 20.4 = 235.5 or 236 mils

Example 2:

(*a*) Known conditions are—

Crest range	7,700 meters
Crest height (above launcher)	+370 meters
Rocket MGR–1A	FTR 762–F–1

(*b*) Add 60 meters to the crest height: 370 + 60 = +430 meters.

(*c*) Compute the elevation corresponding to crest range 7,700 meters and height +430 meters.

Height	*Elevation*
500	288
430	278.9
400	275

Elevation to a point 60 meters above the crest — 278.9 mils

(*d*) Convert 6 PE_r at crest range to mils, using the meters-per-mil factor. From the Ground Data table—

Meters-per-mil factor = 69 meters per mil (by interpolation)

PE_r = 448 meters (by interpolation)

Therefore, the elevation change corresponding to 6 PE_r is

$$\frac{(6 \times 448)}{69} = 39.0 \text{ mils}$$

(*e*) Add the values determined in (*c*) and (*d*) above and record the sum, to the nearest mil, as the intermediate crest minimum quadrant elevation.

278.9 + 39.0 = 317.9 or 318 mils

b. Alternate procedures for computing an intermediate crest minimum quadrant elevation are necessary if the normal procedure (*a* above) cannot be used because the crest height and/or the crest range are not listed in the elevation table of the firing table (table C in MGR-1A firing tables and table G in MGR-1B firing tables). These alternate procedures are as follows:

(1) One alternate procedure is used when the range to crest is less than 5,000 meters (nearest 10 meters).

(*a*) Compute the angle of site to a point at the crest range and the height of crest with respect to the launcher plus 60 meters vertical clearance. (The 60-meter vertical clearance is used for all crest ranges greater than 2,600 meters or for all ranges when the terrain up to 2,600 meters in front of the launcher is occupied and the commander wishes to follow the recommendations of AR 385-62.) Divide the range to the crest into the vertical interval. This quotient (nearest ten thousandth) is the tangent of the angle of site. Enter the Natural Trigonometric Functions in Mils table of the firing table and determine the angle of site in mils corresponding to the tangent (nearest tenth of a mil). (When firing an M27, M47, or M48 warhead, see FM 6-40-1A for possible additional requirements.)

(*b*) Determine the value of 6 PE_r at the crest range and convert this value to mils, using the meters-per-mil factor. Interpolate in the Ground Data table at the crest range (nearest 100 meters) to determine the value of the PE_r and the meters-per-mil factor. For crest ranges less than 5,000 meters, use the PE_r and meters-per-mil factor for a range of 5,000 meters.

(*c*) Determine the elevation corresponding to the crest range (nearest 100 meters) by interpolation from the Ground Data table. For crest ranges less than 1,000 meters, use the elevation for 1,000 meters.

Note: When firing an MGR-1A rocket, use the elevations for ranges less than 5,000 meters as listed in table B-17.

(*d*) The sum of the three angles in (*a*), (*b*), and (*c*) above is the intermediate crest minimum quadrant elevation.

(*e*) The computational procedures are the same for all Honest John rockets. The following example illustrates these procedures:

Example:

1. Known conditions are—

Terrain in front of the launcher	not occupied
Crest range	1,840 meters
Crest height (above launcher)	+430 meters
Rocket MGR-1B	FTR 762-H-1

2. Do not add 60 meters to the crest height since the crest range is less than 2,600 meters and the terrain in front of the launcher is not occupied.

3. Since the crest range is less than the smallest value listed in table G of the firing table, use the alternate procedure for determining intermediate crest minimum quadrant elevation.

4. Determine the angle of site to the crest by converting the vertical interval (+430 meters) to mils. Divide the range to the crest into the vertical interval. This quotient (nearest ten thousandth) is the tangent of the angle of site. Enter the Natural Trigonometric Functions in Mils table and determine the angle of site in mils corresponding to the tangent (nearest tenth of a mil).

$$\text{Tangent} = \frac{430}{1840} = 0.2337$$

Arctan 0.2337 = 233.8 mils (by interpolation)

5. Convert 6 PE_r to mils, using the meters-per-mil factor. Since the crest range is less than 5,000 meters, use the PE_r and meters-per-mil factor for a range of 5,000 meters.

Meters-per-mil factor (colm 4) = 133 meters-per-mil

PE_r (colm 6) = 440 meters

Therefore, the elevation change corresponding to 6 PE_r is:

$$\frac{(6 \times 440)}{133} = 19.8 \text{ mils}$$

6. Compute the elevation corresponding to crest range (nearest 100 meters) 1,800 meters from the Ground Data table:

Elevation (colm 2) = 86.5 mils (by interpolation)

7. Add the values determined in *4*, *5*, and *6* above and record the sum, to the nearest mil, as the intermediate crest minimum quadrant elevation.

233.8 + 19.8 + 86.5 = 340.1 or 340 mils

(2) Another alternate procedure is used when the range to crest is 5,000 meters or greater (nearest 10 meters).

(*a*) Compute the elevation to a point at the crest range and the height of crest with respect to the launcher plus 60 meters. (When firing an M27, M47, or M48 warhead, see FM 6-40-1A for possible additional requirements.) Enter the elevation table of the firing table at the crest range to the nearest listed value and extract the elevation corresponding to the largest listed height. Apply the appropriate portion of the c factor to this elevation to determine the elevation corresponding to the crest range (nearest 10 meters) and the largest listed height. From the elevation corresponding to the largest listed height, subtract the elevation corresponding to the next lower listed height. The difference is the number of mils corresponding to a 100 meter change in height. Next subtract the largest listed height from the total vertical interval and divide 100 into this difference. Multiply the quotient by the difference in mils for a 100 meter change in height determined above. The product (nearest tenth of a mil) is the angle in mils corresponding to the difference in height between the largest listed height and the total vertical interval. Add this angle to the elevation already computed. The sum is the required elevation.

(*b*) Determine the value of 6 PE_r at the crest range and convert this value to mils, using the meters-per-mil factor. Interpolate in the Ground Data table at the crest range (nearest 100 meters) to determine the value of the PE_r and the meters-per-mil factor.

(*c*) The sum of the elevation to the point 60 meters above the crest ((*a*) above) plus the elevation change equivalent to 6 PE_r ((*b*) above) is the intermediate crest minimum quadrant elevation.

(*d*) The computational procedures are the same for all Honest John rockets. The following example illustrates these procedures:

Example:

1. Known conditions are —

Crest range	5,390 meters
Crest height (above launcher)	+2,560 meters
Rocket MGR-1B	FTR 762-H-1

2. Add 60 meters to the crest height: 2,560 + 60 = +2,620 meters.

3. Since the crest height plus 60 meters in higher than the highest value listed in table G of the firing table, use the alternate procedure for determining intermediate crest minimum quadrant elevation.

4. Enter the elevation table of the firing table at the crest range to the nearest listed value (5,400 meters) and extract the elevation corresponding to the largest listed height (2,500 meters): 547.3 mils.

5. Apply the appropriate portion of the c factor to this elevation to determine the elevation corresponding to the crest range (5,390 meters) and the largest listed height: $(-0.1 \times -6.1) + 547.3 = 0.6 + 547.3 = 547.9$ mils.

6. From the elevation corresponding to the largest listed height, subtract the elevation corresponding to the next lower listed height. The difference is the number of mils corresponding to a 100 meter change in height.

$547.3 - 532.2 = 15.1$ mils

7. Subtract the largest listed height from the total vertical interval and divide 100 into this difference. Multiply the quotient by the difference in mils for a 100 meter change in height determined in *6* above. The product (nearest tenth of a mil) is the angle in mils corresponding to the difference in height between the largest listed height and the total vertical interval.

$$\left(\frac{2620 - 2500}{100}\right) \times 15.1 = 1.2 \times 15.1 = 18.12 \text{ or } 18.1 \text{ mils}$$

8. Add the angle in *7* above to the elevation in *5* above. The sum is the elevation to a point 60 meters above the crest.

$18.1 + 547.9 = 566.0$ mils

9. Convert 6 PE_r at crest range (nearest 100 meters) 5,400 meters to mils, using the meters-per-mil factor. Determine the following from the Ground Data table (table F, part 2):

Meters-per-mil factor (colm 4) = 129 meters-per-mil (by interpolation)

PE_r (colm 6) = 432 meters (by interpolation)

Therefore, the elevation change corresponding to 6 PE_r is:

$$\frac{(6 \times 432)}{129} = 20.1 \text{ mils}$$

10. Add the values determined in *8* and *9* above and record the sum, to the nearest mil, as the intermediate crest minimum quadrant elevation.

$566.0 + 20.1 = 586.1$ or 586 mils

3-14. Limits of Piece-Crest and Intermediate Crest Minimum Quadrant Elevations

If the piece-crest is an isolated terrain feature or intermediate crests are isolated peaks rather than general ridge lines, it will probably be unduly restrictive to use the piece-crest or the intermediate crest minimum quadrant elevations as determined in paragraphs 3-12 and 3-13 throughout the deflection capabilities of the unit. The sector of fire should be divided into segments and the appropriate piece-crest or intermediate crest minimum quadrant elevations determined within successive deflection (azimuth) limits from each individual firing position.

3-15. Determination of Firing Limits

a. General. To facilitate the analysis of a firing position, the FDC must determine and record the launcher-rocket minimum quadrant elevation, the piece-crest minimum quadrant elevation, and the greatest intermediate crest minimum quadrant elevation. Before a rocket is fired, a comparison must be made between the data for the rocket to be fired and the minimum quadrant elevations for the firing position. This comparison is made as specified below.

b. Launcher-Rocket Minimum Quadrant Elevation. Compare the launcher-rocket minimum quadrant elevation with the mission *final* quadrant elevation (firing QE including low-level wind corrections). If the launcher-rocket minimum quadrant elevation is greater than the mission *final* quadrant elevation, do not fire the rocket.

c. Piece-Crest Minimum Quadrant Elevation. Use the following procedures for the piece-crest minimum quadrant elevation:

(1) When the mission final quadrant elevation is less than the mission corrected quadrant elevation (because of a low-level tail wind), compare the mission *final* quadrant elevation with the piece-crest minimum quadrant elevation. If the piece-crest minimum quadrant elevation is greater than the mission *final* quadrant elevation, follow the procedures in paragraph 3-16.

(2) When the mission final quadrant elevation is greater than the mission corrected quadrant elevation (because of a low-level head wind), compare the mission *corrected* quadrant elevation with the piece-crest minimum quadrant elevation. If the piece-crest minimum quadrant elevation is greater than the mission *corrected* quadrant elevation, follow the procedures in paragraph 3-16.

d. Intermediate Crest Minimum Quadrant Elevation. Compare the greatest intermediate crest minimum quadrant elevation with the mission *trial* quadrant elevation. If the intermediate crest minimum quadrant elevation is greater than the mission *trial* quadrant elevation, follow the procedures in paragraph 3-16.

3-16. Assurance of Crest Clearance

a. If either the piece-crest minimum quadrant elevation or the intermediate crest minimum quadrant elevation is greater than the mission data (para 3-15*c* or 3-15*d*), the commander should select another position from which to fire the rocket. However, because of the tactical situation and the time element involved, the commander may find it more desirable to fire from the present position than select and move to a new position provided he has reasonable assurance that the probability of clearing the crest warrants firing from that position. The procedure for determining the probability of clearing the crest is as follows:

(1) Determine the crest range and height of crest with respect to the launcher (from a map or by computation).

(2) Determine the range (nearest meter) at the level point corresponding to the mission trial QE.

(3) Determine the QE (nearest tenth of a mil) to the crest, using the procedures in paragraph 3-13*a* or 3-13*b* as appropriate. However, for this computation, do not add 6 PE_r to the QE.

(4) If the crest QE ((3) above) is greater than the mission *trial* QE, the rocket has less than 50 percent assurance of clearing the crest. If the crest QE ((3) above) is less than the mission *trial* QE, determine the range (nearest meter) at the level point corresponding to the crest QE.

(5) Enter the Ground Data table and determine the range probable error (PE_r) corresponding to the range determined in (2) above. Interpolate to the nearest meter.

(6) Subtract the range determined in (4) above from the range determined in (2) above.

(7) Divide the difference obtained in (6) above by the range probable error determined in (5) above. This quotient represents the clearance of the crest expressed in terms of probable error (t). Express the quotient to the nearest hundredth.

(8) Use the quotient obtained in (7) above as the argument (t) for entering the probability table (part 1 of the firing tables or table 2–2, FM 6–40). Enter the vertical column t with the value to one decimal place (tenth) and the horizontal row t with the value to two decimal places (hundredth). The value obtained from the vertical and horizontal intersection of these two entries represents one-half the area under the normal probability curve inclosed by the number of probable errors used for entry. Add 0.5000 to this value to determine the assurance of clearing the crest.

b. The following examples illustrate the procedures for computing the assurance of clearing a crest:

Example 1:

(1) Known conditions are—

Crest range	6,300 meters
Crest height (above launcher)	+520 meters
Mission trial QE	219.7 mils
Rocket MGR–1B	FTR 762–H–1

(2) Enter table G and determine the range (nearest meter) at the level point corresponding to the mission trial QE of 219.7 mils.

Range = 14,703 meters (by interpolation)

(3) Determine the QE to the crest using the procedures in paragraphs 3–13*a*(1) and 3–13*a* (4)(*c*) *Example 1.*

Crest QE = 215.1 mils

(4) Since the crest QE ((3) above) is less than the mission trial QE, determine the range (nearest meter) at the level point corresponding to the crest QE.

Range = 14,406 meters (by interpolation)

(5) Enter table F, Ground Data, with the range at the level point (determined in (2) above) and calculate the range probable error.

PE_r (colm 6) = 248 meters (by interpolation)

(6) Subtract the range determined in (4) above from the range determined in (2) above.

14,703 − 14,406 = 297 meters

(7) Divide the difference obtained in (6) above by the range probable error obtained in (5) above. This expresses the range in (6) in terms of probable errors.

$$t = \frac{\text{range difference}}{PE_r} = \frac{297}{248} = 1.20\ PE_r$$

(8) Enter the probability table with the value of t obtained in (7) above to determine one-half the area under the normal probability curve enclosed by this value: t = 1.20 PE_r corresponds to 0.2908. Add 0.5000 to this value to determine the assurance of clearing the crest.

Assurance = 0.2908 + 0.5000 = 0.7908 = 79.08 percent.

Example 2:

(1) Known conditions are—

Crest range	5,390 meters
Crest height (above launcher)	+2,560 meters
Mission trial QE	581.8 mils
Rocket MGR–1B	FTR 762–H–1

(2) Enter table G and determine the range (nearest meter) at the level point corresponding to the mission trial QE of 581.8 mils.

Range = 28,341 meters (by interpolation)

(3) Determine the QE to the crest using the procedures in paragraphs 3–13*b*(2)(*a*) and 3–13*b* (2)(*d*)*2*, *3*, *4*, *5*, *6*, *7*, and *8*, *Example.*

Crest QE = 566.0 mils

(4) Since the crest QE((3) above) is less than the mission trial QE, determine the range (nearest meter) at the level point corresponding to the crest QE.

Range = 27,932 meters (by interpolation)

(5) Enter table F, Ground Data, with the range at the level point (determined in (2) above) and calculate the range probable error.

PE_r (colm 6) = 240 meters (by interpolation)

(6) Subtract the range determined in (4) above from the range determined in (2) above.

28,341 − 27,932 = 409 meters

(7) Divide the difference obtained in (6) above by the range probable error obtained in (5) above. This expresses the range in (6) in terms of probable errors.

$$t = \frac{\text{range difference}}{PE_r} = \frac{409}{240} = 1.70\ PE_r$$

(8) Enter the probability table with the value of t obtained in (7) above to determine one-half of the area under the normal probability curve enclosed by this value: t = 1.70 PE_r corresponds to 0.3742. Add 0.5000 to this value to determine the assurance of clearing the crest.

Assurance = 0.3742 + 0.5000 = 0.8742 = 87.42 percent.

c. The assurance may be used to determine the probable number of rounds that would fail to clear a crest as follows (assumed assurance is 99.85 percent):

(1) Subtract the percentage of assurance from 100 percent: 100.00 − 99.85 = 0.15 percent.

(2) Convert the percentage difference to a decimal equivalent:

$$\frac{0.15}{100} = 0.0015$$

(3) Compute the number of rounds in which one round will probably fail to clear the crest:

$$\frac{0.0015}{1} = \frac{1}{X} \text{ or } X = \frac{1}{0.0015} = 667$$

The expected number of rounds failing to clear the crest would be one in 667 rockets.

3-17. Determination of Maximum QE

Each time a launcher is emplaced, a maximum quadrant elevation must be calculated. To determine the maximum quadrant elevation which can be fired by a given launcher emplaced on a given slope, algebraically add the measured emplacement angle to the maximum limit to which the launcher can be elevated. The maximum elevation limit of the launcher is shown in the bottom portion of table B-1, appendix B, in the Level (0m) Emplacement Angle column. If large low-level head winds exist, the firing QE for a target near maximum range may, in rare cases, exceed the maximum allowable QE for that particular position-launcher combination and the rocket should not be fired. The calculation of the maximum allowable QE will permit the determination of whether the firing QE will exceed the allowable. The following example illustrates the procedure:

a. Known conditions are—

Launcher	M386
Launcher emplacement angle	−42 mils

b. Enter table B-1 and determine the maximum elevation limit (1244). Add this value to the emplacement angle to determine the maximum quadrant elevation: 1244 + (−42) = 1,202 mils.

★CHAPTER 4

FIRE DIRECTION USING THE M18 GUN DIRECTION COMPUTER (FADAC)

Section I. GENERAL

4–1. General

a. The M18 gun direction computer is used in both the Honest John battalion FDC and the battery FDC to compute the necessary laying and firing data for the rocket. The computer is operated by the assigned personnel who also operate its power generator and the auxiliary equipment.

b. Each rocket firing battery and each headquarters and headquarters and service battery of each Honest John battalion is authorized one M18 gun direction computer. The computer will produce an accurate solution to the ballistic problem in approximately 1 1/2 minutes for most rocket-warhead combinations.

4–2. Duties of the Fire Direction Personnel

a. The minimum number of personnel considered necessary to operate the equipment on a twenty-four hour basis is four, two computer operators and two generator operators. Their duties, in general, are discussed in *b* and *c* below.

b. Computer Operator. The computer operator is responsible for the emplacement, march order, operation, and operator maintenance of the computer and the teletypewriter. His duties are to—

(1) Insure that proper procedures are followed in setting up the computer and teletypewriter.

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

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

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

(5) Perform operator maintenance at regular intervals.

c. Generator Operator. The duties of the generator operator normally are performed as additional duties by the radiotelephone operator. In addition to his regular duties, he is responsible for—

(1) Insuring the proper emplacement of the generators.

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

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

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

(5) Maintaining the prescribed records on generator operation.

Section II. EQUIPMENT DESCRIPTION

4–3. General

a. Hardware. The gun direction computer M18 is an electronic, solid-state, digital computer with a nonvolatile rotating disc memory. Using the Honest John rocket program, it will compute the range, the azimuth of fire, and the ballistic problem and display the data; it will store the firing data and all associated information for 10 separate missions. It will simultaneously store the coordinates and altitudes of

32 targets and 16 firing points. It will compute traverse, zone-to-zone transformation, and intersection survey problems. Using the M537 teletypewriter, it will print a comprehensive record of firing data including all the parameters pertinent to a specific mission as well as the coordinates and altitudes of the targets and the firing points that have been stored in memory.

b. Software. Programs are coded on punched paper tape and are inserted into memory by use of the signal data reproducer (SDR) AN/GSQ-64 (para 4-18 through 4-24). The operator enters information required for solving problems by using the input selection matrix, the keyboard, and the mechanical tape reader.

4-4. Components and Associated Equipment

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

b. Associated Equipment. Associated equipment consists of an M537 teletypewriter, a computer table with an integral power connection panel, a power cable and reel assembly, and two 3-kilowatts, 120/208-volt, 400-hertz, 3-phase, 4-wire generators. The signal data reproducer AN/GSQ-64 and the computer logic unit test (CLUT) set AN/GSM-70 are auxiliary equipment used by the maintenance personnel. Detailed nomenclature, technical characteristics, and other operational information on their use are discussed in detail in the appropriate references listed in appendix A.

Section III. HANDLING THE EQUIPMENT

4-5. General

A minimum of four men are required to set up and prepare for operation or to march order the equipment. The computer weighs approximately 210 pounds and should be handled with care to prevent damage to the equipment or injury to personnel. The computer table weighs 58 pounds, and at least two men are required to set up or march order the table. The teletypewriter weighs 50 pounds and may be handled by one man.

4-6. Preparation for Operation

a. The computer and the teletypewriter are prepared for operation as follows:

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

(2) Unfold and extend each leg an equal length so that the height for the operator will be comfortable and 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 computer on the table.

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

(6) Remove the cover from the teletypewriter and release the carriage and platen locks.

(7) Remove the front and rear covers of the computer.

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

(9) Remove the cap from receptacle J11 on the computer and connect the power cable from the table to this receptacle.

(10) Remove the cover from the receptacle J10 on the computer and connect the teletypewriter signal cable to this receptacle.

(11) Connect the teletypewriter power cable to one of the output receptacles on the table.

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

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

(14) Check the air intake filter beneath the control panel of the computer for obstructions to insure the air will flow freely into the computer and that all six filters are in place.

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

(16) Turn the POWER switch on the teletypewriter to the ON position.

(17) When the POWER READY indicator lights, the computer is ready to operate.

b. When the computer is mounted in a vehicle, only steps (13) through (16) will be applicable.

4-7. March Order

a. The equipment is prepared for traveling as follows:

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

(2) Stop the generator and disconnect the signal and power cables.

(3) Replace the input power cable on the cable and reel assembly.

(4) Secure the teletypewriter carriage and platen locks and replace *all* covers.

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

(6) Secure the plug of the computer power cable to the clamp under the table.

(7) Replace the cover on the teletypewriter.

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

(9) Retract and fold the legs.

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

b. To march order equipment that is mounted in a vehicle, perform steps (1) and (4) only.

Section IV. OPERATOR CONTROLS

4-8. General

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

4-9. Control Panel

The computer control panel consists of seven components (fig 4-2 through 4-8). Each component may be considered a functional area, and each is identified according to its principal use.

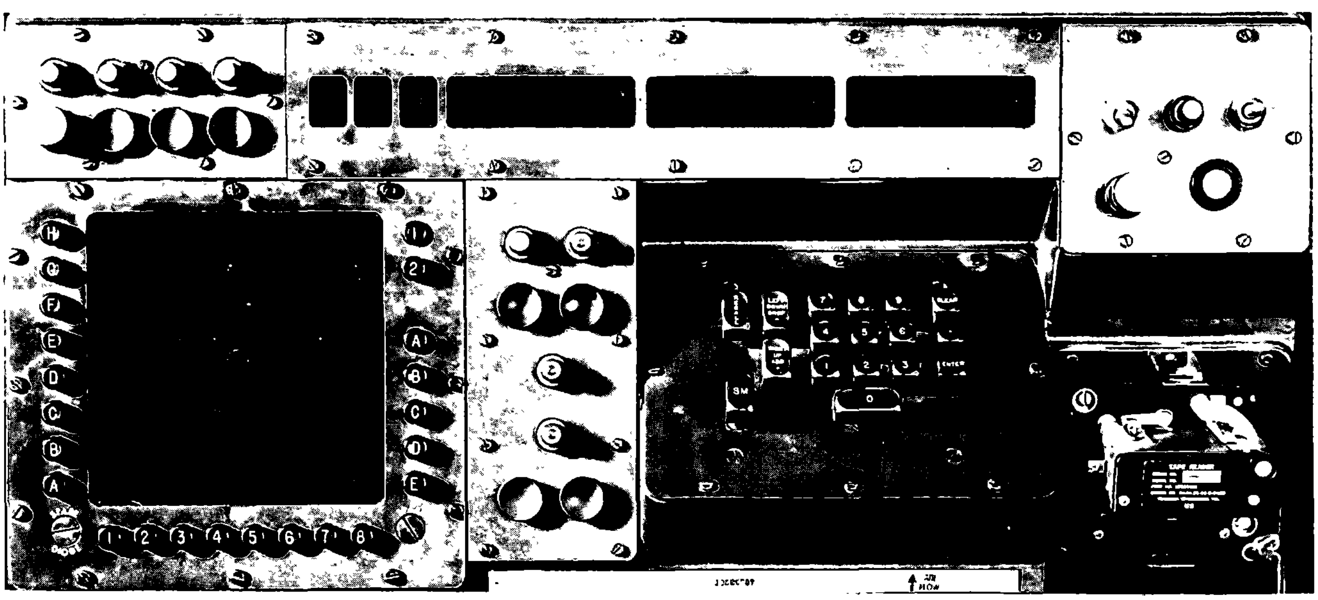


Figure 4-1. Computer Control Panel.

a. Power Panel. The power panel on the upper right section of the control panel, has a toggle switch to control the night lights, a toggle switch to turn the computer on and off,

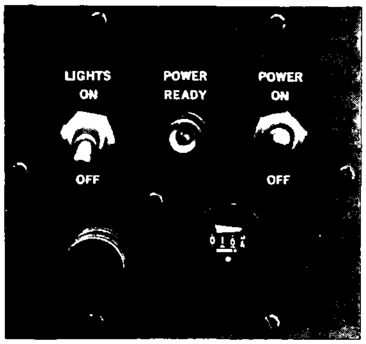


Figure 4–2. Power Panel.

a POWER READY indicator, a night light, and a time meter to indicate the cumulative hours of operation.

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

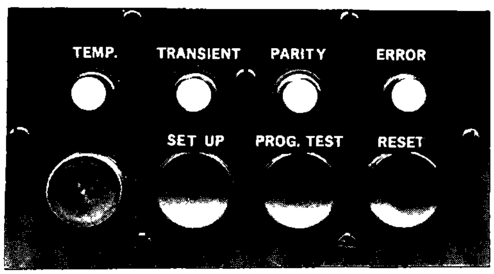


Figure 4–3. Trouble Indicator Panel.

c. Operator Panel. The operator panel in the center of the control panel, has four indicators and four buttons. The four indicators show the operator that the computer is in the compute mode or input-output mode and that the problem at hand has no solution or that a keyboard entry is required. The TRIG and COMPUTE buttons are used in initiating a problem solution. The SEND and RECEIVE buttons are not used in the rocket program.

d. Matrix Panel. The matrix panel on the left side of the control panel, is a selection device that allows the operator to control the elements of data that are entered, recalled, or computed in the solution of a problem. Details describing the use of this panel in the Honest John program are contained in table 4–1.

e. Keyboard. The keyboard located to the right of the operator panel, is used to manually enter numerical data into the computer.

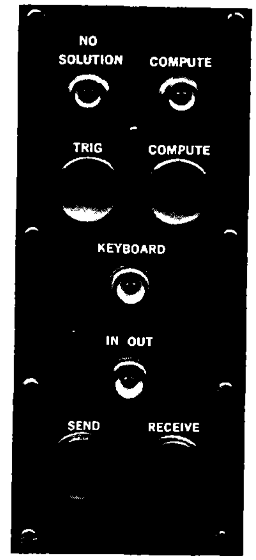


Figure 4–4. Operator Panel.

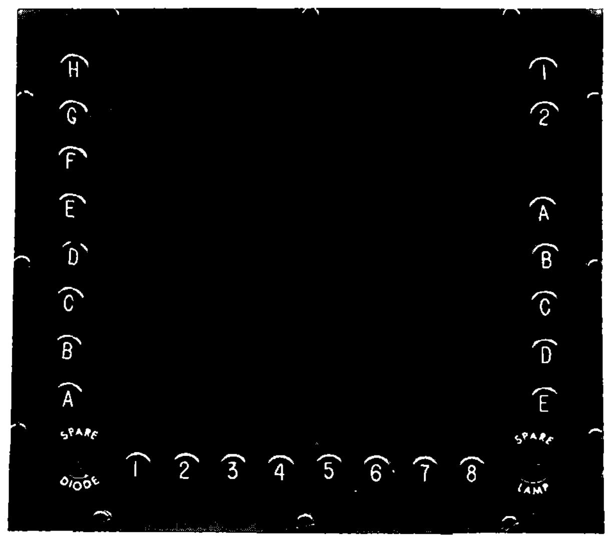


Figure 4–5. Matrix Panel.

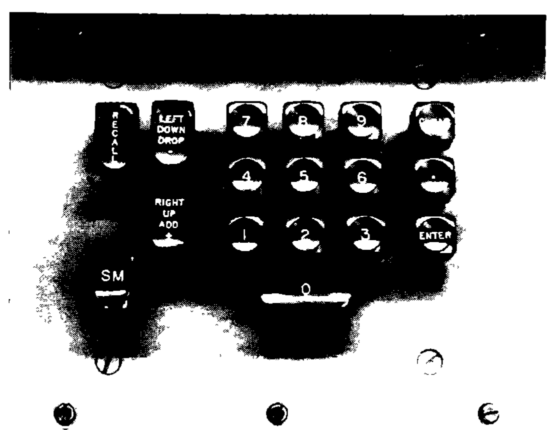


Figure 4–6. Keyboard.

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

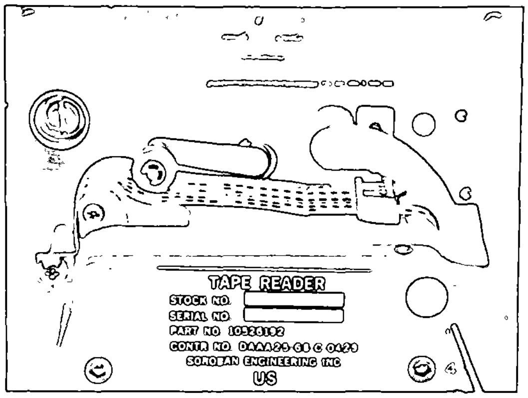


Figure 4-7. Mechanical Tape Reader.

g. Display Panel. The display panel located in the upper center section of the control panel, consists of 18 Nixie tube indicators. These indicators provide numerical, sign, and designation information as it is entered in the computer or as an output display of the solution to a problem. In most instances, the data entered through the keyboard will be displayed on this panel and will be erased when the ENTER key is depressed. 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 depressed.

(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 the security classification of the program entered when program test 1 is conducted. It will 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 depends on the matrix position selected. Normally, the fuze setting, time of flight, range, or northing input or recalled data will be displayed in this window.

(6) The sixth window has five Nixie tubes and is labeled QUADRANT, VERTICAL ANGLE, and ALTITUDE. Normally, the quadrant elevation, vertical angle, or altitude input will be displayed in this window. A keyboard entry normally will be displayed in the rightmost Nixie tube, and subsequent entries will cause each digit to shift to the next Nixie on the left. When the ENTER key is depressed, 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.

4-10. Functions of Controls and Indicators

The function of each control and indicator on the computer control panel (fig 4-1) is described below:

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

b. POWER READY Indicator. The POWER READY indicator lights approximately 20 seconds after the computer is turned on. The indica-

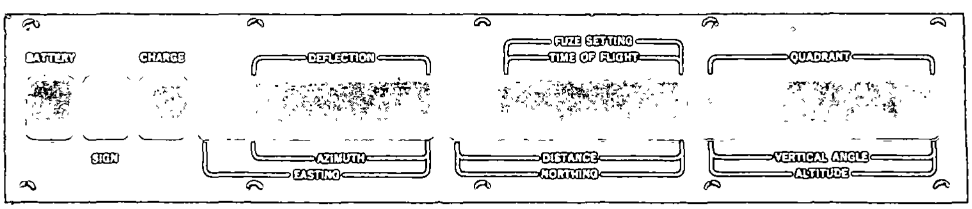


Figure 4-8. Display Panel.

tor blinks when the computer is in the marginal test mode or when the lower blower motor is not operating. The indicator will blink when the back cover has been removed and the MARGINAL TEST switch is in the OFF position of the lower blower is indicated.

c. LIGHTS ON-OFF Switch. THE LIGHTS ON-OFF switch controls the panel lamps for night operation.

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

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

f. TRANSIENT Indicator. The TRANSIENT indicator lights when the line voltage is correct. The indicator blinks when the power supply voltage fluctuates or approaches the operating limits.

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

h. ERROR Indicator. The ERROR indicator is lighted normally. It blinks when there is an internal overflow. Blinking of the indicator may be caused by the entry of a number too large for the computer to use in computations.

i. SET UP Button. When the SET UP button is momentarily depressed, all survey matrix functions are set to minus zero.

j. PROG TEST Button. When the PROG TEST button is momentarily depressed and then a numerical key (1, 2, or 3) is depressed, the computation of one of three stored tests begins. The COMPUTE indicator lights during the solution of the tests.

k. RESET Button. The RESET button is depressed to terminate the mode. Depressing the RESET button also will stop the blinking of a PARITY, TRANSIENT, or ERROR indicator if the malfunction indicated is not recurring.

l. NO SOLUTION Indicator. The NO SOLUTION indicator normally is lighted. It blinks if the data entered for a particular problem produces no solution. A numerical display defines the cause (table 4–2).

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

n. TRIG Button. Depressing the TRIG button causes the computer to compute the solution to a designated survey problem.

o. COMPUTE Button. Depressing the COMPUTE button causes the computer to compute the trajectory for the ballistic problem.

p. KEYBOARD Indicator. The KEYBOARD indicator lights when the computer requires information that must be entered through the keyboard.

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

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

s. RECEIVE Button. The RECEIVE button is not used in the rocket program.

4–11. Keyboard Assembly

a. SM and RECALL Keys. Depressing the SM (sample matrix) # key causes the computer to follow the instructions in the portion of the program indicated by the matrix location selected. Normally, these instructions will require a keyboard entry, in which case the KEYBOARD indicator will light. Depressing the RECALL key causes the computer to recall from memory the data indicated by the matrix location selected.

b. LEFT, DOWN, DROP, – Key. Depressing the LEFT, DOWN, DROP, – key causes a negative sign to be associated with the numerical value entered through the keyboard.

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

d. Numerical Keys 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 and the Decimal Point (.) Key. The numerical keys, and the decimal point key when required, are used to enter numerical values. The keys are interlocked so that the operator cannot make an error by depressing two keys simultaneously. The numerical value is displayed as each numerical key is depressed.

e. CLEAR and ENTER Keys. The CLEAR key is used to erase an erroneous keyboard input. After the CLEAR key has been depressed, the operator can enter the correct information without depressing the SM key again. The ENTER key is used to enter the displayed information into memory. In most cases, an entry error that is discovered after the ENTER key has been depressed may be corrected by reselecting the matrix function, depressing the SM key, and typing the correct data on the keyboard. Some survey procedures require reentry of all data when an error has been made (table 4-1).

Honest John Matrix Design : 1 June 1970

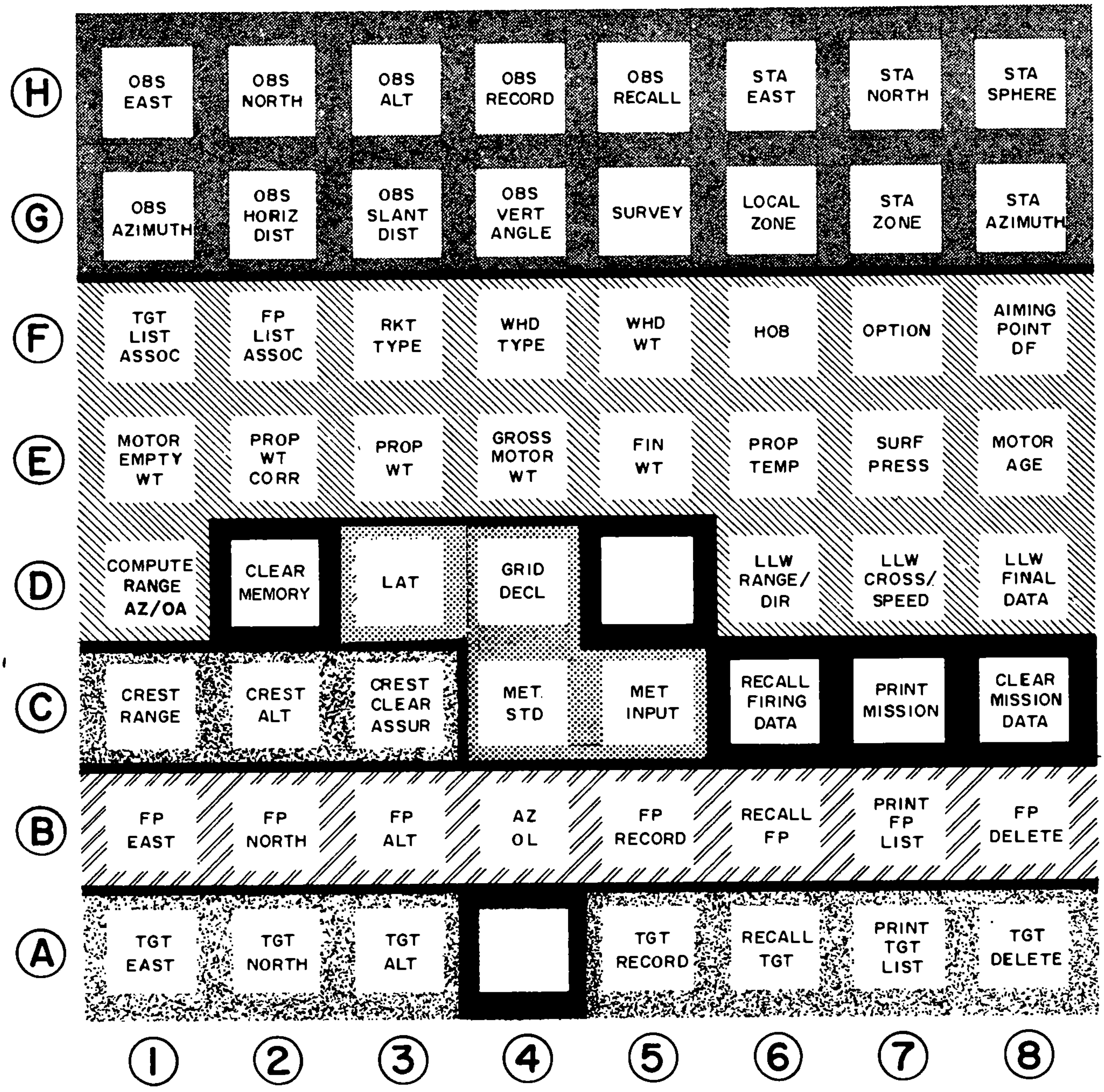


Figure 4-9. Input Selection Matrix.

4-12. Matrix

a. The matrix (fig. 4-9) has 64 windows. The operator selects the desired location on the matrix by depressing two buttons—one numerical button (1 through 8) in the row along the bottom of the matrix and one lettered button (A through H) in the column along the left side of the matrix. The use of each matrix location is explained in detail in table 4-1.

b. The matrix is divided into six color-coded sections for ease of identification of functions in the Honest John program.

(1) The matrix locations used to enter target information (A-1 through A-3 and A-5 through A-8) and crest clearance information (C-1, C-2, and C-3) are colored *blue.*

(2) The matrix locations used to enter firing point data (B-1 through B-8) are colored *yellow.*

(3) The matrix locations used to enter meteorological data (C-4 and C-5), the latitude (D-3), and the grid declination angle (D-4) are colored *green.*

(4) The matrix locations used to enter all mission-associated data necessary for the solution of a fire mission (D-6, D-7, D-8, E-1 through E-8, and F-1 through F-8) and to compute the mission-associated range, azimuth of fire, and orienting angle (D-1) are colored *red.*

(5) The matrix locations for four separate functions (C-6, C-7, C-8, and D-2) are *white.*

(6) The matrix locations used to enter data necessary for the solution of survey problems (G-1 through G-8 and H-1 through H-8) are colored *gray.*

4-13. Numbered and Lettered Mission Association Buttons

There are two numerical buttons, 1 and 2, and five lettered buttons, A through E, along the right side of the matrix panel. These buttons are used to associate specific mission data. Depressing both a numerical button and a lettered button at the same time (e.g., A-1, A-2, B-1, ------ E-1, or E-2 causes the independent sets of firing data to be computed separately and stored in 10 separate memory locations. Targets normally are planned to be attacked from a designated firing point; therefore, all orienting information, rocket and warhead data, and other ballistic information pertaining to a specific firing point-target combination is referred to as being mission associated. Each of the 10 possible missions is identified by its letter-number combination.

Section V. TESTS

4-14. General

When the computer is first set up for operation, when there is a loss of power, or when there is reason to believe that the computer is not operating properly, the operator should perform the program tests described below. The program must have been entered in the computer before the tests are run.

4-15. Program Tests 1 and 2

Program tests 1 and 2 should always be performed when the program is first entered into memory and whenever there is reason to believe the computer is malfunctioning. Test 1 is a test of the program data in the permanent, or "cold," storage section of memory, and test 2 is a test of the data in the working, or "hot," storage section of memory. If these tests are successful, the operator is assured that the program is correctly loaded and the computer is operating properly.

a. The procedure for performing test 1 is as follows:

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

(2) Type 1 on the keyboard; the computer will automatically run a test of the program. The Nixie tubes will flicker while the test is being run. If the test is successful, the final display will be: A X 2 0000000010 00762. If the test is not successful, the NO SOLUTION indicator light will blink and a different set of numbers will be displayed (fig. 4-10).

The following is an explanation of the display:

X—indicates an unlit Nixie.

A—indicates which lettered mission association button (A through E) was depressed.

2—indicates that the data in memory are classified CONFIDENTIAL.

1—indicates first revision.

762—identifies the Honest John program.

(3) If the first attempt is not successful, repeat the test. The second or third attempt may be successful. If there are aging parts in the computer, a test that failed on the first attempt may succeed on the second or even the third attempt. However, when several attempts are frequently necessary to complete a test, maintenance checks should be made as soon as possible.

b. The procedure for performing test 2 is as follows:

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

(2) Type 2 on the keyboard, the computer will automatically run a parity test of the hot storage section of memory. During the test, the three Nixie tubes on the right of the display panel will rapidly display the channel numbers being checked. If the test is successful, the number "136" will be displayed. The channel numbers allocated to the hot storage section are shown in figure 4–11.

(3) If the test is not successful, the PARITY indicator light will blink and the number of the channel containing the error will be displayed. The channel must be cleared by using clear hot storage tape, the procedures described in table 4–1 for matrix locations D–2 (CLEAR MEMORY).

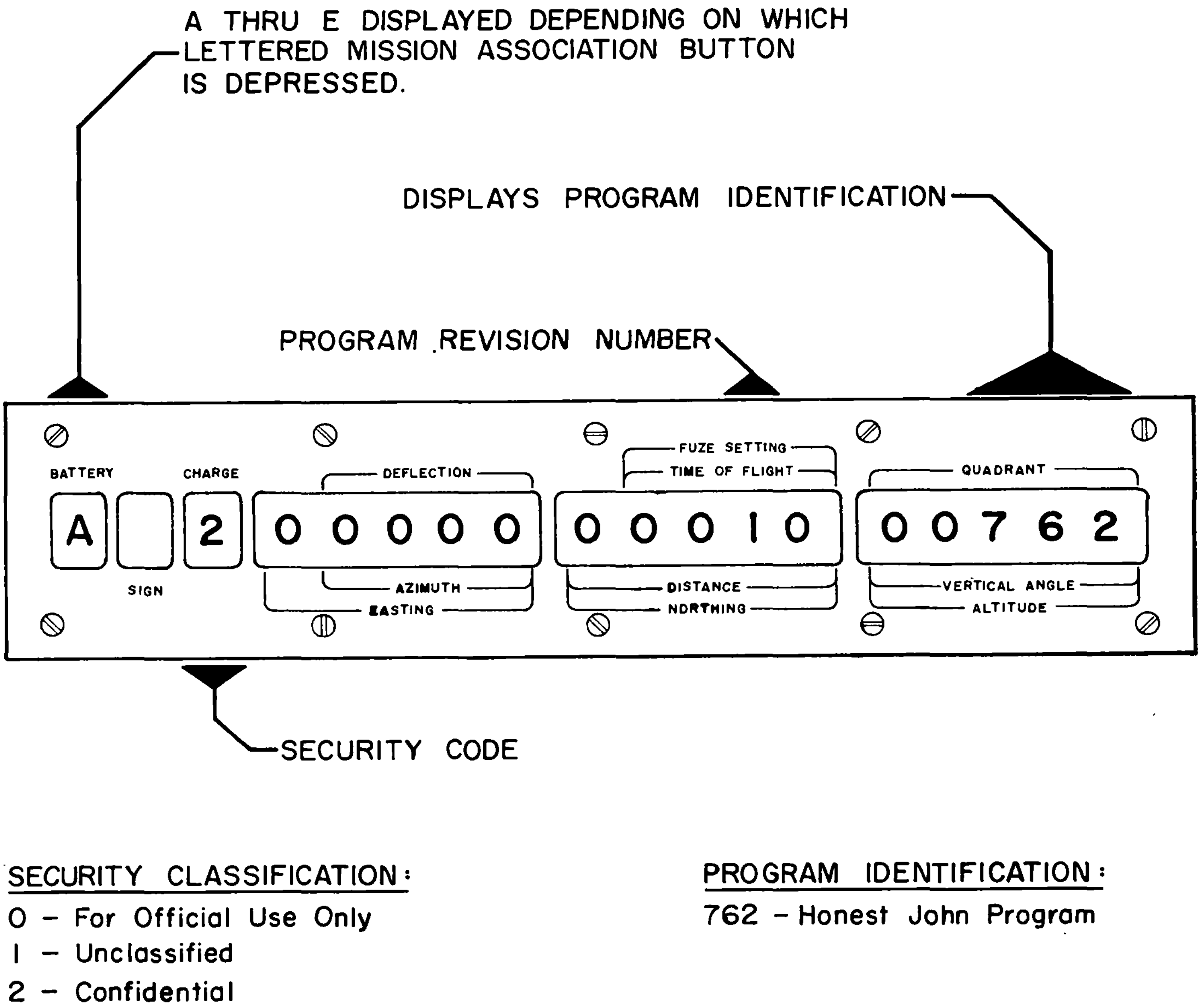


Figure 4–10. Program Test 1 on the Display Panel.

4–16. Marginal Test

a. The marginal test provides the operator with a means of performing a check of the computer's operation under voltage fluctuations. Successful completion of the test assures the operator that the computer will operate correctly under normal conditions. The MARGINAL TEST switch enables the operator to run program test 1 with variable voltages.

b. The marginal test procedure is as follows:

(1) When the POWER READY indicator lights, turn the MARGINAL TEST switch to the 1 position. The POWER READY indicator will blink. Blinking of the POWER READY indicator does not indicate a malfunction.

(2) Depress 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. If neither of these indicators blinks, turn the switch to test position 2, depress the PROG TEST button, and type 1 on the keyboard. Blinking of the PARITY or ERROR indicator indicates that the computer is not operating properly under the marginal conditions induced when the MARGINAL TEST switch was set at the 2 position.

(3) Repeat the procedures in (2) above with the MARGINAL TEST switch in positions 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 computer will operate properly under normal conditions.

c. When program test 1 is successful but the marginal test is not successful, there is an intermittent malfunction in the computer. The computer should be checked by maintenance personnel as soon as possible.

d. In normal operations, the MARGINAL TEST switch should be in the OFF position. When the switch is in this position, the POWER READY indicator should not blink.

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

4–17. Display Test

a. Nixie tubes are designed to display numbers. Each tube contains filaments for displaying each of the ten digits, 0 through 9, and a decimal point. The Nixie tube display test checks the filaments of each tube by causing the display to simultaneously light each filament in succession starting with 0 and ending with the decimal point. The Nixie tube containing letter filaments is not tested. Failure of any filament to light at the proper time indicates that the Nixie tube should be replaced.

b. The procedure for performing the display test is as follows:

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

(2) Type 3 on the keyboard; the computer will automatically test the Nixie tubes by lighting each filament in succession starting with 0 and ending with the decimal point.

Section VI. COMPUTER INPUT

4–18. General

a. The Honest John program is entered into the FADAC by use of a high-speed paper tape reader, the signal data reproducer AN/GSQ–64 (SDR). When connected to the M18 computer, the SDR energizes the recording heads on the disc in the cold storage section of memory. After disconnecting the SDR, the operator disconnects these cold storage recording heads to insure that the program, once loaded, will remain unchanged.

b. The dynamic data necessary for the solution of a problem are entered through the keyboard or the mechanical type reader into the hot storage section of memory. Twelve channels are allocated for these dynamic data (fig 4–11), and the recording heads in this section of memory are always energized. Input is controlled by the selection of one of the 64 matrix locations. The matrix keyboard combination design simplifies operator input. By selecting a specific matrix function and then depressing the SM key or the RECALL key, the operator can enter or recall specific data or initiate a designated computational routine. Standard artil-

Channel Number	Working Storage Locations			
70	Mission E-2 Data	Mission E-1 Data	Mission D-2 Data	Mission D-1 Data
72	Mission C-2 Data	Mission C-1 Data	Mission B-2 Data	Mission B-1 Data
74	Mission A-2 Data	Mission A-1 Data		
76				
110	Target List			Firing Point List
112	Firing Point List			
114	Converted Meteorological Data			
116			Observer Buffer	
130				
132				
134	Observer Buffer		Current Meteorological Data	
136	Current Met		Observer List	

Note: Channel numbers octal base system, even numbers only used.

Figure 4-11. Memory Map.

lery terminology is used on the matrix and, if necessary, one- or two-digit codes, called "flags," may be used to identify input data or to recall data for display or printout.

c. The most accurate information available must be entered into the computer to produce accurate firing data, and care must be taken to prevent the inadvertent use of old meteorological data or other invalid data previously stored in memory. Standard meteorological data are entered when the program is first loaded, and the computer will use standard met data until a current met message is entered. After a current met message has been entered, the met is reset to standard by use of function C–4 (MET STD). The latitude and grid declination angle must be entered to allow the computer to calculate the coriolis effect and to change met wind direction from true azimuth to grid azimuth. All data entered will remain in the computer's memory until they are changed. Other ballistic parameters, such as rocket and propellant weights, propellant temperature, surface barometric pressure, and low-level wind data as well as specific target and firing point information, are mission associated. These data may easily be cleared from memory by use of function C–8 (CLAR MSN DATA).

d. The operator should check each input on the display panel before depressing the ENTER key. Further, if there is any doubt as to what has been entered, the data in memory should be recalled and checked on the display. The teletypewriter may be used to verify most of the data stored in memory by use of function A–7 (PRINT TGT LIST) or B–7, (PRINT FP LIST).

4–19. Five-Digit Coordinates Requirement

The eastive and northing coordinates of each target or firing point entered must consist of at least five digits (nearest meter), or the program will hold and the NO SOLUTION indicator will blink. The display will retain the erroneous coordinate as entered. To correct the error—

a. Depress the SM key; the display will extinguish and the KEYBOARD indicator will light.

b. On the keyboard, type in the correct five-digit coordinate (type leading zeros if necessary).

c. Depress the ENTER key.

4–20. Functions Requiring a Signed Input

Several numerical inputs require that a plus (+) or a minus (−) sign precede the numerical entry. The plus and minus keys on the keyboard are used to enter these signs. In the ballistic and survey programs, the following inputs require a sign:

a. Ballistic Program.

Input value	*Matrix location and designation*
Target altitude	A–3 (TGT ALT)
Firing point altitude	B–3 (FP ALT)
Crest altitude	C–2 (CREST ALT)
Latitude	D–3 (LAT)
Grid declination	D–4 (GRID DECL)
Low-level range wind component	D–6 (LLW RANGE/DIR)
Low-level cross wind component	D–7 (LLW CROSS/SPEED)
Propellant weight correction	E–2 (PROP WT CORR)
Propellant temperature	E–6 (PROP TEMP)

b. Survey Program.

Input value	*Matrix location and designation*
Vertical angle	G–4 (OBS VERT ANGLE)
Local zone number	G–6 (LOCAL ZONE)
Station zone number	G–7 (STA ZONE)
Observer altitude	H–3 (OBS ALT)

4–21. Enabling Procedure

a. The enabling procedure is designed to act as a safeguard against inadvertent operator error. It allows the operator to activate or cancel certain critical functions as desired. The operator is required to select a second key (0 or 9) after he has selected the function and depressed the SM key. This selection precludes accidentally deleting information stored in memory in the event he has selected the wrong matrix buttons. Whenever the enabling procedure is used, a keyboard entry of 0 enables the function while an entry of 9 dismisses the function and terminates the input mode.

b. Four input functions require this procedure. They are:

Input function	*Matrix location and designation*
Target deletion	A–8 (TGT DELETE)
Firing point deletion	B–8 (FP DELETE)
Set met to standard	C–4 (MET STD)
Clear mission data	C–8 (CLEAR MSN DATA)

4–22. Function Values Reset to Minus Zero

a. When certain matrix functions are used, the data entered in complementary functions are set to an unrecognizable form. When recalled, these data will be displayed as zero (or a series of decimal points) preceded by a minus sign. This form is referred to in this manual as *minus zero.* This programmed safety feature prevents the operator from making an incomplete entry or inadvertantly using part of one set of data with part of another. Use of the functions listed below will set entry data in the listed complementary functions to zeros or minus zero.

(1) *Ballistic function.*

Matrix location and designation	*Complementary function*
A–8 (TGT DELETE)	Specific file locations in A–5 (TGT RECORD)
B–8 (FP DELETE)	Specific file locations in B–5 (FP RECORD)
C–3 (CREST CLEAR ASSUR)	C–1 (CREST RANGE) and C–2 (CREST ALT)
D–8 (LLW FINAL DATA)	D–6 (LLW RANGE/DRI) and D–7 (LLW CROSS/SPEED)
F–6 (HOB)	F–7 (OPTION)
F–7 (OPTION)	F–6 (HOB)

(2) *Survey function.*

Matrix location and designation	*Complementary function*
G–5 (SURVEY) *Note:* Each complementary function is set to a new value or to minus zero, depending on the type of survey identified by a flag entry. The process occurs during computations after the TRIG button has been depressed.	Flag 1 (Traverse) G–1 (OBS AZ) G–2 (OBS HORIZ DIST) G–3 (OBS SLANT DIST) G–4 (OBS VERT ANGLE) *Note:* When flag 9 is entered to terminate the mode, the following functions are set to minus zero: H–1 (OBS EAST) H–2 (OBS NORTH) H–3 (OBS ALT) Flag 2 (intersection) G–1 (OBS AZ) G–4 (OBS VERT ANGLE) *Note:* When flag 9 is entered to terminate the mode, the following functions are set to minus zero: H–1 (OBS EAST) H–2 (OBS NORTH) H–3 (OBS ALT) Flag 3 (zone to zone) G–6 (LOCAL ZONE) G–7 (STA ZONE) G–8 (STA AZ) H–6 (STA EAST) H–7 (STA NORTH) H–8 (STA SPHERE)

b. The use of function C–8 (CLEAR MSN DATA) sets all mission-associated data locations to zero. These locations are D–6, D–7, D–8, E–1 through E–8, and F–1, through F–8.

c. Depressing the SET UP button sets all survey functions to minus zero.

4–23. Meteorological Message Input Procedures

a. Entry of the most recent meteorological data is vital to the computation of accurate firing data. The special computer met message (METCM) used by the M18 reports weather conditions that actually exist at the various layers of atmosphere through which the trajectory passes. The computer message is different from the met message used in manual computations, in which the weather conditions existing in one layer, or zone, are weighted against the conditions existing in the lower layers and then reported as a group.

b. The format has been designated by standard international agreement (STANAG 4082). In the rocket program, the met input is stored in working storage. A maximum of 26 lines of met data may be entered. Standard met data are placed in memory when the program is first loaded and are used whenever the met is set to standard by use of matrix function C–4 (MET STD). If fewer than 26 lines of met data are entered, the standard met data will be used for the remaining lines. Care should be exercised to insure that the met being used reports *air pressure* in millibars rather than *density* in grams per cubic meter. The operator can insure that he is using the correct data by comparing the last three digits of the ID line to the 00 line; if the digits are identical, the met message is reporting *air pressure* (fig 4–12).

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

(1) Depress matrix buttons C–5 (MET INPUT) and depress the SM key.

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

(3) On the keyboard, type the identification line (12 digits) of the met message, starting with the date/time group, and then depress the ENTER key; the display will shift to the left and the number 00 will be displayed in the rightmost Nixies.

(4) On the keyboard, the 00 line (16 digits) of the met message starting with 00, and then depress the ENTER key; the number 01 will be displayed.

(5) Enter each successive line of the met message in the same manner. After the last line has been entered, terminate the input mode by typing a decimal point and then depressing the ENTER key.

d. An individual line entry may be made as follows:

(1) Depress matrix buttons C–5 (MET INPUT).

(2) Depress the SM key and type 2 on the keyboard.

(3) Depress the ENTER key.

(4) On the keyboard, type the line number to be reentered. (The line number will be displayed.)

(5) Depress the ENTER key.

(6) Type the correct line (16 digits) on the keyboard.

e. The fastest method of entering met data is by means of punched paper tape through the mechanical tape reader. Meteorological message tapes (fig 4–13) are usually cut but radio teletypewriter equipment, such as the teletypewriter reperforator-transmitter TT–76/GGC, which is a component of radio sets AN/GRC–46, AN/GRC–122, and AN/GRC–142. When the tape is cut by radio teletypewriter, the met data is printed along the margin on the wide side of the tape. A slightly offcenter line of small sprocket holes runs the length of the tape. Opposite each sprocket hole, there may be as many as three punched holes on the wide side of the tape and as many as two punched holes on the narrow side of the tape. Instructions for entering the met message tape are as follows:

(1) Determine the front of the tape by placing the wide side toward the computer with the printing up.

(2) Open the armature clamp on the mechanical tape reader and place the tape under the clamp with the wide side—three holes—toward the computer. Insure that the message portion of the tape is to the left of the read head.

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

(4) Depress matrix buttons C–5 (MET INPUT) and then depress the SM key.

(5) On the keyboard type 1 and depress the ENTER key, the reader will automatically start reading the tape. The reader will stop automatically at the end of the tape, and the input mode will be terminated.

4–24. Detailed Operator Procedures

a. Table 4–1 contains detailed instructions on using each of the input selection matrix functions for the entry or recall of data. The information presented in the table is as follows:

(1) The first column, matrix location/input function, identifies each function by the row (A through H) and the column (1 through 8) in which it is located on the matrix and by its abbreviated designation as it appears on the matrix. The functions are listed according to the alphabetical and numerical order of their locations from A–1 to H–8.

(2) The second column, entry procedures, gives detailed instructions for entering data for a specific function or for solving a problem presented by a particular function. Some matrix locations, such as C–3 (CREST CLEAR ASSUR) and D–8 (LLW FINAL DATA), require the entry of data in other functions prior to their use. Unless a specific entry sequence is indicated, data may be entered in any sequence.

(3) The third column, recall procedures, gives detailed instructions for recalling information stored in memory.

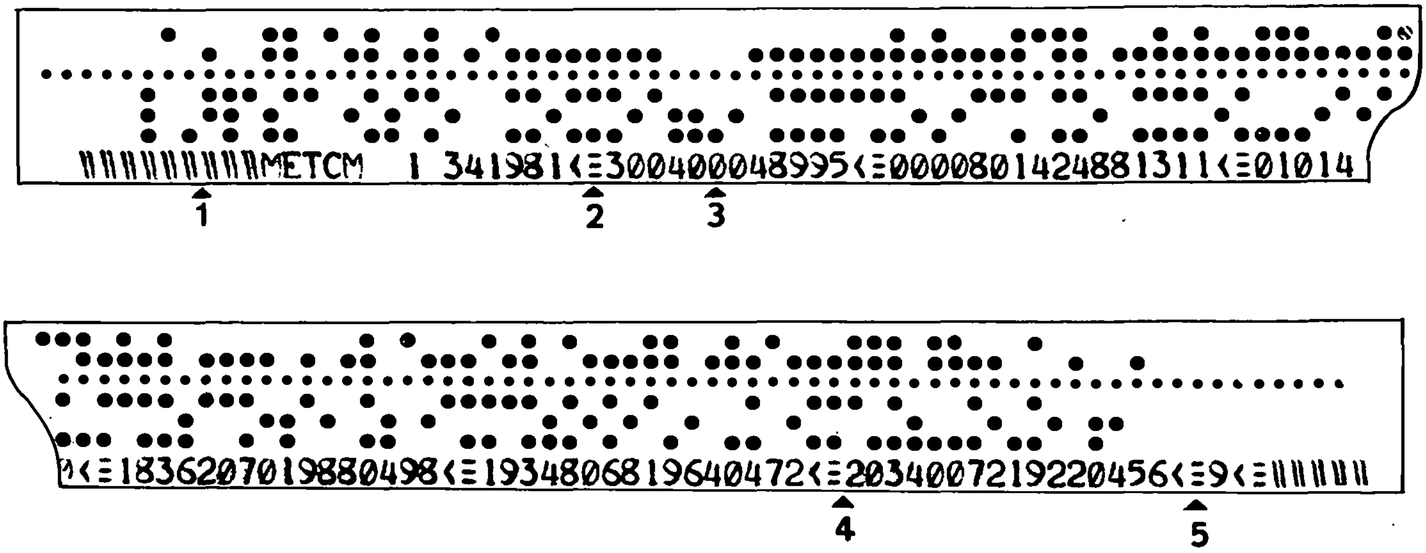
(4) The fourth column, remarks, contains information about the use of each function.

METCMO	512018
070987	012972
00032008	12620972
01042011	12500963
02049010	11980910
03062025	11680840
04058030	10560785

Compare the last 3 digits of the I. D. line to the 00 line.

If the digits are identical, the met message is in consonance with STANAG 4082

Figure 4–12. STANAG 4082 Meteorological Message.



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

Figure 4–13. Meteorological Message Tape.

Whenever the words "mission associated" appear in this column, that input function must be associated with a specific firing point and target combination. This association is accomplished by depressing the appropriate mission association buttons. In all cases, at least one of the lettered buttons (A through E) must be depressed.

b. A graphic illustration of the location in memory of input data is shown in figure 4–11. Whenever data are to be reentered after the CLEAR MEMORY function (D–2) has been used, the operator should refer to figure 4–11 to determine the data that have been cleared.

Section VII. COMPUTER OUTPUTS

4–25. General

a. The output data for the Honest John rocket program is shown on the display panel or by printout on the M537 teletypewriter.

b. The teletypewriter printout formats are shown in figures 4–14, 4–15 and 4–16.

4–26. No Solution Display

a. Whenever data is entered by an erroneous procedure or whenever certain input items are incorrect, # the NO SOLUTION indicator will blink. For most errors, a number code will be displayed to identify the specific incorrect input.

b. Table 4–2 is a reference listing of the no solution displays.

4–27. Teletypewriter Printouts

a. A printout of the target list, the firing point list, or the fire mission data (including the met used) may be obtained by using matrix positions A–7 (PRINT TGT LIST), B–7 (PRINT FP LIST), or C–7 (PRINT MSN), respectively, and the M537 teletypewriter.

b. Figures 4–14, 4–15 and 4–16 illustrate the printout formats for the target list, the firing point list, and the fire mission data.

TGT	TGE	TGN	TGA
01	00000	00000	00000
02	00000	00000	00000
–	–	–	–
–	–	–	–
32	00000	00000	00000

Figure 4–14. Printout Format for the Target List.

FP	AZL	FPE	FPN	FPA
01	0000	00000	00000	0000
02	0000	00000	00000	0000
–	–	–	–	–
–	–	–	–	–
16	0000	00000	00000	0000

Figure 4–15. Printout Format for the Firing Point List.

Symbol printed	Data printed	Explanation of symbols and data
DEF	XXXX	Deflection
FZS	XX.X	Fuze setting
QEL	XXX.X	Quadrant elevation
TGE	XXXXX	Target easting
TGN	XXXXX	Target northing
TGA	XXXX	Target altitude
FPE	XXXXX	Firing point easting
FPN	XXXXX	Firing point northing
EPA	XXXX	Firing point altitude
AZF	XXXX	Azimuth of fire
RNG	XXXXX	Range
HOB	XXX	Height of burst above target
RKT	XX	Flag for rocket type
WHT	X	Flag for warhead type
OPT	X	Flag for height of burst option
LDF	XXXX	Aiming point defelction
AOL	XXXX	Azimuth of the orienting line
ORA	XXXX	Orienting angle
WWT	XXXX	Warhead weight
MEW	XXXX	Motor empty weight
PWC	X.X	Propellant weight correction
PWT	XXXX	Propellant weight
FWT	XXX	Fin weight
GWT	XXXX	Gross motor weight
PRT	XXX	Propellant temperature
SPR	XXX	Surface pressure
LLR	XX	Low level range wind or direction
LLX	XX	Low level crosswind or speed
DQE	XX.X	Final low level wind corrections to elevation
DDF	XXX.X	Final low level wind correction to deflection
GDA	XX	Grid declination angle
LAT	XX	Latitude of the firing point
MET	XXXXXXXXXXXX	Met identification line only
	OOXXXXXXXXXXXXXX	Each line of the met message
	01 etc	

Values printed are positive unless preceded by a minus sign.

Figure 4–16. Printout Format for a Fire Mission.

Table 4-1. Operator Procedures, Honest John Program

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
A-1 TGT EAST	1. Depress matrix buttons A-1. 2. Depress the SM key. 3. On the keyboard, type the target easting to nearest meter. 4. Depress the ENTER key.	See matrix location A-6 (RECALL TGT).	Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. (For corrective action, reinitiate entry procedure and enter value correctly.)
A-2 TGT NORTH	1. Depress matrix buttons A-2. 2. Depress the SM key. 3. On the keyboard, type the target northing to nearest meter. 4. Depress the ENTER key.	See matrix location A-6 (RECALL TGT).	Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. (For corrective action, reinitiate entry procedure and enter the value correctly.)
A-3 TGT ALT	1. Depress matrix buttons A-3. 2. Depress the SM key. 3. On the keyboard, depress the + or − key and then type the target altitude to nearest meter. 4. Depress the ENTER key.	See matrix location A-6 (RECALL TGT).	1. Any value between −300 and +7500 may be entered. 2. Entry must be preceded by a + or − sign.
A-4	Not used	Not used	Not used
A-5 TGT RECORD	1. Enter target coordinates by using input functions A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT.) 2. Depress matrix buttons A-5. 3. Depress the SM key. 4. On the keyboard, type the target list number. 5. Depress the ENTER key. (Target easting, northing, and altitude will be displayed and stored on the target list.)	NA	1. Values must be entered for functions A-1, A-2 and A-3. If not, the NO SOLUTION indicator will blink and ------ 3 will be displayed. 2. Target may be stored as any one of 32 targets on target list. 3. The computer will accept any target number from 1 through 32. 4. Use of this function sets data in A-1, A-2, and A-3 to minus zero.
A-6 RECALL TGT	NA	1. To recall a target from the target list: *a.* Depress matrix buttons A-6. *b.* Depress the SM key. *c.* On the keyboard, type the target number. *d.* Depress the ENTER key. (A vacancy on the list will cause a display of -00000 and the NO SOLUTION indicator to blink.) 2. To recall a mission-associated target: *a.* Insure that the proper mission association buttons are depressed. *b.* Depress matrix buttons A-6. *c.* Depress the RECALL key.	1. Used to obtain the display of a specific target on the list or a mission-associated target. 2. Display will include target easting, northing, and altitude. 3. Used to recall each target on the target list separately. 4. Mission associated only if recalling a mission-associated target.
A-7 PRINT TGT LIST	1. Depress matrix buttons A-7. 2. Depress the SM key. 3. To obtain a printout of the entire target list, type 0 on the keyboard and depress	NA	When the target list is to be printed for less than 32 targets, the RESET button may be depressed to terminate the list at any point.

	the ENTER key. To obtain a printout of a single target, type the target number and depress the ENTER key.		
A–8 TGT DELETE	1. Depress matrix buttons A–8. 2. Depress the SM key. 3. On the keyboard, type the number of target to be deleted. 4. Depress the ENTER key. (Coordinates will be displayed and the KEYBOARD indicator will remain lit.) 5. On the keyboard, type 0 to delete the target or type 9 to dismiss the command. 6. Depress the ENTER key. (Target data will be either retained or destroyed, depending on the last entry.)	NA	To insure against accidental deletion of a target, enabling entry 0 is used to affirm deletion or 9 is used to dismiss the command.
B–1 FP EAST	1. Depress matrix buttons B–1. 2. Depress the SM key. 3. On the keyboard, type the firing point easting to the nearest meter. 4. Depress the ENTER key.	See matrix location B–6 (RECALL FP) or B–7 (PRINT FP LIST).	1. Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. 2. Set to minus zero by the use of function B–5 (FP RECORD).
B–2 FP NORTH	1. Depress matrix buttons B–2. 2. Depress the SM key. 3. On the keyboard, type the firing point northing to nearest meter. 4. Depress the ENTER key.	See matrix location B–6 (RECALL FP) or B–7 (PRINT FP LIST).	1. Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. 2. Set to minus zero by the use of function B–5 (FP RECORD).
B–3 FP ALT	1. Depress matrix buttons B–3. 2. Depress the SM key. 3. On the keyboard, depress the + or − key and then type the firing point altitude to nearest meter. 4. Depress the ENTER key.	See matrix location B–6 (RECALL FP) or B–7 (PRINT FP LIST).	1. Any value between −300 and +7500 may be entered. 2. Set to minus zero by the use of function B–5 (FP RECORD). 3. Entry must be preceded by a + or − sign.
B–4 AZ OL	1. Depress matrix buttons B–4. 2. Depress the SM key. 3. On the keyboard, type the grid azimuth of the orienting line to the nearest mil. 4. Depress the ENTER key.	1. After the firing point has been recorded on the list, matrix position B–7 (PRINT FP LIST) may be used to include the azimuth in the printout of firing point coordinates. 2. After the firing points have been mission-associated, the azimuth of the OL may be recalled by the following procedure: *a.* Depress matrix buttons B–4. *b.* Depress mission buttons. *c.* Depress the RECALL key.	1. A maximum of 6,400 mils may be entered. 2. Set to minus zero by use of function B–5 (FP RECORD).
B–5 FP RECORD	1. Enter firing point coordinates by using input functions B–1 (FP EAST), B–2 (FP NORTH), and B–3 (FP ALT),	NA	1. Values must be entered for B–1, B–2, and B–3. If not, the NO SOLUTION indicator will blink and ------3 will be

Table 4-1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
	and enter the azimuth of the orienting line by using function B-4 (AZ OL). 2. Depress matrix buttons B-5. 3. Depress the SM key. 4. On the keyboard, type the firing point list number. 5. Depress the ENTER key.		displayed. 2. The computer will accept firing point numbers from 1 through 16. 3. Use of this function sets data in B-1, B-2, B-3 and B-4 to minus zero.
B-6 RECALL FP	NA	1. To recall a firing point from the firing point list: *a.* Depress matrix buttons B-6. *b.* Depress the SM key. *c.* On the keyboard, type the firing point number of a specific firing point. *d.* Depress the ENTER key. (A vacancy on the list will cause the NO SOLUTION indicator to blink and a minus zero display.) 2. To recall a mission-associated firing point: *a.* Depress the appropriate mission association buttons. *b.* Depress matrix buttons B-6. *c.* Depress the RECALL key.	1. Mission-associated only if recalling a mission-associated firing point. 2. Display will include firing point easting, northing, and altitude.
B-7 PRINT FP LIST	1. Depress matrix buttons B-7. 2. Depress the SM key. 3. To obtain a printout of the entire firing point list, type 0 on the keyboard and depress the ENTER key. To obtain a printout of a single firing point, type the number of firing point and depress ENTER key.	NA	1. Used to obtain a printout of the firing point numbers, the coordinates of firing points, and the azimuths of the orienting lines of the firing points of either the entire list or a single firing point on the list. 2. The RESET button may be depressed to terminate the printout mode when a printout of less than the complete list is desired.
B-8 FP DELETE	1. Depress matrix buttons B-8. 2. Depress the SM key. 3. On the keyboard type the number of the firing point to be deleted. 4. Depress the ENTER key. (The KEYBOARD indicator will remain lit.) 5. On the keyboard type 0 to delete the firing point or type 9 to dismiss the command. 6. Depress the ENTER key. (Firing point data will be either retained or deleted,	NA	1. Used to replace data on the list with minus zero. 2. To insure against accidental deletion of a firing point, enabling entry 0 is used to affirm deletion or 9 is used to dismiss the command.

	depending on whether 0 or 9 was entered.)		
C–1 CREST RANGE	1. Depress matrix buttons C–1. 2. Depress the SM key. 3. On the keyboard, type in the range to the crest in meters. 4. Depress the ENTER key.	1. Depress matrix buttons C–1. 2. Depress the RECALL key.	1. Mission-associated. 2. Input values are from 600 to 38,000 meters.
C–2 CREST ALT	1. Depress matrix buttons C–2. 2. Depress the SM key. 3. On the keyboard, type the altitude of the crest in meters. 4. Depress the ENTER key.	1. Depress matrix buttons C–2. 2. Depress the RECALL key.	1. Mission-associated. 2. Entry must be preceded by a + or − sign. 3. Input values are from −300 to +7500.
C–3 CREST CLEAR ASSUR	1. Depress matrix buttons C–3. 2. Depress the SM key. (The COMPUTE indicator will light and the assurance, in percentage, of clearing the crest will be displayed in the following format): AXX 05200 X0450 XX98 The input range and altitude used will be displayed in the DEFLECTION and TIME OF FLIGHT windows and the percentage of assurance will be displayed in the last two Nixie tubes of the QUADRANT window.	NA	1. Mission-associated. 2. The program uses a technique that involves the simulation of a minimum trajectory, based on known dispersion, that will be exceeded 99.6 percent of the time. The trajectory ordinate at the crest range is compared to the crest altitude (modified by a buffer distance depending on the warhead-fuze combination). The assurance is computed to the nearest 1 percent. 3. When the computed assurance is less than 50 percent, 0 will be displayed.
C–4 MET STD	1. Depress matrix buttons C–4. 2. Depress the SM key. 3. On the keyboard, type 0 to use standard met or type 9 to dismiss this command. 4. Depress the ENTER key.	1. Depress matrix buttons C–4. 2. Depress the RECALL key. (Either 0 or 9 will be displayed.)	1. Mission-associated. 2. Computer will automatically use current met data for a mission unless this function is used.
C–5 MET INPUT	1. Depress matrix buttons C–5. 2. Depress the SM key. 3. On the keyboard, type the input code: 0—keyboard entry or 1—tape reader 2—individual line 4. If 0 is entered, the computer will demand the identification line by an 88 display. Enter the identification line: 2 digits (date) 3 digits (Greenwich meantime) 1 digit (period of validity) 3 digits (MDP altitude to nearest 10 meters) 3 digits (surface pressure) 5. Depress the ENTER key. 6. After the ENTER key has been depressed, the computer will demand each	1. Depress matrix buttons C–5. 2. Depress the RECALL key. (The identification line of the met message will be displayed.) 3. On the keyboard, type any line number. (That line will be displayed.) 4. Repeat step 3 as required. Depress the RESET button to end the mode. 5. A display of zeros indicates that standard met is in use.	1. The following flags are applicable to entry modes: *Flag* — *Entry Mode* 0 — Manual entry 1 — Tape Reader 2 — Specific line, manually 2. Whenever the ENTER key has been depressed and an incorrect number of digits have been typed for a specific line, the computer will call for reentry of the line by displaying the line number. 3. Whenever the tape reader fails to accept a line, it will stop and that line number will be displayed. The remainder of the met message should be entered manually. 4. Before any met data is entered, the met message should be checked for errors.

Table 4-1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
	line, in turn, by displaying its number (00, 01, 02). Enter each line of met in sequence (16 digits for each line). To terminate the input, enter a decimal point when the line after the last line is demanded. (See remarks column for format.) If a mistake has been made in any line entry and the mode has been terminated, a correction may be made as follows: *a.* Depress the SM key. *b.* Type 2 and depress the ENTER key. (The KEYBOARD indicator will remain lit.) On the keyboard type the line number to be entered. (The line number will be displayed.) *c.* On the keyboard, type the correct data (16 digits) and depress the ENTER key. 7. If a met tape is to be used, it may be entered as follows: *a.* Load the tape into the tape reader. *b.* Depress matrix buttons C-5. *c.* Depress the SM key. *d.* On the keyboard, type 1 and depress the ENTER key. (The reader will automatically read the tape data into memory and end the mode.)		Errors frequently can be detected by visual examination of the printed information along the edge of the tape. 5. Enter the grid declination by using function D-4 (GRID DECL) before entering met.
C-6 RECALL FIRING DATA	NA	1. Depress matrix buttons C-6. 2. Depress the SM key.	1. Mission associated. 2. Data must have been computed. If not, the NO SOLUTION indicator will blink.
C-7 PRINT MSN	1. Insure that the appropriate mission association buttons are depressed. 2. Depress matrix buttons C-7. 3. Depress the SM key. (The computer will start printing the mission data and stop after printing the identification line of met message.) 4. Depress the ENTER key to continue the printout of the body of the met message or depress the decimal key to terminate the mode.	NA	1. This mission-associated function should be used immediately after D-8 (LLW FINAL DATA). If not, the information may be lost when other operations are performed. 2. Before duplicate copies of the mission are printed, low-level wind data must be reentered, computed, and applied.
C-8 CLEAR MSN DATA	1. Depress the appropriate mission association buttons. 2. Depress matrix buttons C-8.	NA	1. Mission associated. 2. This function incorporates an enabling entry of 0 to clear data or 9 to dismiss

	3. Depress the SM key. 4. On the keyboard type 0 to clear data or 9 to dismiss the command.		the clear command. Use of keys 1 through 8 will produce a NO SOLUTION indication and an error display of ------9.
D–1 COMP RANGE AZ/OA	1. Depress the appropriate mission association buttons. 2. 2. Depress matrix buttons D–1. 3. Depress the SM key. (Range, azimuth and orienting angle will be computed and displayed.)	1. Depress the appropriate mission association buttons. 2. Depress the RECALL key. (Data will be displayed if it has been computed; if not, the NO SOLUTION indicator will blind and -00000 will be displayed.)	1. Mission associated. 2. Coordinates of the firing point and target must have been mission associated. If not, the NO SOLUTION indicator will blink and ------5 will be displayed. 3. Set to minus zero by use of function C–8 (CLEAR MSN DATA).
D–2 CLEAR MEMORY	1. Load the appropriate section of the clear hot storage tape into the mechanical tape reader. (This section may be determined by comparing the number at the beginning of the tape section with the line number displayed by the computer in program test 2.) 2. Depress matrix buttons D–2. 3. Depress the SM key. 4. On the keyboard, type the line number displayed by the computer. Three digits must be entered, i.e., 070. Computer reads in the proper section of tape through the mechanical tape reader. This restores the line number entered to the same condition it was in after the program was entered with the signal data reproducer AN/GSQ–64. 5. Refer to map of working storage (fig. 4–11) to determine which data were stored in the cleared line. 6. Reenter data in cleared line by following the normal entry procedure. 7. Initiate program test 2. 8. Repeat steps 1 through 7 until the test of working storage is successful.	NA	1. Used to clear and restore a selected line of working storage to the same condition it was in after the program was entered. The need for use of this function is shown by a blinking PARITY indicator, which indicates an alteration or improper reading from memory. 2. If the program test of working storage is successful (136 displayed) and the parity error persists, the trouble is not in the working storage and the program should be reloaded by using the signal data reproducer AN/GSQ–64. 3. Clear memory tape consists of a section of tape for each line of memory. At the beginning of each section of tape, the number of the channel of memory is printed. The computer will accept only the correct section of the tape according to the keyboard input.
D–3 LAT	1. Depress matrix buttons D–3. 2. Depress the SM key. 3. On the keyboard, depress the + key (for Northern Hemisphere) on the – key (for Southern Hemisphere) and then type the latitude of the unit to the nearest degree. 4. Depress the ENTER key.	1. Depress matrix buttons D–3. 2. Depress the RECALL key.	The computer will accept values from +90° to –90°.
D–4 GRID DECL	1. Depress matrix buttons D–4. 2. Depress the SM key.	1. Depress matrix buttons D–4. 2. Depress the RECALL key.	1. Used to convert met wind direction from true azimuth to grid azimuth. If grid

Table 4–1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
	3. On the keyboard, depress the + or — key and type the numerical value of the grid declination angle to the nearest mil. 4. Depress the ENTER key.		north is to the right of true north, the + sign is used. If grid north is to the left of true north, the — sign is used. 2. The computer will accept values from +64 to —64 mils.
D–5	Not used		Not used
D–6 LLW RANGE DIR	1. Depress matrix buttons D–6. 2. Depress the SM key. 3. On the keyboard, type the low-level range wind component as determined from the windset. Depress the + key to denote a head wind. 4. Depress the ENTER key. *Note:* If pilot balloon data are to be used, the direction of the low-level wind is entered in step 3. Values from 0 to 6400 may be entered.	1. Depress matrix buttons D–6. 2. Depress the RECALL key. (If no value has been entered, -00000 will be displayed.)	1. Mission associated. Either the low-level wind range components (obtained from the windset) or the direction in which the low-level wind is blowing (obtained from a pilot balloon) may be entered. 2. This function must be preceded by a + or — sign when pilot balloon direction data are entered. The computer program will ignore the sign during computations. 3. Set to minus zero by use of function D–8 (LLW FINAL DATA).
D–7 LLW CROSS/ SPEED	1. Depress matrix buttons D–7. 2. Depress the SM key. 3. On the keyboard, type the low-level crosswind component as determined from the windset. Depress the LEFT (—) or RIGHT (+) key to denote direction. 4. Depress the ENTER key. *Note:* If pilot balloon data are to be used, the speed of the low-level wind is entered in step 3.	1. Depress matrix buttons D–7. 2. Depress the RECALL key. If no value has been entered, -00000 will be displayed.	1. Mission associated. Either the low-level crosswind component (obtained from the windset) or the speed of the wind in miles per hour (obtained from a pilot balloon) may be entered. 2. This function must be preceded by a + or — sign when pilot balloon speed data are entered. The computer program will ignore the sign during computation. 3. Set to minus zero by use of function D–8 (LLW FINAL DATA).
D–8 FINAL DATA	1. Depress matrix buttons D–8. 2. Depress the SM key. 3. On the keyboard, type the key for the appropriate flag. *a.* Type 1 if the low-level winds were determined with the windset during other than nighttime conditions. *b.* Type 2 if the low-level winds were determined with the windset during nighttime conditions. *c.* Type 3 if the 01 line of the met message previously entered into the computer is to be used as the basis for low-level wind corrrections. *d.* Type 4 if the data entered in D–6	NA	1. A ballistic computation must precede use of this function. If not, the NO SOLUTION indicator will blink and ------7 will be displayed. 2. When flag 1, 2, or 4 is entered, data must have been entered in D–6 and D–7. If not, the NO SOLUTION indicator will blink and ------7 will be displayed. 3. Depressing the ENTER key causes the computer to apply low-level wind corrections to previously computed firing data. 4. Set to minus zero by function C–8 (CLEAR MISSION DATA). 5. Data in D–6 and D–7 are set to minus

	and D–7 were obtained using a pilot balloon. 4. Depress the ENTER key. (The final deflection and quadrant elevation will be computed and displayed.)		zero during computation.
E–1 MOTOR EMPTY WT	1. Depress matrix buttons E–1. 2. Depress the SM key. 3. On the keyboard type the motor empty weight to the nearest pound. If the weight is not known (as with the MGR–1A rocket), type 0. 4. Depress the ENTER key.	1. Depress matrix buttons E–1 2. Depress RECALL key.	1. Mission associated. 2. The only values that the computer will accept for this function are from 1900 to 2200 for the MGR–1A rocket and from 1335 to 1450 for the MGR–1B rocket. If an improper weight is used, the computations will result in a NO SOLUTION indication.
E–2 PROP WT CORR	1. Depress matrix buttons E–2. 2. Depress the SM key. 3. On the keyboard, depress the + or – key and then type the propellant weight correction to the nearest tenth of a pound. 4. Depress the ENTER key.	1. Depress matrix buttons E–2. 2. Depress the RECALL key.	1. Mission associated. 2. This function is used only for the MGR–1B rocket. 3. This function must be used with a + or – sign, even if zero is entered. 4. The computer will accept any value for this function from +50 to –50 pounds.
E–3 PROP WT	1. Depress matrix buttons E–3. 2. Depress the SM key. 3. On the keyboard, type the stenciled propellant weight for the MGR–1A rocket to the nearest pound. 4. Depress the ENTER key.	1. Depress matrix buttons E–3. 2. Depress the RECALL key.	1. Used for the MGR–1A rocket only. 2. Mission associated. 3. The computer will accept any value for this function from 2,000 to 2,100 pounds.
E–4 GROSS MOTOR WT	1. Depress matrix buttons E–4. 2. Depress the SM key. 3. On the keyboard, type the gross motor weight to the nearest pound. 4. Depress the ENTER key.	1. Depress matrix buttons E–4. 2. Depress the RECALL key.	1. Mission associated. 2. Used for the MGR–1A rocket only. 3. Used only when the motor empty weight is not known and the propellant and fin weights are known and entered. 4. Whenever this function is used, a zero must be entered in matrix location E–1 (MOTOR EMPTY WT). 5. The computer will accept values for this function from 3,900 to 4,300 pounds.
E–5 FIN WT	1. Depress matrix buttons E–5. 2. Depress the SM key. 3. On the keyboard, type the fin weight to the nearest pound. 4. Depress the ENTER key.	1. Depress matrix buttons E–5. 2. Depress the RECALL key.	1. Mission associated. 2. Used with the MGR–1A rocket only. 3. MGR–1A fin weights are: *Fin* — *Weight* M136A1 — 166 pounds M136A2 — 166 pounds M136A2B1 — 172 pounds 4. The MGR–1B fin weight is included in the stenciled motor empty weight.

Table 4-1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
E-6 PROP TEMP	1. Depress matrix buttons E-6. 2. Depress the SM key. 3. On the keyboard, depress the + or − key and type the propellant temperature to nearest degree Fahrenheit. 4. Depress the ENTER key.	1. Depress matrix buttons E-6. 2. Depress the RECALL key.	1. Mission associated. 2. Input must be signed (+ or −). 3. The computer will accept temperatures between −30° and +120° F for the MGR-1B rocket and between 0° and +120° F for the MGR-1A rocket.
E-7 SURF PRESS	1. Depress matrix buttons E-7. 2. Depress the SM key. 3. On the keyboard, type the surface pressure to nearest millibar or a 0 to cause the computer to use the met surface pressure in the met identification line.	1. Depress matrix buttons E-7. 2. Depress the RECALL key.	1. Mission associated. 2. The met surface pressure in the identification line will be corrected by the computer for the difference in altitude between the launcher and the met datun plane (MDP). 3. The computer will accept data on pressure input between 650 and 1,100 millibars.
E-8 MOTOR AGE	1. Depress matrix buttons E-8. 2. Depress the SM key. 3. On the keyboard, type the motor age in months.	1. Depress matrix buttons E-8. 2. Depress the RECALL key.	1. Mission associated. 2. Enter 52 for all values when the motor age exceeds 52 months. 3. Used only with the M27, M47, M48 and M190 warheads.
F-1 TGT LIST ASSOC	1. Depress the appropriate mission association buttons. 2. Depress matrix buttons F-1. 3. Depress the SM key. 4. On the keyboard, type the number given on the target list for the target that is to be mission associated. 5. Depress the ENTER key.	NA	1. Used to mission associate a target previously stored on the target list. 2. When a target that has not been entered on the target list is mission associated, the error display will be ------4. 3. Target will be mission associated when the display appears.
F-2 FP LIST ASSOC	1. Depress the appropriate mission association buttons. 2. Depress matrix button F-2. 3. Depress the SM key. 4. On the keyboard, type the number given on the firing point list for the firing point that is to be mission associated. 5. Depress the ENTER key.	NA	1. Used to mission associate a firing point previously stored on the firing point list. 2. When a firing point that has not been entered on the firing point list is mission associated, the error display will be ------4. 3. Firing point will be mission associated when the display appears.
F-3 RKT TYPE	1. Depress matrix buttons F-3. 2. Depress the SM key. 3. On the keyboard, type the key (flag) for the type of rocket used. 4. Depress the ENTER key.	1. Depress matrix buttons F-3. 2. Depress the RECALL key.	1. Mission associated. 2. Flags are: *Flag* — *Rocket* 31 — MGR-IA 50 — MGR-1B
F-4 WHD TYPE	1. Depress matrix buttons F-4. 2. Depress the SM key.	1. Depress matrix buttons F-4. 2. Depress the RECALL key.	1. Mission associated. 2. Flags are:

	3. On the keyboard, type the key (flag) for the type of warhead used. 4. Depress the ENTER key.		*Flag* / *Warhead* 1 Nuclear M27 2 Nuclear M47 3 Nuclear M48 4 High-explosive M6A1 5 High-explosive M144 6 High-explosive M186 7 Flash-smoke M38 Chemical M190
F–5 WHD WT	1. Depress matrix buttons F–5. 2. Depress the SM key. 3. On the keyboard, type the stenciled warhead weight to the nearest pound. 4. Depress the ENTER key.	1. Depress matrix buttons F–5. 2. Depress the RECALL key.	1. Mission associated. 2. The computer will accept any value for this function from 1,185 to 1,285 pounds for nuclear or chemical warheads and from 1,575 to 1,675 pounds for high-explosive or flash-smoke warheads.
F–6 HOB	1. Depress matrix buttons F–6. 2. Depress the SM key. 3. On the keyboard, type the height of burst in meters. 4. Depress the ENTER key.	1. Depress matrix buttons F–6. 2. Depress the RECALL key.	1. Mission associated. 2. Used only to enter a specific height of burst above target for the nuclear warheads or the M38 warhead. 3. Special instructions are given in FM 6–40–1A. 4. The computer will accept any value from 0 to 1000 for the nuclear warheads and 0 to 2000 for the M38 warhead. 5. When matrix function F–7 (OPTION) is used, the value entered in this function is set to an unrecognizable form.
F–7 OPTION	1. Depress matrix buttons F–7. 2. Depress the SM key. 3. On the keyboard, type the key (flag) for the type of fuze option selected.	1. Depress matrix buttons F–7. 2. Depress the RECALL key.	1. Mission associated. 2. Special instructions are given in FM 6–40–1A. 3. Not used with the flash-smoke warhead M38. 4. Flags are: *Flag* / *Fuze option* 0 Impact 1 Low air 2 High air
F–8 AIMING POINT DF	1. Depress matrix buttons F–8. 2. Depress the SM key. 3. On the keyboard, type the aiming point deflection to the nearest mil.	1. Depress matrix buttons F–8. 2. Depress the RECALL key.	1. Mission associated. 2. The deflection is entered as soon as it is known.
G–1 OBS AZ	1. Depress matrix buttons G–1. 2. Depress the SM key. 3. On the keyboard, type the observer grid azimuth in mils. 4. Depress the ENTER key.	1. Depress matrix buttons G–1.	Used to enter the azimuth in survey (See matrix function G–5 (SURVEY).) Azimuth must be entered to at least the nearest mil but may be entered to the nearest 0.01 mil.

Table 4-1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
G-2 OBS HORIZ DIST	1. Depress matrix buttons G-2. 2. Depress the SM key. 3. On the keyboard, type the observer horizontal distance in meters. 4. Depress the ENTER key.	1. Depress matrix buttons G-2. 2. Depress the RECALL key.	1. Either the horizontal distance or the slant distance (but not both) may be entered. 2. Set to minus zero during computation. 3. Horizontal distance may be entered to at least the nearest meter but may be entered to the nearest 0.01 meter. A maximum of seven digits may be entered. 4. Maximum input is 50,000 meters.
G-3 OBS SLANT DIST	1. Depress matrix buttons G-3. 2. Depress the SM key. 3. On the keyboard, type the observer slant distance in meters.	1. Depress matrix buttons G-3. 2. Depress the RECALL key.	1. Either the slant distance or the horizontal distance (but not both) may be entered. 2. Set to minus zero during computation. 3. Slant distance must be entered to at least the nearest meter but may be entered to nearest 0.01 meter. A maximum of seven digits may be entered. 4. Maximum input is 50,000 meters.
G-4 OBS VERT ANGLE	1. Depress matrix buttons G-4. 2. Depress the SM key. 3. On the keyboard, depress the + or − key and type the observer vertical angle to the nearest mil. 4. Depress the ENTER key.	1. Depress matrix buttons G-4. 2. Depress the RECALL key.	1. A plus or minus sign must precede the entry. 2. Set to minus zero during computation. 3. Used with matrix function G-5 (SURVEY). Must be entered to at least the nearest mil but may be entered to the nearest 0.01 mil. 4. This function requires an entry. If no vertical angle is to be used, enter + 0.
G-5 SURVEY	1. The procedure for solving a traverse is as follows: *a.* Depress matrix buttons G-5. *b.* Depress the SM key. *c.* On the keyboard, type 1 (traverse flag). *d.* Depress the ENTER key. *e.* During matrix location H-5 (OBS RECALL), recall the coordinates and altitude of the initial station or, if the data have not been previously entered, enter these data in matrix locations H-1, H-2 and H-3. *f.* Using matrix location G-1, enter the azimuth to the forward station. *g.* Using matrix locations G-2 or G-3 and G-4, enter the distance and vertical angle.	NA	1. This function provides for entry of a flag to identify the specific survey procedure to be computed; they are: *Flag* — *Procedure* 1 — Traverse 2 — Intersection 3 — Zone to zone 2. The operator should proceed in a fixed sequence in the solution of most survey problems. The sequence is detailed under entry procedures. 3. In the problems in survey, the computer enters the compute mode when the TRIG button is depressed after the last data needed in the solution of a problem has been entered. 4. When an error has been made in the entry of data and computation has

	h. Depress the TRIG button. (The COMPUTE indicator will light momentarily and the coordinates of the forward station will be displayed.) 1. Continue traverse computation by repeating steps f through h. 2. The procedure for solving an intersection is as follows: *a.* Depress matrix buttons G–5 (SURVEY). *b.* Depress the SM key. *c.* On the keyboard, type 2 (intersection flag). *d.* Using matrix function H–5, recall the coordinates and altitude of one of the two observers. *e.* Using matrix functions G–1 and G–4, enter the observer azimuth and vertical angle to the unknown point. *f.* Repeat steps *d* and *e* above for the second observer. (Only one vertical angle may be entered.) *g.* Depress the TRIG button. (The coordinates of the intersection will be computed and displayed.) 3. The procedure for solving a zone-to-zone transformation is as follows: *a.* Depress matrix buttons G–5 (SURVEY). *b.* Depress the SM key. *c.* On the keyboard, type 3 (zone-to-zone flag) and depress the ENTER key. *d.* Using matrix functions H–6, H–7, H–8, G–6, G–7, and G–8, enter the zone-to-zone transformation data. *e.* Depress the TRIG button. (The transposed coordinates and azimuth will be displayed and automatically entered in locations A–1 and A–2.) *Note:* **The altitude of the transposed point is normally determined from a map or the fire mission data and should be entered in matrix function before the coordinates are stored on the target list.**		occurred, the problem must be solved again. Normally this requires reentry of all data. 5. The computed coordinates for each station along a traverse or the unknown station determined by intersection are recorded in H–1, H–2, and H–3 and may be recalled separately if data are needed to the nearest .01 meter. 6. The computed transposed coordinates in the zone-to-zone transformation are recorded in A–1 and A–2.
G–6 LOCAL ZONE	1. Depress matrix buttons G–6. 2. Depress the SM key. 3. On the keyboard, depress the + key (for Northern Hemisphere) or the – key (for Southern Hemisphere) and then type the local UTM grid zone number.	1. Depress matrix buttons G–6. 2. Depress the RECALL key.	1. Used to enter the UTM zone number of the local zone to which coordinates of the station are being transformed. 2. Range of input is from –60 to +60.

Table 4-1. Operator Procedures, Honest John Program—Continued

Matrix location/ input function	Entry procedure	Recall procedure	Remarks
	4. Depress the ENTER key.		
G-7 STA ZONE	1. Depress matrix buttons G-7. 2. Depress the SM key. 3. On the keyboard, depress the + key (for Northern Hemisphere) or the − key (for Southern Hemisphere) and then type the station UTM grid zone number. 4. Depress the ENTER key.	1. Depress matrix buttons G-7. 2. Depress the RECALL key.	1. Used to enter the UTM zone number in the transformation of coordinates from an adjacent zone to a local zone. 2. Range of input is from −60 to +60. 3. Set to minus zero during computations by use of matrix function G-5 (SURVEY).
G-8 STA AZ	1. Depress matrix buttons G-8. 2. Depress the SM key. 3. On the keyboard, type the value of the azimuth in the adjacent zone in mils to the accuracy desired. 4. (Enter the value 6400 to designate grid north or 0 to indicate that no azimuth is being transformed.	1. Depress matrix buttons G-8. 2. Depress the RECALL key.	1. Used to enter the azimuth to be transformed in the zone-to-zone transformation routine. 2. The azimuth must be entered to at least the nearest mil but may be entered to the nearest .01 mil. 3. The value entered in this function is set to minus zero during computation.
H-1 OBS EAST	1. Depress matrix buttons H-1. 2. Depress the SM key. 3. On the keyboard, type the observer easting. 4. Depress the ENTER key.	1. Depress matrix buttons H-1. 2. Depress the RECALL key.	1. Used to enter the observer easting for use in traverse and intersection survey. 2. Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. (For corrective action, reinitiate entry procedure and enter observer easting correctly.) 3. Entry may be made to nearest 0.01.
H-2 OBS NORTH	1. Depress matrix buttons H-2. 2. Depress the SM key. 3. On the keyboard type the observer northing. 4. Depress the ENTER key.	1. Depress matrix buttons H-2. 2. Depress the RECALL key.	1. Used to enter the observer northing for use in traverse and intersection survey. 2. Five-digit coordinates must be entered. If not, the NO SOLUTION indicator will blink and the display will remain. (For corrective action, reinitiate entry procedures and enter correctly.) 3. Entry may be made to nearest 0.01 meters.
H-3 OBS ALT	1. Depress matrix buttons H-3. 2. Depress the SM key. 3. On the keyboard, depress the + or − key and then type the altitude to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons H-3. 2. Depress the RECALL key.	1. Used to enter the observer altitude for use in traverse and intersection survey. 2. Entry must be to at least the nearest meter and may be made to the nearest 0.01 meter.
H-4 OBS RECORD	1. Depress matrix buttons H-4. 2. Depress the SM key.	NA	1. Values must have been entered in matrix locations H-1, H-2, and H-3. If not

	3. On the keyboard, type the number (1 through 9) to identify the observer location (OP) 4. Depress the ENTER key.		the NO SOLUTION indicator will blink. 2. Each observer location must be assigned a number from 1 to 9. 3. The observer number will be displayed in the CHARGE window.
H–5 OBS RECALL		1. Depress matrix buttons H–5. 2. Depress the SM key. 3. On the keyboard, type the observer number and depress the ENTER key. (A vacancy on the list will cause the NO SOLUTION indicator to blink and a display of ------3.)	1. The range of input is from 1 to 9. 2. The observer number will be displayed in the CHARGE window.
H–6 STA EAST	1. Depress matrix buttons H–6. 2. Depress the SM key. 3. On the keyboard, type the easting coordinate of the station to be transformed. (Six-digit coordinates must be entered to identify the 100,000-meter grid square.) 4. Depress the ENTER key.	1. Depress matrix buttons H–6. 2. Depress the RECALL key.	1. Used to enter the UTM easting coordinate of the station to be transformed in the zone-to-zone transformation. 2. The range of input is from 100,000 to 899,999. 3. The entered value is set to minus zero during computation.
H–7 STA NORTH	1. Depress matrix buttons H–7. 2. Depress the SM key. 3. On the keyboard, type the northing coordinate of the station to be transformed. (Seven-digit coordinates must be entered to identify the 100,000-meter grid square.) 4. Depress the ENTER key.	1. Depress matrix buttons H–7. 2. Depress the RECALL key.	1. Used to enter the UTM northing coordinate of the station to be transformed in the zone-to-zone transformation routine. 2. The range of input is from 0 to 10,000,000. 3. The entered value is set to minus zero during computation.
H–8 STA SPHERE	1. Depress matrix buttons H–8. 2. Depress the SM key. 3. On the keyboard type the spheroid number: *Spheroid* — *Flag* Clark 1866 — 1 International — 2 Clark 1880 — 3 Everest — 4 Bessel — 5 4. Depress the ENTER key.	1. Depress matrix buttons H–8. 2. Depress the RECALL key.	1. Used to enter the spheroid flag indicating the mapping spheroid to be used in the zone-to-zone transformation. 2. The range of input is from 1 to 5. 3. The entered value is set to minus zero during computation.

Table 4–2. No Solution Displays

Display	Meaning of display
---------------------- 1	Magnitude of input exceeds limits.
---------------------- 3	Failure to enter one or more of the inputs (easting, northing, or altitude) that identify the observer, firing point, or target before attempting to store the data; recall of a target, firing point, or observer not on the target, firing point, or observer list; or use of the RECALL key with a recall function.
---------------------- 4	Attempt to mission associate a target or firing point not on the target or firing point list.
---------------------- 5	Failure to mission associate firing point or target data.
---------------------- 6	Attempt to compute crest clearance for a mission that has not been computed.
---------------------- 7	Failure to enter low-level wind data, or attempt to compute low-level wind before the mission was computed.
---------------------- 9	Use of incorrect enable or dismiss code.
---------------------- 10	Failure to depress mission association buttons or attempt to print mission before the mission was computed.
---------------------- 11	Improper change of matrix or mission association buttons.
---------------------- 15	Incomplete data for crest clearance computations.
---------------------- 17	Crest range exceeds target range.
---------------------- 19	Target range exceeds maximum range of system.
---------------------- 21	Failure to enter no vertical angle.
---------------------- 22	Failure to enter azimuth.
---------------------- 23	Traverse leg exceeds 50,000-meter limit.
---------------------- 24	Failure to enter azimuth in intersection survey.
---------------------- 25	Entry of two vertical angles in intersection survey.
---------------------- 26	Entry of zero horizontal or slant distance.
---------------------- 27	Failure to enter horizontal or slant range.
-00000	Recall of data that has been set to minus zero or that has not been entered.
--------------------- XY	Improper or incomplete entry at matrix location XY. (X is the lettered row and Y is the numerical column for the matrix location.)
NO SOLUTION indicator blinks and display remains	Failure to enter the proper number of digits.
NSL No Display	One or more of the following: *a.* Attempt to recall data that is not recallable. *b.* Failure to depress matrix buttons. *c.* Use of a blank matrix position. *d.* Failure to depress mission association buttons.

Section VIII. HOW FADAC COMPUTES

4–48. General

The computer solves the gunnery problem for the rocket in three phases:

a. Range, azimuth, and initial firing data selection.

b. Data computation for powered flight.

c. Trajectory computation for free flight.

4–29. Steps in Computation

a. The series of computations made by the computer are depicted in figures 4–17 through 4–20. The six steps in computation are explained below:

(1) *Steps 1 through 3.* Using the coordinates of the firing position and the target, the FADAC mathematically calculates the range and azimuth of fire. Then, using the other initial data entered, it calculates the height of burst relative to the launcher. From this information, the computer selects a trial quadrant elevation based on the empirical data entered in its memory.

(2) *Step 4.* Using the trial quadrant elevation as an argument to enter a table of empirical data stored in the memory, the computer determines the position of the rocket at motor burnout in range (X), (Y), and angle of travel (Ø) along a hypothetical trajectory.

(3) *Step 5.* After motor burnout, the computer considers the velocity and angle of travel at this point and then simulates the flight of the rocket through the existing conditions of weather by using data on the rocket's known ballistic effects of rotation of the earth and gravity and by numerically integrating the equations

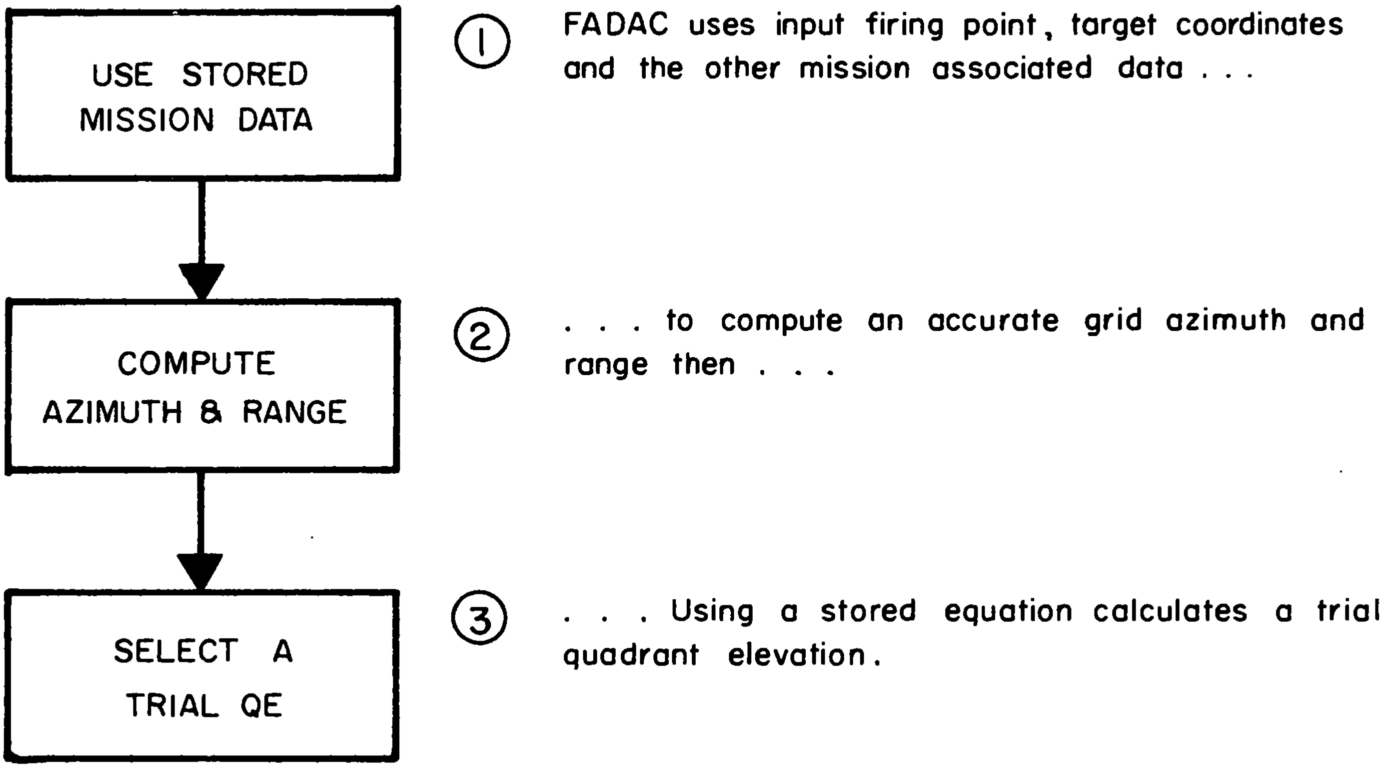


Figure 4–17. Steps 1 Through 3 of Computation.

of motion for a projectile in flight. At each integration, the computer applies the nonstandard conditions to the equations of motion to determine a new velocity, integrates the acceleration of the rocket to find the velocity, and then integrates the velocity of the rocket to determine the rocket's displacement in horizontal distance (X) and vertical distance (Y).

(4) *Step 6.* At the completion of each velocity integration, the computer compares the altitude of the rocket with the target altitude. When the computed altitude of the rocket is equal to or less than the altitude of the target, the computer stops the integration and computes a miss distance by comparing the location of the rocket with that of the target. If the miss distance is less than 30 meters, the computer applies a correction and displays the firing data. If the miss distance is 30 meters or greater, the computer corrects the initial quadrant elevation (step 3) and recomputes the trajectory. The computer continues this comparison until the miss distance is reduced to less than 30 meters.

b. Using the integration method, the computer also applies corrections to deflection for earth curvature, rotation of the earth, and ballistic cross-wind. When the computation is completed, the computer displays the initial deflection, fuze setting, and quadrant elevation. Data for low-level winds are then entered, and the computer computes the corrections, applies them to the initial deflection and quadrant elevation, and displays the final firing data.

4–30. Crest Clearance Assurance

The FADAC computes crest clearance assurance for any crest at a range of 1,000 meters or greater from the launcher. The solution displayed is the percentage of assurance of the rocket clearing a crest. Any computed assurance of less than 50 percent is considered to be zero because, in such situations, the chance of accomplishing the mission is less than even; therefore, the mission should be aborted. The program logic used in the computation of clearance assurance is similar to the manual logic.

(4) Using the trial QE FADAC solves for the range (X_O), height (Y_O) and a velocity (V_O) . . . .

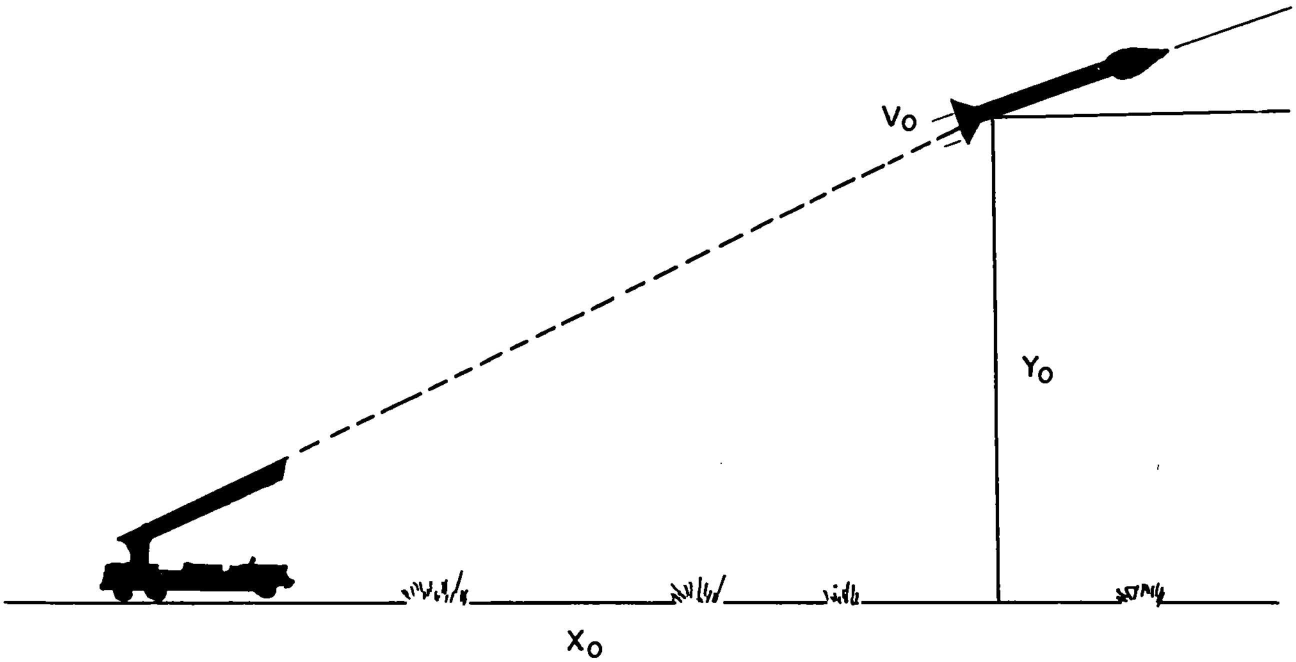
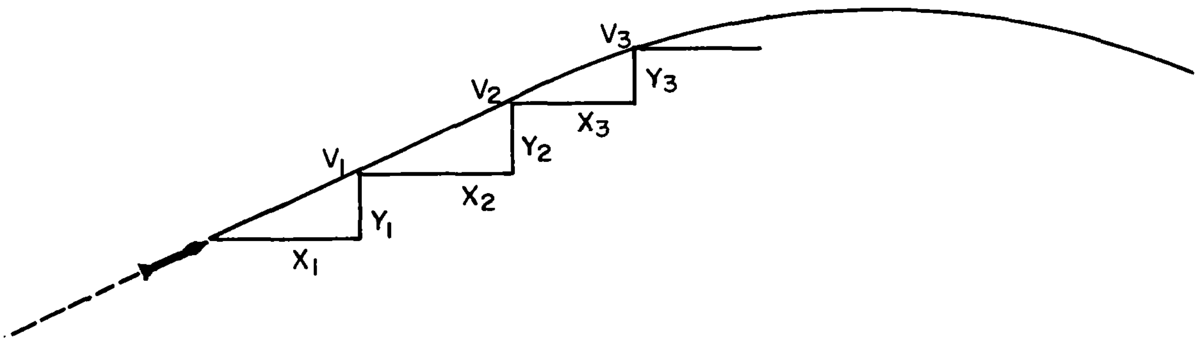


Figure 4–18. Step 4 of Computation.

(5) After motor burnout, FADAC applies all the known ballistic conditions affecting the rocket flight, using equations of motion to compute range (X_1), height (Y_2) and velocity (V_1) for a selected time interval . . . . .



. . . . then integrating acceleration to obtain velocity the computations are repeated for a second time interval to compute range (X_2), height (Y_2) and a new velocity (V_2) and so on . . . .

Figure 4-19. Step 5 of Computation.

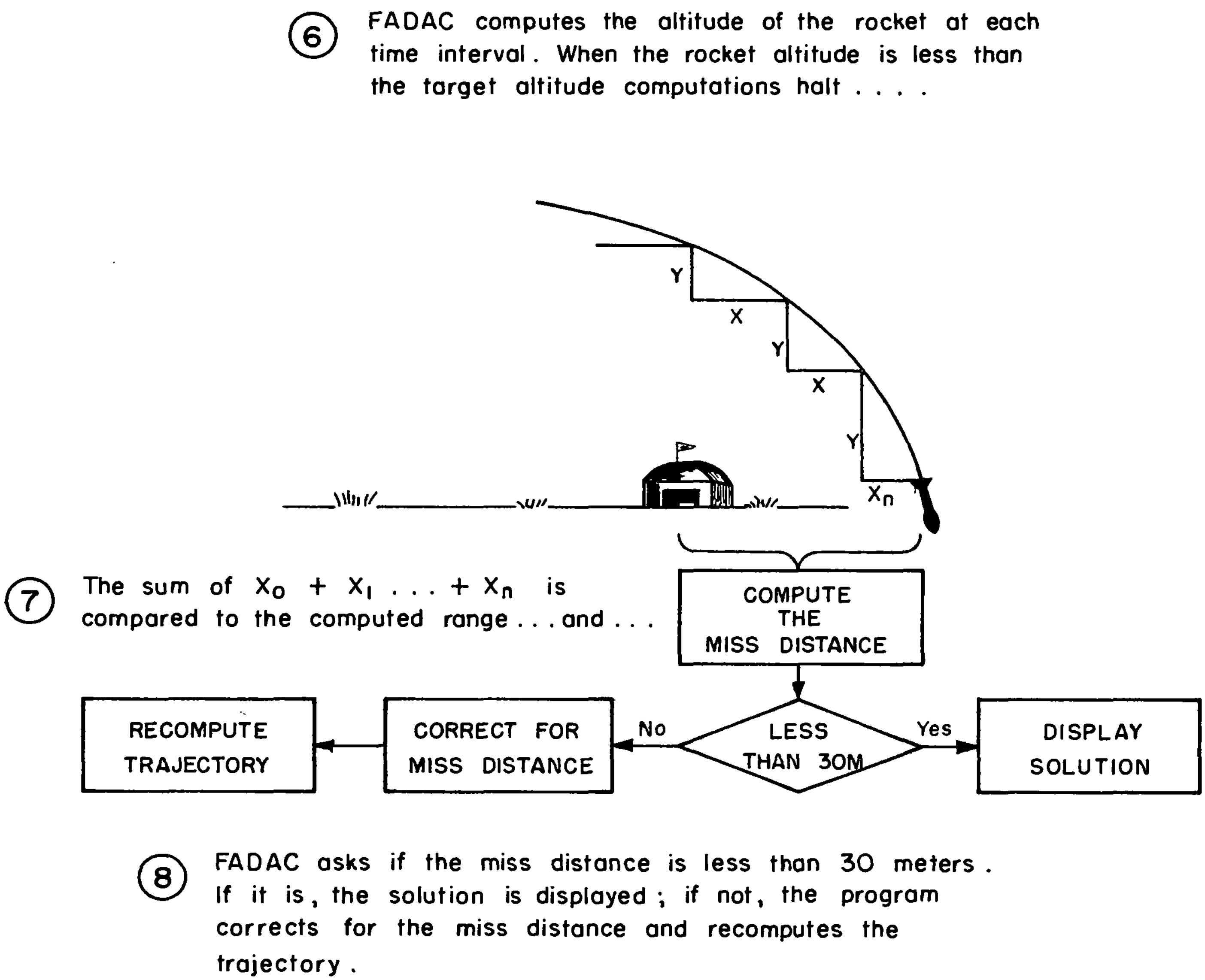


Figure 4–20. Step 6 of Computation.

Section IX. FIRE DIRECTION

4–31. Mission Association

Firing data are mission associated by use of the mission association buttons on the right side of the matrix panel (para 4–13).

4–32. Operator Steps in Solving a Fire Mission

The steps in solving a fire mission problem are performed in the sequence given in *a* through *l* below. However, this sequence is only a guide and it may be altered to fit the availability of data in a given situation. These steps provide an efficient and fast procedure for solving the gunnery problem.

a. Designate the mission number by depressing the appropriate mission association buttons number (1 or 2) and letter button (A, B, C, D, or E).

b. Clear the mission location by using matrix function C–8 (CLEAR MSN DATA).

c. Using matrix function F–1 (TGT LIST ASSOC), select the target by number from the target list. A target must be stored on the target list before it can be mission associated.

d. Using matrix function F–2 (FP LIST ASSOC), select the firing point from the firing point list. A firing point must be stored on the firing point list before it can be mission associated.

e. Compute the range, azimuth of fire, and orienting angle by using matrix function D–1 (COMP RANGE AZ/OA).

f. Enter the met message, grid declination angle, and latitude by using matrix functions C–5 (MET INPUT), D–4 (GRID DECL) and D–3 (LAT). If this information has already been entered, it will be applied to the mission without any action by the operator.

g. Using the appropriate matrix functions, enter the rocket type, warhead type, warhead weight, height of burst or option, empty weight, and other known data.

h. Compute the initial deflection the fuze setting, and the quadrant elevation by depressing the COMPUTE button.

i. Using matrix functions C–1 (CREST RANGE), C–2 (CREST ALT), and C–3 (CREST CLEAR ASSUR), compute the crest clearance if necessary.

j. Approximately 2 minutes prior to firing the mission, enter low-level wind data by using matrix functions D–6 (LLW RANGE/DIR) and D–7 (LLW CROSS/SPEED) and compute and apply low-level wind corrections to obtain final data by using matrix function D–8 (LLW FINAL DATA).

k. Precompute and store mission data by using the procedure in steps *a* through *h.* When new meterological messages are received or a change in other input data has occurred, update the mission as follows:

(1) Depress the appropriate mission association buttons and use matrix function C–6 (RECALL FIRING DATA) to recall the mission firing data.

(2) Use matrix function C–4 (MET STD) to dismiss met standard, if current met is to be used to compute the mission.

(3) Using matrix function C–5 (MET INPUT), enter the latest met message.

(4) Using the appropriate matrix functions, enter any new data pertinent to the mission and repeat steps *h* through *j.*

l. After the final data have been computed (step *j*), obtain a printout of the mission by using matrix function C–7 (PRINT MSN).

m. When a particular mission set of data is no longer needed, clear the data from the hot storage section of memory by using matrix function C–8 (CLEAR MSN DATA).

Section X. REFERENCE INFORMATION

4–33. Rocket Reference Data

The rocket programs compute weight data on the basis of the types of rocket, warhead, and launcher being used; therefore, manual weight computations are unnecessary. Table 4–3 shows the matrix input function for weight data applicable to the rocket types.

Table 4–3. Rocket Weight Data

Matrix location	Applicable to rocket types	Remarks
E–1 (MOTOR EMPTY WT)	MGR–1A and MGR–1B	Weight stenciled on motor.
F–5 (WHD WT)	MGR–1A and MGR 1B	Weight stenciled on warhead.
E–2 (PROP WT CORR)	MGR–1B only	Weight stenciled on motor.
E–5 (FIN WT)	MGR–1A only	166 pounds or 172 pounds, according to fin type.
E–3 (PROP WT)	MGR–1A only	Weight stenciled on motor. Use only when E–2 is not used.
E–4 (GROSS MOTOR WT)	MGR–1A only	Weight stenciled on motor.

4–34. Rocket Warhead Data

The use of matrix input functions F–6 (HOB) and F–7 (OPTION) depends on the type of warhead being fired. Rocket and warhead combinations and fuzing information and the appropriate inputs for matrix functions F–6 (HOB) and F–7 (OPTION) are shown in table 4–4. For additional information, see FM 6–40–1A.

Table 4–4. Rocket Warhead Data

Warhead type	Flag	Applicable matrix location	Remarks
Nuclear M27 Nuclear M47 Nuclear M48	1 2 3	F–6 (HOB) F–7 (OPTION)	Enter either HOB or OPTION. See FM 6–40–1A.
HE M6A1 HE M144 HE M186	4 5 6	F–7 (OPTION) only	Enter one of the following flags: 1—low airburst. 2—high airburst.
Flash-smoke M38 (practice)	7	F–6 (HOB) only	Enter height of burst above target in meters.
Chemical M190 (E19R2)	8	F–7 (OPTION) only	Enter one of the following flags: 1—low airburst. 2—high airburst.

4–35. Computer Meteorological Message Tape Preparation

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

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

c. The procedures for cutting a training met message tape are as follows:

(1) Advance the tape 4 to 5 inches by using the tape advance lever on the teletypewriter reperforator-transmitter TT–76.

(2) Cut the text of the message starting with the identification lines (12 digits each), and then cut the met data lines. Use 16 digits for each data line, and use only *one* carriage return (CR) and *one* line feed (LF) instruction at the end of each line.

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

(4) Advance the tape 3 to 4 inches by using the BLANK key or the tape advance lever on the TT–76.

Table 4–5. Standard Computer Meteorological Message Tape Preparation Procedures

Message parts	Met message test	Machine functions	Remarks CR-Carriage return LF-Line feed
		Advance the tape 4 to 5 inches by using the BLANK key on the TT–76 teletypewriter.	Blank tape is used to thread the tape into the mechanical tape reader.
Introduction Valid time group	METCM0512018 070952031972	1 CR, 1 LF 1 CR, 1 LF	Identification lines.
Body.	0002000526621972 0102601026281940 0203002026021884 0305102225881862 * * * * 1018205025100543	1 CR, 1 LF 1 CR, 1 LF 1 CR, 1 LF 1 CR, 1 LF * * * * 1 CR, 1 LF	The carriage return code causes the computer to store the 16 digits preceding the code.
	9	1 CR	The digit 9 is a stop instruction.
		Advance the tape 3 to 4 inches by using the BLANK key on the TT–76 teletypewriter.	

4-36. Flag Card

Figure 4-21 shows the flag card, which contains all reference data in a ready-to-use form.

FLAG CARD - HONEST JOHN ROCKET (M31, M50) REVISION 1 PROGRAM

Detailed procedures are contained in FM 6-40-1

Program Test Nr 1 will result in the following display: 2 00000 00010 00762

SECTION I - FLAGS

1. LLW FINAL DATA (D-8)
   1 - All other than nightime
   2 - Nightime conditions
   3 - Pilot balloon or line 01 met

2. LAT (D-3), ADJ ZONE (G-6) LOCAL ZONE (G-7)

   + Northern hemisphere
   - Southern hemisphere

3. RKT TYPE (F-3)
   31 - MGR-1A
   50 - MGR-1B

4. WHD TYPE (F-4)
   1 - Nuclear M27
   2 - Nuclear M47
   3 - Nuclear M48
   4 - HE M6A1
   5 - HE M144
   6 - HE XM186
   7 - Flash/smoke M38
   8 - Chemical M190

5. OPTION (F-7)
   0 - Impact
   1 - Low air
   2 - High air

6. SURVEY (G-5)
   1.- Traverse
   2 - Intersection
   3 - Zone to zone

7. SPHERE(H-8)
   1 - Clarke 1866
   2 - International
   3 - Clarke 1880
   4 - Everest
   5 - Bessel

SECTION II - HOT MEMORY STORAGE CAPACITY

TGT RECORD (A-5)	-	32
FP RECORD (B-5)	-	16
OBS RECORD (H-4)	-	9
MISSIONS (A1...E5)		10

SECTION III - WEIGHT INPUT LIMITS

Function	Type	Limits
MOTOR EMPTY WT (E-1)	MGR 1A Rkt	1900-2200
	MGR 1B Rkt	1335-1450
PROP WT CORR (E-2)	MGR 1B Rkt	-50 -+50
PROP Wt (E-3)	MGR 1A Rkt	2000-2100
GROSS MOTOR WT (E-4)	MGR 1A Rkt	3900-4500
FIN WT (E-5)	MGR 1A Rkt	166-172
WHD WT (F-5)	M27,M47,M48 or M190 whd	1185-1285
	HE or Flash/smk	1575-1675

SECTION IV NO SOLUTION INDICATIONS

...... 1 Input value too large
...... 3 Input data incomplete
...... 4 Firing point or target not on list
...... 5 Inputs for RG/AZ/OA computation incomplete
...... 6 No mission defined for crest clearance
...... 7 Incomplete LLW data
...... 9 Incorrect enable code
..... 10 Improper use of function
..... 11 Matrix or mission buttons improperly changed
..... 15 Incomplete data for crest clearance
..... 17 Crest range exceeds target range
..... 19 Out of range
..... 21 Improper vertical angle entry
..... 22 Azimuth not entered
..... 23 Traverse leg exceeds limit of 50,000
..... 24 Improper azimuth entry
..... 25 Two vertical angles entered for intersection
..... 26 Zero entered for horizontal range
..... 27 Range not entered
-00000 Recalling nonexistent data
NSL Matrix buttons not depressed, blank matrix window used, unused button depressed or mission association buttons not depressed
XY Improper or incomplete entry at matrix location XY

Figure 4-21. Flag card.

Section XI. SOLVING PROBLEMS BY USE OF FADAC

4–37. General

a. The problems in this section illustrate the computation of firing data for the Honest John rocket and the computation of selected types of survey by use of the M18 gun direction computer FADAC. The problems should be solved in sequence for maximum training value and understanding.

b. After setting up the computer, the operator should run program tests 1 and 2 to insure that the computer is operating properly.

4–38. Sequence of Events in Processing a Fire Mission

a. In most tactical situations, the sequence of events in processing a fire mission dictate the receipt and computation of specific data when using the FADAC. These events normally occur in the following sequence:

(1) Position areas and firing points (FP) are selected, survey is conducted, and communications are established.

(2) The battalion fire direction center receives the fire mission from higher headquarters.

(3) The battalion S3 or fire direction officer issues a fire order to include a mission association number (the firing point-target association letter and number used by the FADAC operator to enter data).

(4) On the basis of the information in the fire mission and the fire order and the data computed by the FADAC the S3 issues a warning order to the battery designated to fire the mission.

(5) The FADAC operator enters all available data into the computer, to include the latest meteorological message, and computes the range, azimuth of fire, orienting angle, initial firing data, and, if necessary, crest clearance assurance.

(6) The azimuth of fire and orienting angle are sent to the firing platoon as soon as possible.

(7) When the firing platoon reaches the firing position the surface pressure and propellant temperature are measured. These data as well as the aiming point deflection are sent to the fire direction center, where they are entered into the FADAC.

(8) Using the latest propellant temperature, surface pressure, and meteorological data, the FADAC operator computes firing data, which are sent to the firing platoon.

(9) Two minutes prior to firing, the low-level wind data are measured and sent to the fire direction center.

(10) The FADAC operator immediately enters the low-level wind data (or causes the computer to calculate corrections from the 01 line of the met message) and computes final data.

(11) The final deflection and quadrant elevation are sent to the firing platoon immediately.

b. The sequence of events discussed above may vary with the situation. In some cases, firing may take place from the position area. In that event, step (7) is not necessary.

4–39. Computation of Traverse

a. From the data determined by the battalion survey section, the following field notes are available:

(1) The coordinates of the survey control point (SCP) are 46963.6–31694.5 and the altitude is 418.8 meters.

(2) Traverse field data are as follows:

	Azimuth (mils)	*Distance (meters)*	*Vertical angle (mils)*
From SCP to TS1	5598.1	918.06	−2.6
From TS1 to TS2	692.5	1121.87	−4.4
From TS2 to TS3	5858.7	995.08	−3.3
From TS3 to FP1	5008.3	1120.62	−2.5

b. The operator of the M18 computer can compute the coordinates of each traverse station (TS) and of firing point 1 by using the following procedure.

(1) Depress matrix buttons G–5 (SURVEY) and then depress the SM key.

(2) Type (traverse flag) 1 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons H–1 (OBS EAST) and then depress the SM key.

(4) On the keyboard, type 46963.6 (the easting coordinate of the SCP) and depress the ENTER key.

(5) Depress matrix buttons H–2 (OBS NORTH) and then depress the SM key.

(6) On the keyboard, type 31694.5 (the

northing coordinate of the SCP) and depress the ENTER key.

(7) Depress matrix buttons H-3 (OBS ALT) and then depress the SM key.

(8) On the keyboard, type 418.8 (the altitude of the SCP to the nearest 0.1 meter) and depress the ENTER key.

(9) Depress matrix buttons G-1 (OBS AZIMUTH) and then depress the SM key.

(10) On the keyboard, type 5598.1 (the azimuth from the SCP to TS1) and depress the ENTER key.

(11) Depress matrix button G-2 (OBS HORIZ DIST) and then depress the SM key.

(12) On the keyboard, type 918.06 (the horizontal distance from the SCP to TS1) and depress the ENTER key.

(13) Depress matrix buttons G-4 (OBS VERT ANGLE) and then depress the SM key.

(14) On the keyboard, type −2.6 (the vertical angle from the SCP to TS1) and depress the ENTER key.

(15) Depress the TRIG buttton; the coordinates and altitudes of TS1 will be computed and displayed: 46313 32342 417.

(16) If these coordinates are to be saved, the operator may store them in the computer memory as follows:

(*a*) Depress matrix locations H-4 (OBS RECORD) and then depress the SM key.

(*b*) On the keyboard type 1 (file number) and depress the ENTER key.

Note: Although the coordinates are displayed only to the nearest meter, they are computed and stored to the nearest 0.01 meter. To recall the coordinates to the nearest 0.01 meter, depress matrix buttons H-1 (OBS EAST) and then depress the RECALL key. The northing and altitude may be recalled in a similar manner.

(*c*) Depress matrix buttons H-5 (OBS RECALL) and then depress the SM key.

(*d*) Type 1 on the keyboard and depress the ENTER key.

(17) Using the field data from TS1 to TS2, continue the traverse by repeating steps (9) through (15). The coordinates and altitude of TS2 are: 47019 33215 412.

(18) Using the field data from TS2 to TS3, continue the traverse by again repeating steps (9) through (15). The coordinates and altitude of TS3 are: 46514 34073 409.

(19) Using the field data from TS3 to FP1, continue the traverse by again repeating steps (9) through (15). The coordinates and altitude of firing point 1 are: 45417 34300 406.

4-40. Entry of the Firing Point List

When the firing point list is available, the data are entered into the computer.

a. Firing Point List

Number	*Coordinates*		*Altitude*	*Azimuth of Orienting Line*
1	45417	34300	+406	2615
2	48410	35893	+446	285
3	49263	34126	+451	1721
4	48842	35369	+448	1258

b. Entry Procedures

(1) Depress matrix buttons B-1 (FP EAST) and then depress the SM key.

(2) Type 45417 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons B-2 (FP NORTH) and then depress the SM key.

(4) Type 34300 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons B-3 (FP ALT) and then depress the SM key.

(6) Type +406 on the keyboard and depress the ENTER key.

(7) Depress matrix buttons B-4 (AZ OL) and then depress the SM key.

(8) Type 2615 on the keyboard and depress the ENTER key.

(9) Depress matrix buttons B-5 (FP RECORD) and then depress the SM key.

(10) Type 1 (firing point list number) on the keyboard and depress the ENTER key.

(11) Repeat steps (1) through (10) and enter the appropriate data for firing points 2, 3, and 4.

4-41. Zone-to-Zone Transformation by Use of the M18 Gun Direction Computer

a. The grid location of an enemy position was determined by using a map of UTM grid zone 14S and reported to higher headquarters. The Honest John battalion survey control was obtained by using UTM grid zone 15S data. The target data sent to the FDC was: 14S QP73709-29446.

b. The fire direction officer notes that the lower left corner of the 14S QP 100,000-meter grid square is labeled 600,000–38,000,000 (Northern Hemisphere). This means that the grid may be written as 673709 3829446 in lieu of using the QP 100,000-meter grid square designation.

c. Map projections are based on Clarke 1866 spheroid data.

d. The transformation of coordinates from the adjacent zone (14S) to the local zone (15S) is accomplished as follows:

(1) Depress matrix buttons G–5 (SURVEY) and depress the SM key.

(2) Type 3 (zone-to-zone flag) on the keyboard and depress the ENTER key.

(3) Depress matrix buttons H–6 (STA EAST) and then depress the SM key.

(4) Type 673709 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons H–7 (STA NORTH) and then depress the SM key.

(6) Type 3829446 on the keyboard and depress the ENTER key.

(7) Depress matrix buttons H–8 (STA SPHERE) and then depress the SM key.

(8) Type 1 (flag for Clarke 1866 spheroid) on the keyboard and depress the ENTER key.

(9) Depress matrix buttons G–6 (LOCAL ZONE) and then depress the SM key.

(10) Type +15 on the keyboard and depress the ENTER key.

(11) Depress matrix buttons G–7 (STA ZONE) and then depress the SM key.

(12) Type +14 on the keyboard and depress the ENTER key.

(13) Depress matrix buttons G–8 (STA AZ) and then depress the SM key.

(14) Type 0 on the keyboard and depress the ENTER key.

Note: An entry of zero indicates that no azimuth is to be transformed. An entry of 6400 mils would be used for north.

(15) Depress the TRIG button; the following converted coordinates will be displayed: 23369 354850.

e. The fire direction officer designates this location as target number 1. Before entering the target on the target list, the vertical control operator (VCO) would determine the altitude from a map.

4–42. Entry of the Target List

a. The following list of targets has been furnished the fire direction center:

Target	*Grid*	*Altitude*
1	23369 35485	357
2	45380 65184	601
3	31564 39611	393
4	25261 41419	400

b. These targets are entered on the target list by using the following procedure:

(1) Depress matrix buttons A–1 (TGT EAST) and then depress the SM key.

(2) Type 23369 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons A–2 (TGT NORTH) and then depress the SM key.

(4) Type 35485 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons A–3 (TGT ALT) and then depress the SM key.

(6) Type +357 on the keyboard and depress the ENTER key.

(7) Depress matrix buttons A–5 (TGT RECORD) and then depress the SM key.

(8) Type 1 on the keyboard and depress the ENTER key.

(9) Repeat steps (1) through (8) and enter the appropriate data for targets 2, 3, and 4.

4–43. Entry of Grid Declination and Latitude

a. The map of the battalion area of operations is used to determine the grid declination angle and the latitude of the area of operations.

b. The grid declination angle (the angle between true north and grid north) is +21 mils. The latitude of the center of the battalion area is 34° north. These data are entered as follows:

(1) Depress matrix buttons D–3 (LAT) and then depress the SM key.

(2) Type +34 on the keyboard and depress the ENTER key.

(3) Depress matrix button D–4 (GRID DECL) and then depress the SM key.

(4) Type +21 on the keyboard and depress the ENTER key.

4–44. Entry of the Meteorological Message

a. The entry of current meteorological message is vital to the computation of valid firing data. As soon as met data is received, it should be entered.

b. A met message may be received on paper tape or in printed form. The battalion has received the following computer met message:

METCM 1 344982 281002 036976

Line number	*Wind direction (10 mils)*	*Wind speed (knots)*	*Temp (0.1°K)*	*Pressure (mbs)*
00	280	004	2845	0976
01	385	009	2873	0965
02	459	013	2931	0938
03	460	013	2932	0895
04	445	003	2905	0844
05	079	003	2863	0796
06	136	004	2826	0750
07	375	003	2795	0704
08	292	006	2762	0651
09	420	004	2738	0622
10	440	009	2710	0585
11	382	010	2676	0549
12	450	012	2611	0498
13	486	011	2525	0437
14	495	007	2442	0381
15	508	009	2410	0330
16	528	007	2381	0283
17	560	010	2360	0240

MET—Meteorological message
CM—Computer
1—Octant 1 of the Northern Hemisphere (from 90° to 180° W)
344—Latitude of center of area (34.4° N)
982—Longitude of center of area (98.2° W)
28—Period of validity begins on 28th day of month
100—Start of the period is 1000 hours (1000 GMT)
2—Valid period lasts 2 hours (until 1200 GMT)
036—Height of MDP in decameters (360 meters)
976—Pressure at MDP in millibars (976)

c. The procedure of manual entry of the met message is as follows:

Note: See paragraph 4–23*c*.

(1) Depress matrix buttons C–5 (MET INPUT) and then depress the SM key.

(2) Type 0 (flag indicating manual entry) on the keyboard and depress the ENTER key (88 will be displayed).

(3) On the keyboard, type the identification line of the message starting with the 12-six-digit date-time group (281002036976) and depress the ENTER key (00 will be displayed).

(4) On the keyboard, type the 00 line of the message (0028000428450976) and depress the ENTER key (01 will be displayed).

(5) Repeat step (4) for each subsequent line of the message until the last line has been entered. Terminate the entry mode by typing a decimal point (.) and depressing the ENTER key.

4–45. Computation of Initial Data for Fire

Note: See paragraph 3–5.

a. The battalion S3 notes that the target in the call for fire is a preplanned target already entered in the FADAC as target number 1. He designates mission association number A–1 in his fire order.

MISSION A–1
LAUNCHER NUMBER 2
FIRING POSITION NUMBER 2
TARGET NUMBER 1

b. The FADAC operator computes the initial laying data as follows:

(1) Depress mission association button A–1.

(2) Depress matrix buttons C–8 (CLEAR MISSION DATA) and then depress the SM key.

(3) Type 0 on the keyboard. (This insures that memory location A–1 is clear.)

(4) Depress matrix buttons F–1 (TGT LIST ASSOC) and then depress the SM key.

(5) Type 1 on the keyboard and depress the ENTER key. (Display 23369 35485357 will appear.)

(6) Depress matrix buttons F–2 (FP LIST ASSOC) and then depress the SM key.

(7) Type 2 on the keyboard and depress the ENTER key. (Display 48410 35893 446 will appear.)

Note: Target number 1 and firing point number 2 are now associated with mission A–1. Any other data pertaining to this mission must be entered by depressing mission association buttons A–1.

(8) Depress matrix buttons D–1 (COMPUTE RANGE/AZ/OA) and depress the SM key. The following data will be displayed:

Range	25044 (meters)
Azimuth of fire	4783 (mils)
Orienting angle	1902 (mils)

c. The S3 then issues the warning order (para 3–5*c*) to the firing battery and designates a flash-smoke M38 warhead and the MGRIB rocket. The height of burst desired is 200 meters.

d. The following information is received from the launcher platoon designated to fire the mission:

Motor empty weight	1390 pounds
Warhead weight	1620 pounds
Stenciled propellant weight correction	+1.0 pounds
Propellant temperature	+48° F
Surface air pressure	976 millibars

e. These data are entered as follows:

(1) Ensure that mission association buttons A-1 are depressed.

(2) Depress matrix buttons F-3 (RKT TYPE) and depress the SM key.

(3) Type 50 on the keyboard and depress the ENTER key.

(4) Depress matrix buttons F-4 (WHD TYPE) and then depress the SM key.

(5) Type 7 on the keyboard and depress the ENTER key.

(6) Depress matrix buttons F-5 (WHD WT) and then depress the SM key.

(7) Type 1620 on the keyboard and depress the ENTER key.

(8) Depress matrix button F-6 (HOB) and then depress the SM key.

(9) Type 200 on the keyboard and depress the ENTER key.

(10) Depress matrix buttons E-1 (MOTOR EMPTY WT) and then depress the SM key.

(11) Type 1390 on the keyboard and depress the ENTER key.

(12) Depress matrix buttons E-2 (PROP WT CORR) and then depress the SM key.

(13) Type +1.0 on the keyboard and depress the ENTER key.

(14) Depress matrix buttons E-6 (PROP TEMP) and then depress the SM key.

(15) Type +48 on the keyboard and depress the ENTER key.

(16) Depress matrix buttons E-7 (SURF PRESS) and then depress the SM key.

(17) Type 976 on the keyboard and depress the ENTER key.

(18) Depress the COMPUTE button. The computation will begin and in approximately 40 seconds the following firing data will be displayed:

Fuze setting	54.4
Quadrant elevation	446.9

Note: It is not necessary to send these data to the firing platoon; however, it is necessary to compute a ballistic trajectory before calculating crest clearance assurance.

4-46. Computation of Crest Clearance for Fire Mission 1

a. From an inspection of the operations map along or near the line of fire, the S3 notes that the trajectory will pass over a hill that it may not clear with the assurance required.

b. The following data are extracted from the map:

Altitude of crest	960 meters
Range to crest	3650 meters

c. Crest clearance assurance is computed as follows:

(1) Depress matrix buttons C-1 (CREST RANGE) and then depress the SM key.

(2) Type 3650 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons C-2 (CREST ALT) and then depress the SM key.

(4) Type +960 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons C-3 (CREST CLEAR ASSUR) and then depress the SM key. The following solution will be displayed: AXX 03650 X0960 XXX99. The input range and altitude will be displayed in the DEFLECTION and TIME OF FLIGHT windows and the percentage of assurance (99) will be displayed in the QUADRANT window.

4-47. Computation of Final Data for Fire Mission 1

a. After the firing platoon has arrived at the firing point and the rocket launcher has been laid, the referred deflection, the latest propellant temperature, and the surface pressure at the firing point are reported to the FDC.

Referred deflection	1443 mils
Propellant temperature	+49° F
Surface pressure	965 millibars

b. These data are entered as follows:

(1) Depress the matrix buttons F-8 (AIMING POINT DF) and then depress the SM key.

(2) Type 1443 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons E-6 (PROP TEMP) and then depress the SM key.

(4) Type +49 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons E-7 (SURF PRESS) and then depress the SM key.

(6) Type 965 on the keyboard and depress the ENTER key.

(7) Depress the COMPUTE button. The following solution will be displayed:

Deflection	1440
Fuze setting	54.3
Quadrant elevation	446.0

c. The deflection, fuze setting, and quadrant elevation are sent to the firing platoon.

d. Two minutes prior to firing, the platoon commander reports the low-level wind data and the conditions under which they were determined.

Condition	Nighttime
Wind set:	
Rangewind	H6
Crosswind	R9

e. These data are entered as follows:

(1) Depress matrix buttons D–6 (LLW RANGE/DIR) and then depress the SM key.

(2) Type +6 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons D–7 (LLW CROSS/SPEED) and then depress the SM key.

(4) Type RIGHT +9 on the keyboard and depress the ENTER key.

(5) Depress the matrix buttons D–8 (LLW FINAL DATA) and then depress the SM key.

(6) On the keyboard, type 2 (flag 2 indicates nighttime conditions) and depress the ENTER key. The following final firing data will be displayed:

Deflection	1403
Time	54.3
Quadrant elevation	455.1

4–48. Printing the Mission

a. A printed record of each mission should be made as soon as final data are computed.

b. The procedure for making a printed record is as follows:

(1) Insure that the teletypewriter is connected to the computer.

(2) Position the typewriter paper.

(3) Depress matrix buttons C–7 (PRINT MISSION) and then depress the SM key. The mission will be printed to include the identification line of the met message.

(4) If a printout of the met message is desired, depress the ENTER key. If not, depress the decimal (.) key.

4–49. Printing the Firing Point List and the Target List

a. Printouts of the firing point list and the target list are normally required during the preparation of the situation map and as part of the unit journal record. These printouts should also be used to verify correct input in the M18.

b. The procedure for obtaining a printout of the firing point list is as follows:

(1) Depress matrix buttons B–7 (PRINT FP LIST) and then depress the SM key.

(2) Type 0 on the keyboard and depress the ENTER key. (The printout will start.)

(3) Depress the RESET button to terminate the printout. (The printout may be terminated at any point.)

c. The procedure for obtaining a printout of the target list is as follows:

(1) Depress matrix buttons A–7 (PRINT TGT LIST) and then depress the SM key.

(2) Type 0 on the keyboard and depress the ENTER key.

(3) Depress the RESET button to terminate the printout.

d. To print a single item from either list, enter the specific firing point or target number in step (2).

4–50. Location of a Point by Intersection Survey

a. During training, the Honest John battalion established two observation posts for the purpose of locating the impact point of the rockets fired.

b. The following data are available:

Observer	*Coordinates*		*Altitude*	*Azimuth to impact*	*Vertical angle*
01	43560	49584	452	6230	−25
02	44325	49750	440	5578	NA

c. The operator computes the location of the impact point as follows:

(1) Depress matrix buttons G–5 (SURVEY) and then depress the SM key.

(2) On the keyboard, type 2 (the flag for intersection survey) and depress the ENTER key.

(3) Depress matrix buttons H–1 (OBS EAST) and then depress the SM key.

(4) On the keyboard, type 43560 (the east-

ing coordinate of 01) and depress the ENTER key.

(5) Depress matrix buttons H-2 (OBS NORTH) and then depress the SM key.

(6) On the keyboard, type 49584 (the northing coordinate of 01) and depress the ENTER key.

(7) Depress matrix buttons H-3 (OBS ALT) and then depress the SM key.

(8) On the keyboard, type +452 (the altitude of 01) and depress the ENTER key.

(9) Depress matrix buttons H-4 (OBS RECORD) and then depress the SM key.

(10) Type 1 on the keyboard and depress the ENTER key.

(11) Repeat steps (3) through (10) and enter the data for observer 02.

(12) Depress matrix buttons H-5 (OBS RECALL) and then depress the SM key.

(13) Type on the keyboard and depress the ENTER key. The coordinates and altitude of 01 will be displayed.

(14) Depress matrix buttons G-1 (OBS AZIMUTH) and then depress the SM key.

(15) On the keyboard, type 6230 (the azimuth from 01 to the impact point) and depress the ENTER key.

(16) Depress matrix buttons G-4 (OBS VERT ANGLE) and then depress the SM key.

(17) On the keyboard, type-25 (the measured vertical angle from 01 to the impact point) and depress the ENTER key.

(18) Depress matrix buttons H-5 (OBS RECALL).

(19) Type 2 on the keyboard and depress the ENTER key. The coordinates and altitude of 02 will be displayed.

(20) Depress matrix buttons G-1 (BOS AZIMUTH) and then depress the SM key.

(21) On the keyboard, type 5578 (the azimuth from 02 to the impact point) and depress the ENTER key.

(22) Depress the TRIG button. The coordinates and altitude of the impact point will be computed and displayed: 43379 50656 425.

4-51. Deletion of Targets and Firing Points From the Lists

a. To delete a specific target from the target list when the target is no longer required, the operator uses the following procedure:

(1) Depress matrix buttons A-8 (TGT DELETE) and then depress the SM key.

(2) On the keyboard, the number of the target to be deleted and depress the ENTER key. The KEYBOARD indicator will remain lit.

(3) On the keyboard, type 0 (the flag for the enabling procedure for this function).

b. To delete a specific firing point from the firing point list, the operator uses the following procedure:

(1) Depress matrix buttons B-8 (FP DELETE) and then depress the SM key.

(2) On the keyboard, type the number of the firing point to be deleted and depress the ENTER key. The KEYBOARD indicator will remain lit.

(3) Type 0 on the keyboard.

4-52. Updating Ballistic Data

a. Frequently, an input value, such as the propellant temperature, surface pressure, or meteorological data, will change between the time a fire mission is received and the time of firing. Whenever this change occurs, the most recent value should be entered and new firing data computed. The speed with which the computer develops firing data is a significant advantage over the manual system when updating ballistic data.

b. Whenever low-level wind data cannot be determined, the FADAC will compute and apply low-level wind corrections by using the data in line 01 of the met message already stored in memory. Fire mission 2 illustrates this capability.

4-53. Fire Mission 2

Note: See paragraph 3-6.

a. The battalion S3 notes that the target is a preplanned target stored on the target list as target number 2. He selects launcher number 1 to fire the mission from firing point number 3 and issues the following fire order:

MISSION A-2
LAUNCHER NUMBER 1
FIRING POSITION NUMBER 3
TARGET NUMBER 2

b. The FADAC operator clears memory locations for mission A-2 as follows:

(1) Depress mission association buttons A-2.

(2) Depress matrix buttons C-8 (CLEAR MISSION DATA) and then depress the SM key.

(3) Type 0 on the keyboard and depress the ENTER key.

c. The operator computes initial data as follows (firing points and targets have been entered; see paragraphs 4-40 and 4-42):

(1) Depress matrix buttons F-1 (TGT LIST ASSOC) and then depress the SM key.

(2) Type 2 on the keyboard and depress the ENTER key. (Display 45380 65184 601 will appear.)

(3) Depress matrix buttons F-2 (F-2 LIST ASSOC) and then depress the SM key.

(4) Type 3 on the keyboard and depress the ENTER key. (Display 49263 34126 451 will appear.)

(5) Depress matrix buttons D-1 (COMP RANGE AZ) and then depress the SM key. The following data will be displayed:

Azimuth of fire	6273 (mils)
Range	31300 (meters)
Orienting angle	1848 (mils)

d. The S3 then issues the warning order (para 3-6*c*) to the firing battery and specifies an MGR-1B rocket with a chemical warhead and a high height-of-burst options.

e. The latest available met message is entered. (Use the meteorological message given in paragraph 4-44 for mission number 1.)

f. The following information is received from launcher platoon 1:

Warhead weight	1261 pounds
Motor empty weight	1395 pounds
Stenciled propellant weight correction	+13.4 pounds
Propellant temperature	+22° F
Surface pressure	968 millibars
Motor age	More than 52 months

g. Other known data are:

Grid declination	+21 mils
Latitude of launcher	34° N

h. All data are entered and initial firing data are computed as follows:

(1) Insure that mission association buttons A-2 are depressed.

(2) Depress matrix buttons F-3 (RKT TYPE) and then depress the SM key.

(3) Type 50 on the keyboard and depress the ENTER key.

(4) Depress matrix buttons F-4 (WHD TYPE) and then depress the SM key.

(5) Type 8 (flag for the M190 chemical warhead) on the keyboard and depress the ENTER key.

(6) Depress matrix buttons F-5 (WHD WT) and then depress the SM key.

(7) Type 1261 on the keyboard and depress the ENTER key.

(8) Depress matrix buttons F-7 (OPTION) and then depress the SM key.

(9) Type 2 on the keyboard and depress the ENTER key.

(10) Depress matrix buttons E-1 (MOTOR EMPTY WT) and then depress the SM key.

(11) Type 1395 on the keyboard and depress the ENTER key.

(12) Depress matrix buttons E-2 (PROP WT CORR) and then depress the ENTER key.

(13) Type +13.4 on the keyboard and depress the ENTER key.

(14) Depress matrix buttons E-6 (PROP TEMP) and then depress the SM key.

(15) Type +22 on the keyboard and depress the ENTER key.

(16) Depress matrix buttons E-7 (SURF PRESS) and then depress the SM key.

(17) Type 968 on the keyboard and depress the ENTER key.

(18) Depress matrix buttons E-8 (MOTOR AGE) and then depress the SM key.

(19) Type 52 on the keyboard and depress the ENTER key.

(20) Depress the COMPUTE button. The following firing data will be displayed in approximately 2.5 minutes (the longer computational time is caused by a requirement for record trajectory computations with this warhead):

Fuze setting	75.4
Quadrant elevation	633.5

Note: Grid declination and latitude need not be reentered if they were entered previously. These data are *not* mission associated.

i. The following met has been received:

METCM 1 344982 311702 036972

Line number	Wind direction (10 mils)	Wind speed (knots)	Temp (0.1°K)	Pressure (mbs)
00	054	001	2823	0972
01	522	008	2859	0960
02	503	019	2915	0933
03	480	014	2898	0889
04	548	010	2872	0838
05	006	013	2841	0789
06	035	010	2806	0743
07	046	008	2770	0699
08	028	009	2728	0656
09	625	011	2689	0617
10	558	018	2665	0578
11	553	021	2643	0542
12	544	021	2596	0492
13	567	032	2514	0431
14	570	042	2433	0378
15	578	040	2401	0321
16	591	036	2328	0276
17	606	044	2286	0242

Note: The latest met data are entered as soon as the message is received by using the same procedure as that outlined in paragraph 4–44.

j. The firing platoon has arrived at the firing point and the launcher has been laid. The latest data reported by the platoon are as follows:

Referred deflection	1437 mils
Surface pressure	961 millibars
Propellant temperature	+19° F

Windset is *not* working.

k. The S3 decides to update all parameters and use the latest met message to compute final low-level winds and final data. To do so, the FADAC operator uses the following procedure:

(1) Depress matrix buttons E–6 (PROP TEMP) and then depress the SM key.

(2) Type +19 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons E–7 (SURF PRESS) and then depress the SM key.

(4) Type 961 on the keyboard and depress the ENTER key.

(5) Depress matrix button F–8 (AIMING POING DF) and then depress the SM key.

(6) Type 1437 on the keyboard and depress the ENTER key.

(7) Depress the COMPUTE button. In approximately 2.5 minutes, the following updated firing data will be displayed:

Deflection	1441
Fuze setting	77.6
Quadrant elevation	651.7

Note: These data are not sent to the platoon. Low-level wind corrections are applied immediately by using the latest met data already stored in memory.

(8) Depress matrix buttons D–8 (LLW FINAL DATA) and then depress the SM key.

(9) Type 3 on the keyboard and depress the ENTER key. The following final data will be displayed:

Deflection	14120
Fuze setting	77.6
Quadrant elevation	657.7

4–54. Special Inputs Required for the MGR–1A Rocket

a. When the MGR–1A rocket is used, special arithmetic procedures to determine data concerning the rocket empty weight are frequently required. These data are automatically computed by the FADAC.

b. Fire mission 3, detailed in paragraph 4–55 below, is an example of required weight entries for the MGR–1A rocket.

4–55. Fire Mission 3

Note: See paragraph 3–7.

a. The following data were given in the call for fire and the fire order:

Rocket	MGR–1A (flag 31)
Warhead	M144 (flag 5)
Height of burst	low
Firing point number	4
Target number	3
Mission number	B–1

b. The latest meteorological message is as follows:

METCM 1 344982 010402 036986

Line number	Wind direction (10 mils)	Wind speed (knots)	Temp (0.1°K)	Pressure (mbs)
00	026	020	2803	0986
01	016	033	2793	0973
02	640	028	2768	0950
03	639	039	2735	0898
04	624	038	2704	0844
05	620	032	2671	0791
06	600	034	2634	0742
07	587	034	2593	0695
08	575	032	2567	0651
09	573	032	2535	0608
10	595	030	2496	0569
11	595	035	2458	0531
12	588	032	2415	0478
13	594	042	2347	0414
14	566	035	2277	0357

c. Data furnished by the launcher platoon are as follows:

Gross motor weight	4,117 pounds
Warhead weight	1,620 pounds

Propellant weight	2,049 pounds
Propellant temperature	+78° F
Surface pressure	988 millibars
Fin weight	166 pounds

d. Using the entry procedures outlined in paragraph 4-44, the operator enters the met message.

e. The FADAC operator then enters all known information and computes initial laying data as follows:

(1) Insure that mission buttons B-1 are depressed.

(2) Use input function C-8 (CLEAR MSN DATA) to clear the mission data.

(3) Depress matrix buttons F-1 (TGT LIST ASSOC) and then depress the SM key.

(4) Type 3 on the keyboard and depress the ENTER key. (Display 31564 39611 393 will appear.)

(5) Depress matrix buttons F-2 (FP LIST ASSOC) and then depress the SM key.

(6) Type 4 on the keyboard and depress the ENTER key. (Display 48842 35369 448 will appear.)

(7) Depress matrix buttons F-3 (RKT TYPE) and then depress the SM key.

(8) Type 31 on the keyboard and depress the ENTER key.

(9) Depress matrix buttons F-4 (WHD TYPE) and then depress the SM key.

(10) Type 5 on the keyboard and depress the ENTER key.

(11) Depress matrix buttons F-5 (WHD WT) and then depress the SM key.

(12) Type 1620 on the keyboard and depress the ENTER key.

(13) Depress matrix buttons F-7 (OPTION) and then depress the SM key.

(14) Type 1 on the keyboard and depress the ENTER key.

(15) Depress matrix buttons E-1 (MOTOR EMPTY WT) and then depress the SM key.

(16) Type 0 on the keyboard and depress the ENTER key.

(17) Depress matrix buttons E-3 (PROP WT) and then depress the SM key.

(18) Type 2049 on the keyboard and depress the ENTER key.

(19) Depress matrix buttons E-4 (GROSS MOTOR WT) and then depress the SM key.

(20) Type 4117 on the keyboard and depress the ENTER key.

(21) Depress matrix buttons E-5 (FIN WT) and then depress the SM key.

(22) Type 166 on the keyboard and depress the ENTER key.

(23) Depress matrix buttons E-6 (PROP TEMP) and then depress the SM key.

(24) Type +78 on the keyboard and depress the ENTER key.

(25) Depress matrix buttons E-7 (SURF PRESS) and then depress the SM key.

(26) Type 988 on the keyboard and depress the ENTER key.

(27) Depress matrix buttons D-1 (COMP RANGE AZ/OA) and then depress the SM key. The following laying data will be displayed:

Range	17791 (meters)
Azimuth of fire	5045 (mils)

Note: These data are sent to the firing platoon in a warning order.

f. As soon as the rocket has been laid and the aiming point deflection (1462) has been reported, firing data are computed as follows:

(1) Depress matrix buttons F-8 (AIMING POINT DF) and then depress the SM key.

(2) On the keyboard, type 1462 (the reported aiming poing deflection) and depress the ENTER key.

(3) Depress the COMPUTE button. The following initial firing data will be computed and displayed:

Deflection	14132
Fuze setting	43.4
Quadrant elevation	529.7

Note: These data are sent to the firing platoon.

g. The low-level winds are measured by using the windset. Conditions are "all other than nighttime." Readings reported are:

Range wind	T1
Cross wind	L37

h. The operator enters the low-level wind data and computes final firing data as follows:

(1) Depress matrix buttons D-6 (LLW RANGE/DIR) and then depress the SM key.

(2) Type −1 on the keyboard and depress the ENTER key.

(3) Depress matrix buttons D-7 (LLW CROSS/SPEED) and then depress the SM key.

(4) Type −37 on the keyboard and depress the ENTER key.

(5) Depress matrix buttons D–8 (LLW FINAL DATA) and then depress the SM key.

(6) Type 1 on the keyboard and depress the ENTER key. The following final data will be displayed:

Deflection	1648
Fuze setting	43.4
Quadrant elevation	527.4

Section XII. COMMON MISTAKES AND MALPRACTICES

4–56. General

Inaccuracies in FADAC computations and, consequently, a lack of faith in the reliability of the FADAC are too often the result of recurring mistakes and malpractices by the FADAC operator. A mistake is an unintentional error in action or perception committed by the operator while following correct procedure. A mistake usually indicates operator carelessness or lack of concentration, which can be detected only by a positive check or very close supervision. A malpractice is a procedural error and usually indicates incomplete or incorrect training of the operator. The best preventive for mistakes and malpractices if the formation of proper habits by the operator while in training; personnel responsible for training FADAC operators must insist on exactness and allow no deviation from correct procedures. A further preventive for errors is to establish proper supervisory procedures for the fire direction officer and chief computer so that all mistakes are detected and corrected prior to firing.

4–57. FADAC Operator Procedures

a. Common Mistakes. Some of the common mistakes made by FADAC operators in determing firing data with the FADAC are as follows:

(1) *Transposition of digits when entering data.* The program has certain operator input controls that allow entry of values only when the values are within reasonable limits; however, these limits are often broad. For example, the input range for the motor emply weight of the MGR–1B rocket is from 1335 pounds to 1450 pounds, and the aiming point deflection is from 0 to 3200 mils. A common transposition error would be that of receiving a correct motor emply weight of 1339 pounds and incorrectly entering the value as 1393.

(2) *Use of the wrong sign when entering a signed value.* A critical parameter that is signed can easily be entered with the wrong sign and, when the parameter is recalled for a check, the error may be overlooked. For example, a propellant temperature of +30° might be entered as −30°—a mistake that would result in extremely erroneous firing data.

(3) *Inadvertent use of standard met.* Since the use of current met or standard met is mission associated, the operator might inadvertently compute final firing data by using standard met instead of current met. This error could occur if the operator fails to check the enabling flag entered in function C–4 (MET STD). Whenever final mission data are to be computed, (flag) 9 must be entered in this function for the specific mission. This error frequently occurs when the operator correctly enters flag 9 but has the wrong mission association buttons depressed. He then changes the mission association buttons but fails to reenter flag 9.

(4) *Entry of data through the wrong matrix location.* This error does not occur frequently, since the matrix location is lighted when it is activated and input values are normally program controlled. However, a careless operator might enter valid input in the wrong matrix location. For example, grid declination might be erroneously entered as latitude or vice versa.

(5) *Use of the wrong file number in recording target or firing point data.* The program will accept 32 targets and 16 firing points, and, during the entry of these data, the use of the proper file number (flag) when data are stored is critical. For example, during the sequential entry of a firing point list, a file number might be used twice. This action would cause the second entry to erase the previous data. Printouts of data stored on these lists should be obtained by using functions A–7 (PRINT TGT LIST) and B–7 (PRINT FP LIST) to provide a thorough check of the stored data.

b. Malpractices. Significant malpractices that detract from the proficiency of fire direction centers using the FADAC are as follows:

(1) *Failure to check stored data.* The variable ballistic parameters that are entered by the FADAC operator (warhead weight, motor empty

weight, propellant temperature, etc.) and that apply to a specific mission should be recalled and checked prior to computation of final firing data. This procedure will insure that the operator is aware of the information used in computations.

(2) *Failure to check the input data displayed on the display panel.* This error occurs when an operator attempts to enter data too rapidly. The data displayed on the display panel must be verified by the FADAC operator as well as by the fire direction officer. This step is essential in any system of checks with the FADAC, since it is the only positive means of detecting keyboard entry errors.

(3) *Failure to clean air filters.* All six filters used with the FADAC should be inspected once daily and cleaned if dust or dirt is noted. If the FADAC is operated in a dusty or dirty environment, dirty air filters will cause increased FADAC downtime.

(4) *Failure to perform proper generator maintenance.* Two 3-kw, 400-hertz, 3-phase 120/208-volt generators are authorized for each FADAC. The second generator is authorized to insure operational capability at all times, including periods of generator maintenance. The generator should be rotated every 12 or 24 hours to allow time for periodic maintenance in accordance with TM 5–6115–271–14 and TM 5–2805–203–14.

CHAPTER 5

FIRING BATTERY OPERATIONS

5-1. General

Duties of individual launcher crewmen for the Honest John system are described in FM 6-59 (M386 and M33 launchers) and FM 6-60 (M289 launcher). The procedures and techniques presented in this chapter are directly related to the 762-mm rocket (HJ) and must be accorded particular emphasis in the unit training program.

5-2. Areas Requiring Special Attention

a. Laying the Launcher for Direction. The orienting angle method will be the primary method of laying the launcher for direction. The unit survey section will carry survey control to each firing position and establish an orienting line for each position. The launcher can be laid by azimuth; however, this procedure is not recommended for normal use, since the possibility of an orientation error is extremely high.

b. Boresighting. On-carriage sighting and aiming equipment must be checked prior to each firing. These checks are conducted as prescribed in the appropriate field manuals.

c. Temperature Conditioning. A temperature-conditioned rocket is one in which the propellant temperature is uniform throughout the grain. Temperature conditioning is essential to insure even burning of the propellant. If the rocket motor is improperly conditioned, the temperature gradient (differences in temperature throughout the propellant grain) will cause uneven burning and will contribute to the thrust malalinement error. Further, a temperature gradient makes it impossible to obtain a valid propellant temperature measurement for use in computing temperature corrections. Blankets are provided for insulation and temperature conditioning purposes when authorized, and proper use of this equipment is essential. The following measures should be taken to condition the rocket:

(1) The rocket should not be exposed to the direct rays of the sun or to a cold chilling wind (unless absolutely necessary). Exposure to such environments for even a short period of time will result in an improperly conditioned rocket.

(2) Blankets should be installed when the rocket motors are drawn from the SASP and uncrated. They should be used primarily for insulating purposes in all temperature conditions above the minimum firing limit (no heat applied). If the ambient temperature is expected to drop below the minimum firing limit, the motor should be heated continuously for a minimum of 24 hours prior to firing. Heating for 48 hours is recommended. Blankets should remain on the rocket until at least 15 minutes prior to firing (longer if possible).

Note: Always insulate. Heat only when necessary.

d. Seating of Propellant. The launcher should be elevated to at least 800 mils to properly seat the propellant grain in the MGR-1A rocket prior to setting the firing elevation.

5-3. Low-Level Winds

The measurement of low-level winds and the correlation of the wind effects to cause the rocket to respond favorably is a difficult problem. Low level winds affect the rocket during the entire burning phase; the effects are greatest just as the rocket leaves the launcher and diminish rapidly toward motor burnout. Low-level winds are measured by exposing the anemometer of a wind measuring set at a height of 50 feet. This measurement is weighted to provide an estimate of wind that the rocket actually "sees" (senses) during the burning phase. This method produces valid results (within accepted tolerances) if the procedures outlined in paragraphs 5-5 through 5-7 are followed.

5-4. Low-Level Wind Corrections

Corrections for low-level winds may be determined in the fire direction center or in the firing section. The primary, and recommended, method of measuring the velocity and direction of the low-level wind is to use the table of organization and equipment windset. If the windset is not available, low-level winds may be measured by means of a 30-gram pilot balloon and a theodolite (para 3–9*a*) or, as a last resort, low-level wind readings may be obtained from line 01 of the met message (para 3–9*b*).

5–5. Windset Check With the Windspeed Simulator

An accuracy check of the operation of the Honest John windset can now be made with the windspeed simulator AN/GMM–7. The simulator is a simple hand-operated device which rotates the shaft of the windset transmitter, through means of a gear train, at a known speed and from a known direction. It allows a check of the alinement of the sine-cosine potentiometer, a windspeed and wind direction test, and a test of both the direct circuitry and the averaging circuitry of the windset data box. The simulator requires no external power source. It operates within a temperature range of −30° F to +135° F and is accurate within ±1 mph. The azimuth indicator dial is marked from 0° to 360° in 15° increments. Total weight of the case, simulator, wind velocity meter, and remaining components is about 45 pounds. Complete nomenclature is simulator, windspeed, AN/GMM–7, FSN 6660–904–9425, LIN number T59138. TM 11–6660–235–12 contains the operator procedures and spare parts information, and one copy of the manual is packed with each simulator. The simulator is authorized on the basis of one per battalion. The battery normally used to operate the indicator meter in the simulator is the BA 1090/U; however, a common 9-volt dry-cell battery, such as those used in transistor radios, may also be used.

a. The windset should be tested with the simulator before each rocket firing or at least once each month. Both the direct circuits and the averaging circuits should be tested at 5, 10, 15, 20, 25, and 30 miles per hour and at azimuth settings every 15° from 0° to 360°. To test the *direct* circuitry, use the procedures outlined in TM 11–6660–235–12. To test the *averaging* circuitry, use the procedures outlined in the windset manual, TM 11–6660–255–12.

b. The test of the averaging circuitry will determine the best operating circuit of the particular windset. This circuit should be used whenever the averaging circuits of the windset are used.

5–6. Use of Windsets

a. *Placement of Windset.* The windset should be emplaced approximately 50 meters in front of the launcher and, for safety and the protection of equipment, at least 25 meters to the side of the trajectory. These distances may be paced by a launcher crewman, since they are not critical. The most important consideration is to locate the windset so that the wind pattern at the set is similar to the wind pattern at the launcher.

b. *Orientation of Windset Mast.* The windset mast should be initially oriented parallel to the azimuth of fire. If the deflection corrections for nonstandard conditions exceed 25 mils, the mast should be reoriented to the corrected firing azimuth before corrections for low-level winds are determined. Care must be exercised to insure the windset mast is not misoriented 3,200 mils.

c. *Profile Corrections.* Wind velocity usually increases with height, and the wind structure (wind profile) varies with the time of day. It is impossible for an anemometer exposed at 50 feet in the air to measure such variations. Therefore, the low-level wind measurements obtained in the firing section must be weighted to account for these differences. Wind profile correction factors are normally incorporated into the low-level wind correction tables found in the tabular firing tables. This results in two such tables—one for NIGHTTIME conditions and the other for ALL OTHER THAN NIGHTTIME conditions. A third table is included for the pilot balloon or met line 01 technique and has no profile correction factor incorporated. NIGHTTIME is defined as the period extending from 1 hour before sunset to 1 hour after sunrise, with clear skies (or few clouds) and wind speeds less than 10 miles per hour. If *all* NIGHTTIME conditions do not exist simultaneously, the tables for ALL OTHER THAN NIGHTTIME conditions must be used. The appropriate table is entered with the corrected quadrant elevation to the nearest mil to obtain low-level wind factors that include profile corrections. The low-level wind readings are multiplied by these factors to obtain low-level wind corrections.

5–7. Techniques for Determining and Applying Low-Level Wind Corrections

If the windset is used for measuring low-level winds, either the recurring wind technique or the predicted wind technique for determining and applying low-level wind corrections may be used.

The tactical considerations will normally require that the predicted technique be used. However, the condition of the windset must also be considered, since the recurring technique may not be used if the test with the windspeed simulator discussed in paragraph 5-5 indicates that the averaging circuits of the windset data box are not working properly.

a. Predicted Wind Technique. The predicted wind technique consists of applying corrections for the measured wind to the launcher and firing the rocket at a specified time (time on target minus time of flight). Both procedure 1 (*c* below) and procedure 2 (*d* below) may be used with the predicted wind technique.

Note: The predicted wind technique is based on the assumption that the rocket will be fired shortly after low-level wind readings are taken. Should a hold be experienced during countdown, units must determine before firing that the wind readings have not changed drastically from those upon which corrections were based.

b. Recurring Wind Technique. The recurring wind technique consists of applying corrections for the measured low-level winds to the launcher and firing the rocket when the same wind conditions recur within a tolerance of ±1 mile per hour in both range wind and cross wind components. Only procedure 1 (*c* below) may be used with the recurring wind technique.

c. Procedure 1. If the windspeed simulator indicates that the averaging circuits on the windset are working properly, the following procedure should be used to measure the wind and determine corrections:

(1) After the mast has been raised to full height and the circuits have been tested for proper operation, note the direct readings for range wind and cross wind at X−4.

(2) Set the MINUTES switch to the best operating circuit, as determined by the windspeed simulator test discussed in paragraph 5-5.

(3) Set the AVERAGE/DIRECT switch on DIRECT for 5 seconds.

(4) Set the AVERAGE/DIRECT switch on AVERAGE.

(5) At X−2, record the range wind and cross wind component readings.

(6) Enter the firing table or the wind card and determine the appropriate unit correction factors for a 1-mile-per-hour low-level range (head or tail) wind and low-level cross wind. The argument for entry is the corrected quadrant elevation to the nearest mil.

(7) Multiply the unit correction factors by the windset readings in (5) above. The products are the low-level wind corrections.

(8) Apply the corrections computed in (7) above to the launcher.

Note: For the predicted wind technique, fire the rocket at X−0. For the recurring wind technique, fire the rocket whenever both range and cross wind components read within ±1 mile per hour of the readings obtained in (5) above.

Example:

(*a*) Known data are—

Rocket	MGR-1B
Firing table	FTR 762-G-1
Conditions	ALL OTHER THAN NIGHTTIME
Corrected QE	457.8 mils

(*b*) Record the wind components at X−2:

Cross wind	R6 mph
Range wind	H3 mph

(*c*) Enter table M-1 with the corrected QE to the nearest mil (458 mils) and determine the unit correction factors:

Cross wind	2.98
Range (head) wind	+1.12

(*d*) Determine the low-level wind corrections:

Cross wind correction = 2.98 × R6 = R17.88 or R18 mils

Range wind correction = +1.12 × H3 = +3.36 or +3.4 mils

d. Procedure 2. If the windspeed simulator indicates that the averaging circuits on the windset are *not* working properly, the following procedure should be used to measure the wind and determine corrections:

(1) Set the AVERAGE/DIRECT switch on DIRECT at X−5.

(2) Record a series of 10 readings 15 seconds apart in both range wind and cross wind.

(3) Sum the ten crosswind readings and the ten range wind readings. Then displace the decimal point one place to the left for each sum. Express the average of each sum to the nearest mile per hour.

(4) Enter the firing table or the wind card and determine the appropriate unit correction factor for a 1-mile-per-hour low-level range (head

or tail) wind and low-level cross wind. The argument for entry is the corrected quadrant elevation to the nearest mil.

(5) Multiply these unit correction factors by the averages computed from the windset readings in (3) above. The products are the low-level wind corrections.

(6) Apply the corrections computed in (5) above to the launcher.

Note: At X−0, fire the rocket.

Example:

(*a*) Known data are—

Rocket	MGR–1B
Firing table	FTR 762–G–1
Conditions	ALL OTHER THAN NIGHTTIME
Corrected QE	666.2 mils

(*b*) Record the wind components:

Time	*Cross wind (mph)*	*Range wind (mph)*
X−5 minutes	R6	H19
X−4 minutes 45 seconds	R1	H20
X−4 minutes 30 seconds	L4	H20
X−4 minutes 15 seconds	L8	H18
X−4 minutes	L13	H16
X−3 minutes 45 seconds	L16	H12
X−3 minutes 30 seconds	L18	H8
X−3 minutes 15 seconds	L19	H3
X−3 minutes	L20	T1
X−2 minutes 45 seconds	L19	T7

(*c*) Sum all readings of the same sign:

L4		H19	
L8		H20	
L13		H20	
L16		H18	
L18		H16	
L19		H12	
L20	R6	H8	T1
L19	R1	H3	T7
L117	R7	H116	T8

(*d*) Subtract the smaller sum in both cross and range wind from the corresponding larger sum and affix the sign of the larger:

L117	H116
−R 7	−T 8
L110	H108

(*e*) Displace the decimal point one place to the left to find the average:

Average L11.0 = L11 H10.8 = H11

(*f*) Enter table M–1 with the corrected QE to the nearest mil (666 mils) and determine the unit correction factors:

Cross wind	3.55
Range (head) wind	+1.75

(*g*) Determine the low-level wind corrections:

Cross wind correction = 3.55 × L11 = L39.05 or L39 mils.

Range wind correction = +1.75 × H11 = +19.25 or + 19.2 mils.

e. Criteria for selecting the Recurring Wind or Predicted Wind Technique. The commander should consider the following factors in selecting the low-level wind correction technique for a particular mission:

(1) *Accuracy.* Both the recurring wind and predicted wind techniques are acceptable. However, the recurring wind technique generally will produce more accurate results.

(2) *Timeliness of fire.* With the predicted wind technique, the rocket can be fired at a designated time. With the recurring wind technique, the exact time of firing cannot be predicted. The probability of the wind recurring within the prescribed tolerance of ± 1 mile per hour in both components is as follows:

(*a*) If the last windset reading is recorded 2 minutes prior to the time of firing (X−2), allowing 2 minutes for the launcher crew to compute and apply launcher corrections, the correct wind will recur—

40 percent of the time at X−0.

20 percent of the time between X−0 and X+3 minutes.

15 percent of the time between X+3 and X+8 minutes.

5 percent of the time between X+8 and X+18 minutes.

20 percent of the time after X+18 minutes.

(*b*) If the last windset reading is recorded 4 minutes prior to the time of firing (X−4), allowing 4 minutes for the launcher crew to compute and apply corrections, the correct wind will recur—

35 percent of the time at X – 0.
20 percent of the time between X – 0 and X + 3 minutes.
15 percent of the time between X + 3 and X + 8 minutes.
5 percent of the time between X + 8 and X + 18 minutes.
25 percent of the time after X + 18 minutes.

Note: Because of the fluctuations, direction, and speed of low-level winds, a wind that does not recur within a few minutes is not likely to recur within a reasonable length of time. The less time the launcher crew requires to compute and apply corrections, the better the chances are of obtaining a recurring wind.

5–8. Rocket Data Recorder Sheet

DA Form 2257–R (Rocket Data Recorder Sheet) (fig 5–1), may be used by the assembly and transport section, the firing section, and the fire direction center for recording data. The assembly and transport section should prepare two copies of the form upon receipt of a motor and warhead. When the rocket is issued to a firing section, one copy of the form should be given to the firing section and the other copy to the fire direction center. DA Form 2257–R will be reproduced locally on 8- x 10½-inch paper.

ROCKET DATA RECORDER SHEET
(FM 6–40–1)

UNIT	DATE	TIME FIRED

ASSEMBLY AND TRANSPORT PLATOON COMMANDER'S DATA

ROCKET IDENTIFICATION		MGR–1B ROCKET	
1. MOTOR TYPE		12. MOTOR EMPTY WEIGHT	lb
2. MOTOR SERIAL NO		13. WARHEAD SECTION WEIGHT	lb
3. MOTOR LOT NO		14. PROPELLANT WEIGHT CORR	lb
4. MOTOR ASSEMBLY TYPE		15. DATE LOADED	
5. MOTOR ASSEMBLY SERIAL NO		MGR–1A ROCKET	
6. MOTOR ASSEMBLY LOT NO		16. PROPELLANT WEIGHT	lb
7. SPIN ROCKET TYPE		17. SPIN ROCKET PROPELLANT WEIGHT	lb
8. SPIN ROCKET LOT NO		18. MOTOR EMPTY WEIGHT	lb
9. WARHEAD TYPE		19. GROSS MOTOR WEIGHT	lb
10. WARHEAD SERIAL NO		20. WARHEAD SECTION WEIGHT	lb
11. WARHEAD LOT NO		21. TOTAL FIN WEIGHT (166 LBS OR 172 LBS)	lb

LAUNCHER PLATOON COMMANDER'S DATA

WARNING ORDER		LAUNCHER PLATOON COMMANDER'S REPORT	
22. LAUNCHER TO FIRE		34. MEASURED AZIMUTH OF FIRE	₥
23. FIRING POSITION		35. MEASURED ORIENTING ANGLE	₥
24. TYPE ROCKET		36. AIMING POINT DEFLECTION	₥
25. TYPE WARHEAD		37. FIRING LIMIT (IF NEC)	
26. FUZE OPTION*	AIR IMPACT	38. LAUNCHER–ROCKET ME	₥
27. HEIGHT OF BURST OPTION*	HIGH LOW	39. ANGLE OF SIGHT TO MASK	₥
28. METHOD OF FIRE		40. RANGE TO MASK	
29. TIME OF FIRE		41. PROPELLANT TEMPERATURE	°F
INITIAL LAYING DATA		42. SURFACE PRESSURE	mb
30. AZIMUTH OF ORIENTING LINE	₥	43. FUZE TYPE	
31. AZIMUTH OF FIRE	₥	44. FUZE LOT NO	
32. ORIENTING ANGLE	₥	45. FUZE TIMER NO 1 SERIAL NUMBER	
33. TRIAL QUADRANT ELEVATION	₥	46. FUZE TIMER NO 2 SERIAL NUMBER	

WINDSET LOW LEVEL WIND DATA:	DF	QE	FINAL FIRING DATA			
47 DIRECT READING AT X –	L R	H T	52. CORR DATA FROM FDC	DF	TI	QE
48. UNIT CORR FACTORS		+ –	53. LOW LEVEL WIND CORR	L R		+ –
49. AVERAGE READING AT X –	X L R	X H T	54. FUZE CORR M411 FUZE		+ –	
50. LOW LEVEL WIND CORR	= L R	= + –	55. DATA FIRED	DF	TI	QE
51. DIRECT READING AT TIME OF FIRING	L R	H T	56. REMARKS			

DA FORM 2257-R, 1 Jun 72 PREVIOUS EDITION IS OBSOLETE. *SEE FM 6–40–1A (HONEST JOHN)

Figure 5–1. Rocket data recorder sheet.

CHAPTER 6

SPECIAL CONSIDERATIONS

6-1. Verification of Firing Data

a. General. Units may make certain tests of their firing data and other information to insure that the data are reasonable and to avoid gross errors. The FADAC tape contains a magnitude limit for each of the items of information listed below. Attempts to enter numbers outside these limits will result in a blinking NO SOLUTION light and an error display. When the problem is computed manually, these same tolerances may be applied to manual data to test their magnitude.

Item	*Limits* Minimum	*Limits* Maximum
Warhead weight:		
Light warheads	1,185	1,285 pounds
Heavy warheads	1,575	1,675 pounds
Height of burst:		
Tactical warheads	0	2,000 meters
Flash-smoke warheads	0	2,000 meters
Motor empty weight:		
MGR-1A	1,900	2,200 pounds
MGR-1B	1,335	1,450 pounds
Stenciled propellant weight correction (MGR-1B)	−50	+50 pounds
Propellant weight (MGR-1A)	2,000	2,100 pounds
Gross motor weight (MGR-1A)	3,900	4,300 pounds
Propellant temperature:		
MGR-1A	0°	+120° F
MGR-1B	−30°	+120° F
Crest altitude, target altitude, firing point altitude, and observer altitude relative to sea level	−300	+7,500 meters

b. Checking validity of Met Message. The met message is one of the most important sources of data for FDC computations. Rather than accept it at face value from the met station, units should examine the items in the message to determine the probability of their being accurate and reasonable.

(1) The first check is to determine whether any significant changes in the atmosphere have occurred since the message was prepared. If the winds have increased noticeably or if other significant changes in weather conditions have occurred, the message may no longer be valid.

(2) The second check is to examine the data in each line to see whether abrupt changes occur from line to line. For example, if the temperature in line 04 is 984 and the temperature in line 05 is 798, the line 05 digits may have been transposed and the temperature probably should read 978.

(3) The third check is to compare the surface pressure in the heading of the computer met message with the pressure in line 00. The last three digits of the values should be identical.

Note: The check in (3) above applies to the new computer met message (implemented on or after 1 October 1970), which contains pressure in millibars in the last four-digit column, and not to the old computer met message, which contained density in grams per cubic meter in the last four-digit column.

(4) The fourth check is to compare the barometer reading at the launcher with the pressure value in the heading of the ballistic met message or in the heading/line 00 of the computer met message after correction for the difference in altitude between the MDP and the firing point. If these readings differ by more than ±5 millibars, first verify that the proper scale of the barometer is being read and then check with the met station to determine whether the pressure reading is still valid. This verification is necessary to avoid an error in reading the unit barometer and because the determination of the other values in the met message by the met station is based on a beginning pressure value set on the barometer in the radiosonde. If surface pressure has changed significantly since the met message was produced, the temperature and pressure readings in the remaining lines of the met messages have changed also and the met message may no longer be valid. If surface pressure has not changed significantly since the met message was produced, the unit barometer is in error.

c. Verifying Low-Level Wind Data. The most important method of verifying the low-level wind data is to test the operation of the windset, using the windspeed simulator AN/GMM-7 and the procedures stated in TM 11-6660-235-12. This should be accomplished before the windset is used for data readings. If the windspeed simulator is not available, visual checks of wind direction and windspeed may be made, using the indicated readings shown in the lid of the data box. Rough checks may also be made by comparing windset readings with values in line 01 of the met message. The latter procedure is limited in usefulness, since many exceptions can occur to cause valid windset readings which do not match met message readings.

6-2. Use of Supplemental Data in the Firing Tables

Certain information contained in the firing tables is not used for firing data computations but may be useful for other related calculations.

a. The Areas of the Normal Probability Curve table contains information which can be used in determining single-shot hit probability and in determining assurance of clearing a crest. The method of determining single-shot hit probability is identical to the method shown in chapter 2, FM 6-40. Use of the table to determine assurance of crest clearance is covered in paragraph 3-16 of this manual.

b. The Ground Data table contains several items, all of which are referenced to the level point.

(1) The elevation, column 2; the c factor, column 3; and the time of flight, column 5, are identical to the values in tables G and H in the MGR-1B rocket firing tables and tables C and D in the MGR-1A rocket firing tables.

(2) The meters-per-mil value, column 4, can be used to calculate the fork, in mils, using the formula FORK = 4 PE_r/(m/mil). It is also used in the crest clearance computations (para 3-12*c*) to convert PE_r (probable error in range for ground impact) in meters to mils.

(3) The probable error in range for ground impact, column 6, indicates simple trajectory dispersion when firing on a horizontal plane and without an airburst fuze.

Note: The probable errors in Honest John firing tables differ from the probable errors in cannon firing tables in that the rocket probable errors are estimates of the total weapon system dispersion which would be expected in the field and are not just estimates of the weapon's precision.

(4) The probable error in deflection (PE_d), column 7, applies to both a ground impact burst and an airburst, since the action of an airburst fuze does not affect the deflection dispersion. The deflection PE increases with range, varying from 37 meters to 626 meters, for example, for the MGR-1B rocket with light warhead fired from the M386 launcher.

(5) The probable error in range for airburst (PE_R), column 8, is the combination of the trajectory dispersion of column 6 and the action of an airburst fuze. In every instance, incorporation of an airburst fuze into firings results in a smaller dispersion for the round and, therefore, a smaller PE. This is true because the dispersion in the fuze itself is small enough to compress the distribution.

(6) The probable error in height for airburst (PE_H), column 9, is the vertical component of the distribution pattern of airburst rounds, or, stated another way, PE_H is the vertical component of the combination of the simple trajectory dispersion of column 6 plus the action of the airburst fuze.

(7) The angle of fall, column 10, is self-explanatory. It is useful in computations for the terminal end of the trajectory, such as target dead space or burst point location, where rough estimates are sufficient. The general procedure is to assume that the trajectory is a straight line and use the natural trigonometric functions of the angle of fall for determining the range difference for a given height change or vice versa.

c. The Δ R, Δ H tables (tables N and O in the MGR-1B rocket firing tables and tables H and I in the MGR-1A rocket firing tables) contain two types of information for trajectories fired under standard conditions. Table N (table H) contains the range and height components of the total distance a burst point would move were the elevation to be increased by 10 mils *while the time of flight remained constant* (fig 6-1).

Table O (table I) contains the range and height components of the total distance a burst point would move along a given trajectory if the time of flight were increased 1 second (fig 6-2).

The two tables may be combined to determine the range change and height change when a burst point is moved from one trajectory to another and the time of flight is also changed (fig 6-3).

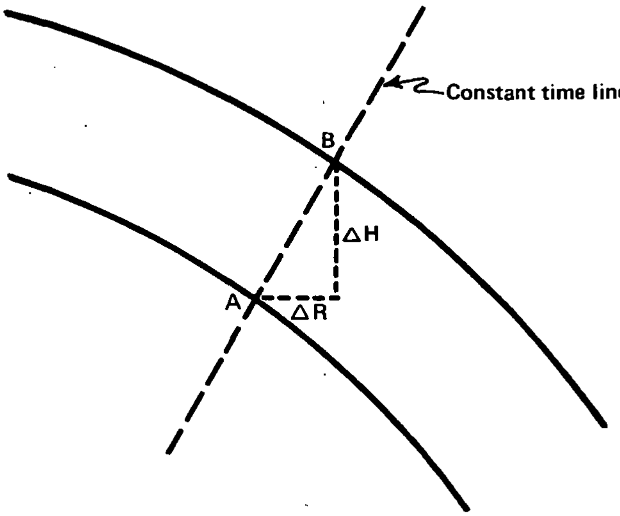


Figure 6-1. Change in quadrant elevation when time remains constant.

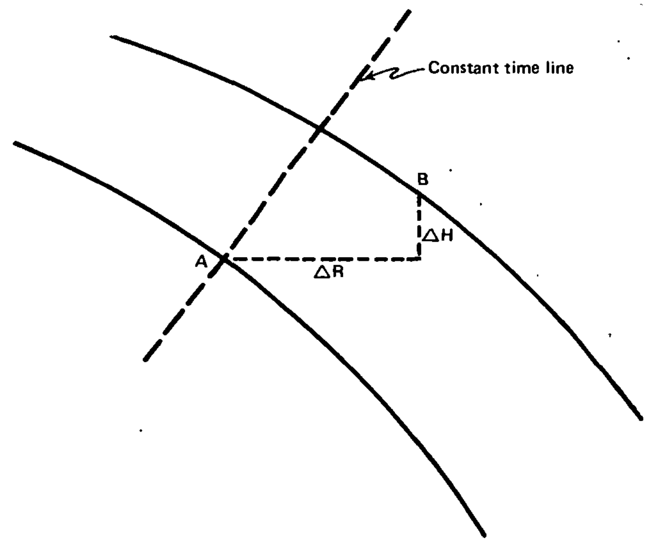


Figure 6-3. Change in quadrant elevation and time simultaneously.

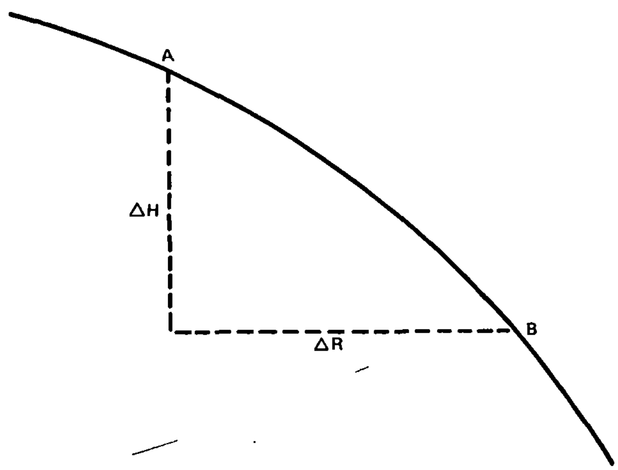


Figure 6-2. Change in time when quadrant elevation remains constant.

This is accomplished by solving the two equations $\Delta R = \Delta QE (\Delta R/\Delta QE) + \Delta TF (\Delta R/\Delta TF)$ $\Delta H = \Delta QE \Delta H/\Delta QE) + \Delta TF (\Delta H/\Delta TF)$, where $(\Delta R/\Delta QE)$ and $(\Delta H/\Delta QE)$ are extracted from table N (table H) and $(\Delta R/\Delta TF)$ and $(\Delta H/\Delta TF)$ are extracted from table O (table I). The following examples illustrate the use of the Δ R, Δ H tables and the c and t factors from the Elevation and Time of Flight tables:

Example 1:

Known conditions—

Range to burst	20,000 meters
Height of burst above launcher	500 meters
Firing table	FTR 762-H-1

What is the amount of change in burst point location which will occur for a 5-mil decrease in QE with no change in TF?

Solution:

Enter the Δ R, Δ H (Elevation) table (table N) with a range to burst of 20,000 meters and a height of burst above launcher of 500 meters, and extract the values for Δ R and Δ H of +12 meters and +204 meters, respectively. Since these values are for an increase of 10 mils, the signs must be reversed and the values must be reduced for the amount of QE change: $+12/10 \times -5 = -6$ and $+204/10 \times -5 = -102$. The height of burst would therefore decrease 102 meters and the range to burst would decrease 6 meters for a 5-mil decrease in QE with no change in TF.

Example 2:

Known conditions—

Range to burst	28,500 meters
Height of burst above launcher	1,300 meters
Firing table	FTR 762-H-1

What is the change in burst point location for a 2.4-second decrease in TF with no change in QE?

Solution:

Enter the Δ R, Δ H (Time of Flight) table (table O) with a range to burst of 28,000 meters and a height of burst above launcher of 1,500 meters and, using the same interpolation procedures as those used for firing data calculations, determine the Δ R and Δ H factors for range 28,500 to be +221 and −260, respectively. In the same manner, determine factors in the 1,000-meter HOB column to be +215 and −261. By interpolation between the 1,000-meter HOB values and the 1,500-meter HOB values, determine Δ R and Δ H values for 1,300-meters HOB of +219 and −260 respectively. Since these values are for an increase in time of flight of 1 second, the sign must be reversed and the values must be increased for the total decrease in time of flight of 2.4 seconds: $+219 \times -2.4 = -525.6$ and $-260 \times -2.4 = +624.0$. The burst point would therefore decrease 526 meters in range and increase 624 meters in height for a decrease in TF of 2.4 seconds.

Example 3:

Known conditions—

Range to burst	31,000 meters
Height of burst above launcher	500 meters
Firing table	FTR 762-H-1

What increase in QE and TF is required to increase the burst point range by 100 meters?

Solution:

Enter the Elevation table (table G, page 278) and the Time of Flight table (table H, page 279) and determine the c and t factors for range 31,000 meters and HOB +500 meters to be 4.9 mils/100 meters and 0.53 second/100 meters. Therefore, an increase of 4.9 mils in QE and an increase of 0.53 second in TF would be required to increase the range of the burst point by 100 meters.

Example 4:

Known conditions—

Range to burst	31,000 meters
Height of burst above launcher	500 meters
Firing table	FTR 762-H-1

What are the approximate changes in QE and TF equivalent to miss distances of −330 meters in range and −410 meters in HOB?

Solution:

Enter tables N and O with a range of 31,000 meters and an HOB of 500 meters and extract the following four values:

$\Delta R/\Delta QE = -4$ $\quad$ $\Delta H/\Delta QE = +324$

$\Delta R/\Delta TF = +189$ $\quad$ $\Delta H/\Delta TF = -298$

Since the values extracted from table N are for an increase of 10 mils in QE, they must be divided by 10 to determine the changes for an increase of 1 mil in QE.

$$-4/10 = -0.4 \text{ and } +324/10 = +32.4$$

Substituting these values in the equations discussed above and solving them simultaneously, we have:

$$\Delta R = \Delta QE\ (\Delta R/\Delta QE) + \Delta TF\ (\Delta R/\Delta TF)$$
$$\Delta H + \Delta QE\ (\Delta H/\Delta QE) + \Delta TF\ (\Delta H/\Delta TF)$$
$$-330 = \Delta QE\ (-0.4) + \Delta TF\ (+189)$$
$$-410 = \Delta QE\ (+32.4) + \Delta TF\ (-298)$$

Multiply by the coefficient of Δ QE:

$$(-330)\ (+32.4) = \Delta QE\ (-0.4)\ (+32.4) + \Delta TF\ (+189)\ (+32.4)$$
$$(-410)\ (-0.4) = \Delta QE\ (+32.4)\ (-0.4) + \Delta TF\ (-298)\ (-0.4)$$
$$-10692 = -12.96\ \Delta QE + 6123.6\ \Delta TF$$
$$164 = -12.96\ \Delta QE + 119.2\ \Delta TF$$

Changing signs and adding:

$$-10856 = 6004.4\ \Delta TF$$
$$TF = -1.808 \text{ seconds}$$

Substituting back into the first equation:

$$-330 = -0.4\ \Delta QE + (-1.808)\ (+189)$$
$$-330 = -0.4\ \Delta QE - 341.712$$
$$0.4\ \Delta QE = -11.712$$
$$\Delta QE = -29.28 \text{ mils}$$

Therefore, for observed miss distances of −330 meters in range and −410 meters in HOB, the equivalent QE and TF errors are −29.3 mils and −1.81 seconds, respectively.

Example 5:

Known conditions—

Range to impact	20,000 meters
Height of impact above launcher	1,000 meters
Fuze setting fired	43.6 seconds
Firing table	FTR 762-H-1

Had the fuze functioned properly, what is the probable burst location for a desired airburst round which failed to achieve an airburst?

Solution:

Using the same nonstandard conditions as those used in initial computations, calculate the fuze setting to the actual impact point. For this problem, assume a time of 45.4 seconds. Subtract from this the fuze setting fired to determine a Δ time: $45.4 - 43.6 = 1.8$ seconds. Enter table O with range 20,000 meters and height 1,000 meters and extract the two values of Δ R and Δ H: +323 and −141. Multiply these by the Δ time just determined: $+323 \times 1.8 = 581.4$

meters and $-141 \times 1.8 = -253.8$ meters. Algebraically subtract the Δ range from the range to impact (20,000 − 581 = 19,419) and the Δ height to the impact altitude (1000 − (−254) =1254). The probable burst location, had the fuze functioned properly, would therefore be at a range of 19,419 meters and at a height above launcher of 1,254 meters.

6-3. Safe Firing Limits

Conditions may occur which give rise to the question of whether final launcher settings are safe. An example of this would be large low-level cross wind corrections which cause the launcher deflection to be laid outside the left/right limits of the safety diagram. The following guidance is furnished for commanders and safety officers: Providing that all of the following conditions have been met, the final launcher setting is safe to fire:

a. The firing data have been computed accurately.

b. The *trial* QE is equal to or exceeds the QE to the minimum range line and is less than or equal to the QE to the maximum range line, the *trial* time of flight is equal to or greater than the time of flight to the minimum time line, and the aiming point deflection is within the left/right limits of the impact area. (For the M38 warhead, additional conditions specified by AR 385-62 to prevent ricochet of the ballast should also be met.)

c. Rocket component data and atmospheric data for FDC computations have been collected accurately.

d. Firing data have been accurately applied to the rocket and launcher.

6-4. FADAC vs Manual Computations

The following list shows those differences between FADAC and manual gunnery computations for the Honest John rocket:

a. The computer met message contains unweighted zone quantities only; the ballistic met message contains weighted values. The FADAC uses all lines of the met up to the line which contains the maximum ordinate as it computes the equations of motion. Manual procedures use only the one line which contains the maximum ordinate, and the weighting technique is provided to take account of values in the lower lines.

b. Firing data for targets occurring on the ascending branch of the trajectory can be computed manually but cannot be computed by FADAC.

c. FADAC has no capability to compute piece-crest clearance; this must always be done manually. However, intermediate crest clearance may be computed by FADAC.

d. Manual computations require entry into firing table addendums or FM 6-40-1A for additional data. No input data are required from these sources for FADAC computations, since the data are already stored in the program.

e. Data for firing the chemical warhead M190 with both the MGR-1A and MGR-1B rockets can be computed by means of FADAC. However, no firing table addendum is available for this warhead with the MGR-1A rocket. Therefore, when data are computed manually, the M190 warhead can be fired only with the MGR-1B rocket.

6-5. Choice of Height of Burst for Training Firings

a. Rockets fired at heights of burst lower than 2.45 probable errors in height above the ground (PE_h) have more than a 5 percent chance of impacting, simply because they fall in the lower portion of the vertical dispersion pattern.

b. Some local range regulations preclude higher heights of burst. However, units can significantly reduce their impact percentage by simply raising the burst point to a height sufficient to provide at least a 95 percent probability of an airburst (2.45 PE_H). The heights of burst for given launcher-target ranges which will provide a 95 percent probability of an airburst are shown in fig 6-4.

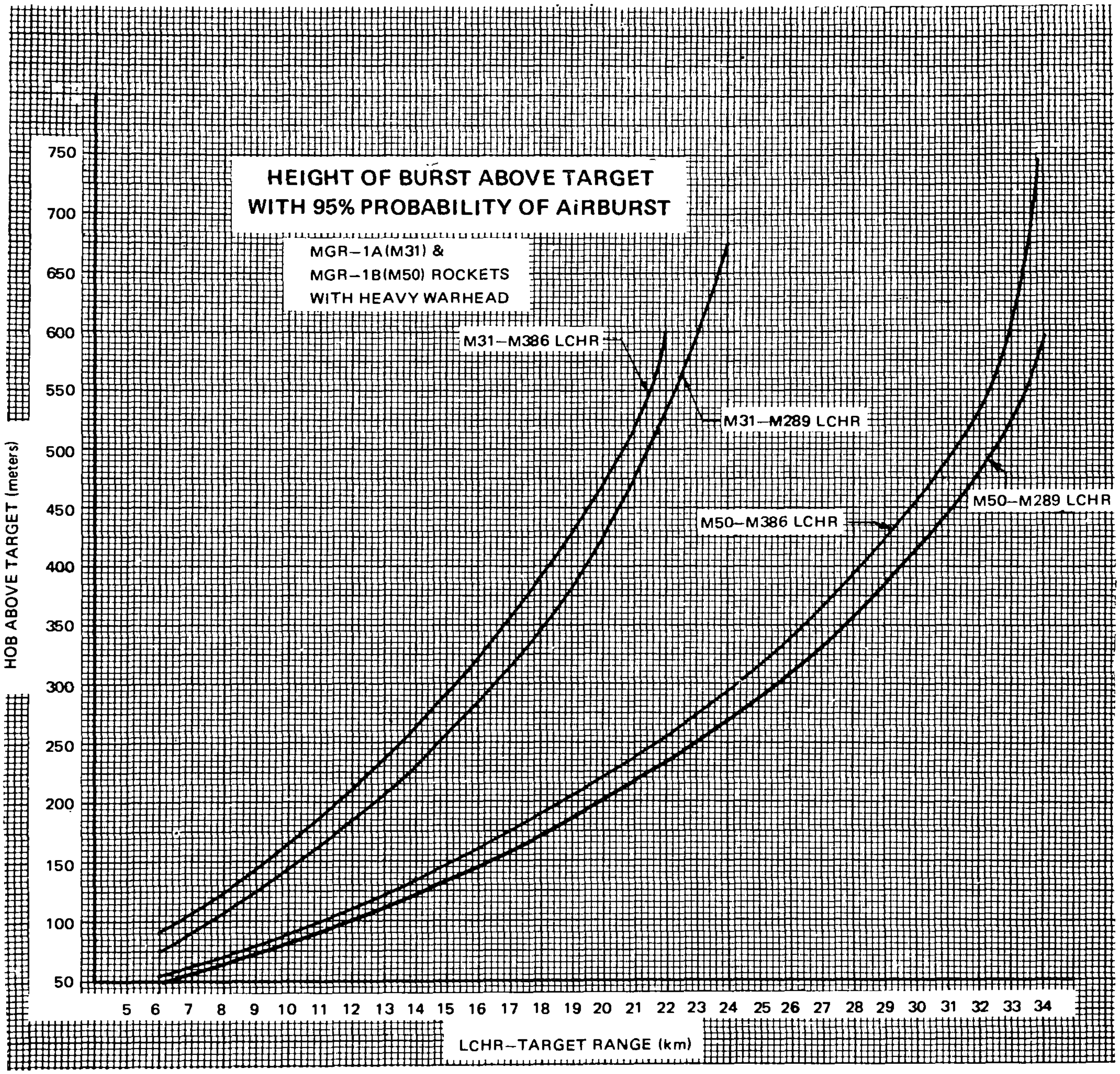


Figure 6-4. Probability of airburst for a given range and height of burst.

APPENDIX A

REFERENCES

A–1. Publication Indexes

Department of the Army pamphlets of the 310–series should be consulted frequently for the latest changes to or revisions of references given in this appendix and for new publications relating to material covered in this manual.

A–2. Army Regulations (AR)

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

A–3. Army Training Tests (ATT)

6–175	Field Artillery Battalion (Battery) Honest John
32–400	Electronic Warfare (EW) Army Type Divisions, Brigades, Battalions, Other Units and Teams

A–4. Army Training Programs (ATP)

6–175	Field Artillery Rocket Units, Honest John Rocket

A–5. Department of the Army Pamphlets (DA Pam)

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

A–6. Field Manuals (FM)

5–25	Explosives and Demolitions
6–2	Field Artillery Survey
6–10	Field Artillery Communications
6–15	Artillery Meteorology
6–20–1	Field Artillery Tactics
6–20–2	Field Artillery Techniques
6–40	Field Artillery Cannon Gunnery
(S) 6–40–1A	Field Artillery Honest John Rocket Gunnery (U)
6–59	Field Artillery Rocket Honest John with Launchers M386 and M33
6–60	Field Artillery Rocket Honest John with Launcher M289
6–61	Field Artillery Battalion, Honest John
6–125	Qualification Tests for Specialists, Field Artillery
6–140	Field Artillery Cannon Battalions and Batteries
(C) 6–141–2 (Modified)	Nonnuclear Employment of Field Artillery Weapons Systems (Selected Munitions) (U)

(C) 6–155–1	Special Procedures for Employment of Selected Ammunition with Free Rockets (U)
21–5	Military Training Management
21–6	Techniques of Military Instruction
21–26	Map Reading
21–30	Military Symbols
(C) 32–5	Signal Security (SIGSEC) (U)
(C) 32–6	SIGSEC Techniques (U)
101–31–1	Staff Officers' Field Manual, Nuclear Weapons Employment, Doctrine and Procedures
(S) 101–31–2	Staff Officers' Field Manual, Nuclear Weapons Employment Effects Data (U)
101–31–3	Staff Officers' Field Manual, Nuclear Weapons Employment Effects Data

A–7. Firing Tables (FTR)

762–A–2	Firing Tables for Launcher, Rocket: 762-mm Truck Mounted M289, Firing Rocket, 762-mm; M31 Mods with Warhead HE, 762-mm Rocket, M6E1; Warhead, 762-mm Rocket, Flash-Smoke M38, and Warhead HE, 762-mm Rocket M144
762–B–2	Firing Tables for Launcher, Rocket: 762-mm, Truck-Mounted M289, Firing Rocket, 762-mm; M31 Mods with AKM86, M27, M47, M48 and M190 Warheads
762–C–1	Firing Tables for Launcher, Rocket 762-mm, M33 Firing Rocket 762-mm, M31 Mods with AKM86, M27, M47, M48 and M190 Warheads
762–D–1	Firing Tables for Launcher, Rocket 762-mm, M33 Firing Rocket 762-mm, M31 Mods with Warhead HE 762-mm Rocket M6E1, Warhead HE 762-mm Rocket M144, Warhead 762-mm Rocket M38 and Warhead, Fragmentation M57 Mods
762–E–1	Firing Tables for Launcher Rocket 762-mm, Truck Mounted M386; Firing Rocket, 762-mm; M31 Mods with AKM86, M27, M47, M48, and M190 Warheads
762–F–1	Firing Tables for Launcher, Rocket: 762-mm Truck Mounted M386, Firing Rocket, 762-mm: M31 Mods with Warhead, HE, 762-mm Rocket, M6E1; Warhead, 762-mm Rocket M38 Mods, M144, and HE M57
762–ADD–A–1	Firing Table Addendum for Launchers M289, M33, M386, Firing Rocket 762-mm M31 Mods with Warhead M144
762–ADD–B–1	Firing Table Addendum for Launchers M289, M33, M386. Firing Rocket 762-mm M31 Mods with Warhead M6E1
762–G–1	Firing Tables for Launcher, Rocket: 762-mm Truck Mounted, M386 Firing Rocket, 762-mm M50 Mods with Warhead Sections M27, M47, M48, M190
762–H–1	Firing Tables for Launcher Rocket: 762-mm Truck Mounted, M386 Firing Rocket, 762-mm: M50 Mods with Warhead Section, HE: M144 Warhead Section, Practice M38
762–I–1	Firing Tables for Launcher Rocket: 762-mm M33 Firing Rocket, 762-mm: M50 Mods with Warhead Sections M27, M47, M48, M190
762–J–1	Firing Tables for Launcher Rocket: 762-mm M33 Firing Rocket, 762-mm M50 Mods with Warhead Section HE: M144 Warhead Section, Practice M38
762–K–1	Firing Tables for Launcher, Rocket: 762-mm Truck Mounted, M289 Firing Rocket, 762-mm M50 Mods with Warhead Sections M27, M47, M48, M190
762–L–1	Firing Tables for Launcher, Rocket, 762-mm Truck Mounted, M289, Firing

	Rocket, 762-mm M50 Mods with Warhead Section, HE: M144 Warhead Section, Practice M38
762-ADD-C-1	Firing Table Addendum for Launcher M289, M33, M386. Firing Rocket, 762-mm M50 Mods with Warhead Sections M144 and M186
762-ADD-D-1	Firing Table Addendum for Launcher M289, M33, M386. Firing Rocket 762-mm M50 Mods with Warhead Section, Gas, Nonpersistent, GB, M190
762-ADD-E-1	Firing Table Addendum for Launchers M289, M33, M386. Firing Rocket 762-mm M50 Mods with Warhead Section, HE M6E1

A-8. Technical Manuals (TM)

5-6115-271-14	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Generator Set, Gasoline Engine 3 kw, Military Design (Less Engine) 3 kw, AC, 400-Hz, DOD model MEP-021A; Generator Set, Gasoline Engine, 3 kw, Military Design (Less Engine) 3 kw, AC, 60-Hz, DOD Model MEP-016A; Generator Set, Gasoline Engine, 3 kw, Military Design (Less Engine) 3 kw, DC 220 28-volt: DOD Model MEP-026A
6-230	Logarithmic and Mathematical Tables
9-1055-202-10	Operator's Manual: Truck-Mounted 762-mm Rocket Launcher M289
9-1055-202-20	Organizational Maintenance: 762-mm Truck-Mounted Rocket Launcher M289
9-1055-202-20P	Organizational Repair Parts & Special Tools List for Launcher, 762-mm Rocket Truck Mounted M289
9-1055-203-ESC	Equipment Serviceability Criteria for Heating and Tiedown Unit, 762-mm Rocket, Truck-Mounted, M78A1
9-1055-203-14	Organizational, DS and GS Maintenance—Manual for Heating and Tiedown Kit, 762-mm Rocket, Truck-Mounted: M78A1
9-1055-203-24P	Organizational, Direct Support, General Support and Depot Maintenance Repair Parts and Special Tools List For Heating and Tiedown Kit 762-mm Rocket, Truck Mounted: M78A1 and M78A1E1
9-1055-205-ESC	Equipment Serviceability Criteria for Launcher, Rocket, 762-mm Truck-Mounted, M386
9-1055-205-10	Operator's Manual: Truck-Mounted 762-mm Rocket Launcher M386
9-1055-205-20	Organizational Maintenance: Truck-Mounted 762-mm Rocket Launcher M386
9-1055-205-20P	Organizational Repair Parts and Special Tool List for Truck-Mounted 762-mm Rocket Launcher M386
9-1055-208-ESC	Equipment Serviceability Criteria for Handling Unit, 762-mm Rocket Trailer-Mounted, M405 and M405A1
9-1055-208-12	Operator and Organizational Maintenance Manual: Trailer-Mounted 762-mm Rocket Handling Units M405 and M405A1
9-1055-208-20P	Organizational Maintenance Repair Parts and Special Tool Lists for Trailer-Mounted 762-mm Rocket Handling Units M405 and M405A1
(C) 9-1100-200-12	Operator and Organizational Maintenance (Prelaunch Procedures) M27, M47, M48 Atomic Warhead Sections. M72 Training Warhead Section (U)
9-1100-200-20P	Organizational Maintenance Repair Parts and Special Tool Lists (Illustrated Parts Breakdown) M27, M47, M48 Atomic Warhead Sections, M72 Training Warhead Section
9N-1105-200-12	Operation and Organizational Maintenance Honest John Training 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)
9-1220-221-20P	Organizational Maintenance Repair Parts and Special Tools Lists for Computer, Gun Direction, M18
9-1340-202-ESC	Equipment Serviceability Criteria for 762-mm Rocket System
9-1340-202-12	Operator and Organizational Maintenance Manual: 762-mm Rockets MGR-1A and MGR-1B (Honest John Rocket System)
9-1340-202-20P	Organizational Maintenance Repair Parts and Special Tools Lists for Rocket, 762-Millimeter, MGR1B (M50 Series) and MGR1A (M31 Series) (Honest John Rocket System)
9-1340-211-12	Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tools Lists: Warhead Section, 762-mm Rocket, High Explosive: M144 and M186
9-1340-213-12	Operator and Organizational Maintenance Manual, Warhead Section, 762-mm Rocket, High Explosive, M6.
9-1340-218-12	Operator and Organizational Maintenance Manual: Warhead Section, 762-Millimeter Rocket, Training: M132
9-1340-221-12	Organizational Maintenance Manual (Includes Repair Parts and Special Tool Lists): Warhead Section, 762-mm Rocket Training: M42
9-4931-204-12/2	Operator and Organizational Maintenance Manual: Test Set, Computer Logic Unit AN/GSM-70 (Composite Test Tape A Program Printout)
9-6920-213-14	Operator, Organizational, DS and GS Maintenance Manual: 762-mm Training Rocket Motors M84 and M98 (Honest John Rocket System)
11-6660-235-12	Organizational Maintenance Manual Including Repair Parts: Simulator, Windspeed AN/GMM-7
11-6660-255-12	Organizational Maintenance Manual Including Repair Parts and Special Tools List: Wind Measuring Sets AN/PMQ-6 and AN/PMQ-6A
11-6675-200-10	Operator's Manual: Theodolites ML-47-C through ML-47-R, ML-247, and ML-247A and double center theodolites ML-474/GM and ML-474A/GM

A-9. Allied Communications Publications (ACP)

134(A)	Telephone Switchboard Operating Procedures

APPENDIX B

TABLES

Table B-1. Launcher-Rocket Elevation Limits

Launcher	Rocket	Launcher-rocket minimum elevation limits: 10° Forward slope (−178m) emplacement angle ₥	Level (0m) emplacement angle ₥	10° Reverse slope (178m) emplacement angle ₥	Launcher-rocket minimum elevation calculations: Emplacement from ₥	Angle thru ₥	Launcher-rocket minimum elevation ₥
M386	MGR-1A	178	178	296	−178	60	178
					61	178	118 + emplacement angle
M386	MGR-1B	72	72	250	−178	0	72
					1	178	72 + emplacement angle
M289	MGR-1A	178	178	356	−178	0	178
					1	178	178 + emplacement angle
M289	MGR-1B	178	178	356	−178	0	178
					1	178	178 + emplacement angle
M33	MGR-1A	178	178	356	−178	0	178
					1	178	178 + emplacement angle
M33	MGR-1B	72	72	250	−178	0	72
					1	178	72 + emplacement angle

Launcher	Rocket	Launcher-rocket maximum elevation limits: 10° Forward slope (−178m) emplacement angle ₥	Level (0m) emplacement angle ₥	10° Reverse slope (178m) emplacement angle ₥	Launcher-rocket maximum elevation calculations: Emplacement from ₥	Angle thru ₥	Launcher-rocket maximum elevation ₥
M386	A11	1066	1244	1422	−178	178	1244 + emplacement angle
M289	A11	888	1066	1244	−178	178	1066 + emplacement angle
M33	A11	924	1102	1280	−178	178	1102 + emplacement angle

Note: All additions are algebraic.

Table B-2. Minimum Quadrant Elevation (FTR 762-A-2)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	83	900	83
200	83	1000	83
300	83	1100	86
400	83	1200	90
500	83	1300	93
600	83	1400	97
700	83	1500	101
800	83	1600	105

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
1700	109	3400	180
1800	113	3500	182
1900	116	3600	184
2000	120	3700	186
2100	123	3800	188
2200	126	3900	191
2300	130	4000	193
2400	133	4100	195
2500	136	4200	197
2600	139	4300	198
2700	164	4400	200
2800	167	4500	202
2900	169	4600	204
3000	172	4700	206
3100	174	4800	208
3200	176	4900	210
3300	178	5000	212

Table B–3. Minimum Quadrant Elevation (FTR 762–B–2)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	76	2600	130
200	76	2700	155
300	76	2800	157
400	76	2900	159
500	76	3000	161
600	76	3100	163
700	76	3200	165
800	76	3300	167
900	76	3400	168
1000	76	3500	170
1100	80	3600	172
1200	84	3700	174
1300	87	3800	176
1400	91	3900	178
1500	94	4000	179
1600	99	4100	181
1700	102	4200	182
1800	106	4300	184
1900	108	4400	185
2000	112	4500	187
2100	115	4600	188
2200	118	4700	190
2300	121	4800	191
2400	124	4900	193
2500	127	5000	194

Table B–4. Minimum Quadrant Elevation (FTR 762–C–2)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	92	1600	120
200	92	1700	126
300	92	1800	130
400	92	1900	135
500	92	2000	140
600	92	2100	143
700	92	2200	147
800	92	2300	150
900	92	2400	154
1000	92	2500	157
1100	96	2600	161
1200	101	2700	187
1300	106	2800	189
1400	111	2900	192
1500	116	3000	195

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
3100	197	4100	215
3200	198	4200	216
3300	200	4300	218
3400	202	4400	219
3500	204	4500	220
3600	206	4600	222
3700	208	4700	223
3800	210	4800	224
3900	212	4900	226
4000	214	5000	227

Table B–5. Minimum Quadrant Elevation (FTR 762–D–1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	100	2600	172
200	100	2700	198
300	100	2800	201
400	100	2900	203
500	100	3000	206
600	100	3100	208
700	100	3200	210
800	100	3300	212
900	100	3400	214
1000	100	3500	216
1100	105	3600	218
1200	110	3700	220
1300	115	3800	222
1400	120	3900	224
1500	125	4000	226
1600	131	4100	228
1700	136	4200	229
1800	141	4300	230
1900	145	4400	232
2000	150	4500	233
2100	153	4600	235
2200	158	4700	236
2300	161	4800	237
2400	165	4900	239
2500	169	5000	240

Table B–6. Minimum Quadrant Elevation (FTR 762–E–1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	91	300	91
200	91	400	91

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
500	91	2800	188
600	91	2900	191
700	91	3000	194
800	91	3100	196
900	91	3200	197
1000	91	3300	199
1100	95	3400	201
1200	100	3500	203
1300	105	3600	205
1400	110	3700	207
1500	115	3800	209
1600	120	3900	211
1700	124	4000	213
1800	130	4100	214
1900	134	4200	215
2000	139	4300	217
2100	142	4400	218
2200	146	4500	219
2300	149	4600	220
2400	153	4700	222
2500	156	4800	223
2600	160	4900	224
2700	186	5000	226

Table B-7. Minimum Quadrant Elevation (FTR 762-F-1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	99	2600	171
200	99	2700	197
300	99	2800	200
400	99	2900	202
500	99	3000	205
600	99	3100	207
700	99	3200	209
800	99	3300	211
900	99	3400	213
1000	99	3500	215
1100	104	3600	217
1200	109	3700	219
1300	114	3800	221
1400	119	3900	223
1500	124	4000	225
1600	130	4100	227
1700	135	4200	228
1800	140	4300	229
1900	144	4400	231
2000	149	4500	232
2100	152	4600	234
2200	157	4700	235
2300	160	4800	236
2400	164	4900	238
2500	167	5000	239

Table B-8. Minimum Quadrant Elevation (FTR 762-G-1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	91	2600	108
200	91	2700	130
300	91	2800	130
400	91	2900	130
500	91	3000	130
600	91	3100	130
700	91	3200	130
800	91	3300	130
900	91	3400	130
1000	91	3500	130
1100	91	3600	130
1200	93	3700	130
1300	96	3800	130
1400	97	3900	131
1500	98	4000	131
1600	98	4100	131
1700	99	4200	132
1800	102	4300	132
1900	102	4400	132
2000	104	4500	133
2100	104	4600	133
2200	105	4700	133
2300	106	4800	134
2400	106	4900	134
2500	107	5000	134

Table B-9. Minimum Quadrant Elevation (FTR 762-H-1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	97	1600	105
200	97	1700	106
300	97	1800	107
400	97	1900	108
500	97	2000	109
600	97	2100	110
700	97	2200	111
800	97	2300	111
900	97	2400	113
1000	97	2500	113
1100	98	2600	114
1200	99	2700	137
1300	101	2800	137
1400	102	2900	137
1500	103	3000	137

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
3100	138	4100	141
3200	138	4200	141
3300	138	4300	141
3400	138	4400	142
3500	138	4500	142
3600	139	4600	143
3700	139	4700	143
3800	139	4800	144
3900	140	4900	144
4000	140	5000	145

Table B–10. Minimum Quadrant Elevation (FTR 762–I–1)

To calculate the *piece-crest minimum QE*, add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	83	2600	99
200	83	2700	122
300	83	2800	122
400	83	2900	122
500	83	3000	122
600	83	3100	122
700	83	3200	122
800	83	3300	122
900	83	3400	122
1000	83	3500	122
1100	84	3600	122
1200	85	3700	122
1300	87	3800	123
1400	88	3900	123
1500	89	4000	123
1600	91	4100	123
1700	92	4200	124
1800	93	4300	124
1900	93	4400	124
2000	95	4500	125
2100	95	4600	125
2200	97	4700	125
2300	97	4800	126
2400	98	4900	126
2500	98	5000	126

Table B–11. Minimum Quadrant Elevation (FTR 762–J–1)

To calculate the *piece-crest minimum QE*, add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	88	300	88
200	88	400	88

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
500	88	2800	130
600	88	2900	130
700	88	3000	130
800	88	3100	130
900	88	3200	130
1000	88	3300	131
1100	89	3400	131
1200	91	3500	131
1300	93	3600	131
1400	94	3700	132
1500	95	3800	132
1600	96	3900	132
1700	99	4000	133
1800	100	4100	133
1900	101	4200	133
2000	103	4300	134
2100	103	4400	134
2200	104	4500	134
2300	105	4600	135
2400	106	4700	135
2500	106	4800	136
2600	107	4900	136
2700	130	5000	137

Table B–12. Minimum Quadrant Elevation (FTR 762–K–1)

To calculate the *piece-crest minimum QE*, add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	84	2600	99
200	84	2700	122
300	84	2800	122
400	84	2900	122
500	84	3000	122
600	84	3100	122
700	84	3200	122
800	84	3300	122
900	84	3400	122
1000	84	3500	122
1100	85	3600	122
1200	86	3700	122
1300	86	3800	122
1400	88	3900	122
1500	89	4000	122
1600	91	4100	123
1700	92	4200	123
1800	92	4300	123
1900	93	4400	124
2000	94	4500	124
2100	95	4600	125
2200	96	4700	125
2300	97	4800	125
2400	97	4900	126
2500	98	5000	126

Table B-13. Minimum Quadrant Elevation (FTR 762-L-1)

To calculate the *piece-crest minimum QE,* add the piece-crest QE of the appropriate range in the table below to the measured angle of site to crest. If the range to crest falls between 100-meter increments, use the higher value of the two piece-crest QE's involved.

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
100	88	900	88
200	88	1000	88
300	88	1100	89
400	88	1200	90
500	88	1300	92
600	88	1400	93
700	88	1500	94
800	88	1600	96

Range to crest	Piece-crest QE (mils)	Range to crest	Piece-crest QE (mils)
1700	97	3400	129
1800	98	3500	130
1900	99	3600	130
2000	100	3700	130
2100	101	3800	131
2200	102	3900	131
2300	103	4000	131
2400	104	4100	132
2500	105	4200	132
2600	106	4300	133
2700	128	4400	133
2800	129	4500	134
2900	129	4600	134
3000	129	4700	135
3100	129	4800	135
3200	129	4900	136
3300	129	5000	136

Table B-14. Time to Read Vertical and Horizontal Angles, Pilot Balloon Techniques for Low-Level Winds (MGR-1A and MGR-1B)

All other than nighttime conditions		Nighttime conditions	
QE mils	Time in seconds	QE mils	Time in seconds
200	20	200	24
240	22	220	26
280	25	240	27
320	27	260	29
360	30	280	30
400	32	300	31
450	35	320	33
500	37	340	34
550	40	360	35
600	42	380	36
650	44	400	37
700	46	440	39
800	49	480	41
900	52	520	43
		560	45
		600	46
		650	48
		700	50
		750	51
		800	52
		850	54
		900	55

Table B–15. Windspeed Table for Low-Level Winds, Pilot Balloon Techniques
(Argument for entry is vertical angle to nearest tenth degree.)

	Elevation Angle of Balloon in Degrees and Tenths of a Degree									
Degrees	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Windspeed (miles per hour)									
5	94.4	92.5	90.8	89.0	87.4	85.8	84.3	82.8	81.3	78.9
6	78.6	77.3	76.0	74.8	73.7	72.5	71.4	70.3	69.3	68.3
7	67.3	66.3	65.4	64.5	63.6	62.7	61.9	61.1	60.3	59.5
8	58.8	58.0	57.3	56.6	55.9	55.3	54.6	54.0	53.4	52.8
9	52.2	51.6	51.0	50.4	49.9	49.4	48.8	48.3	47.8	47.3
10	46.8	46.4	45.9	45.5	45.0	44.6	44.1	43.7	43.3	42.9
11	42.5	42.1	41.7	41.3	41.0	40.6	40.2	39.9	39.5	39.2
12	38.9	38.5	38.2	37.9	37.6	37.3	37.0	36.7	36.4	36.1
13	35.8	35.5	35.2	34.9	34.7	34.4	34.1	33.9	33.6	33.4
14	33.1	32.9	32.6	32.4	32.2	31.9	31.7	31.5	31.3	31.0
15	30.8	30.6	30.4	30.2	30.0	29.8	29.6	29.4	29.2	29.0
16	28.8	28.6	28.4	28.3	28.1	27.9	27.7	27.5	27.4	27.2
17	27.0	26.9	26.7	26.5	26.4	26.2	26.0	25.9	25.7	25.6
18	25.4	25.3	25.1	25.0	24.8	24.7	24.5	24.4	24.3	24.1
19	24.0	23.9	23.7	23.6	23.5	23.3	23.2	23.1	22.9	22.8
20	22.7	22.6	22.5	22.3	22.2	22.1	22.0	21.9	21.7	21.6
21	21.5	21.4	21.3	21.2	21.1	21.0	20.9	20.8	20.7	20.6
22	20.4	20.3	20.2	20.1	20.0	19.9	19.8	19.8	19.7	19.6
23	19.5	19.4	19.3	19.2	19.1	19.0	18.9	18.8	18.7	18.6
24	18.6	18.5	18.4	18.3	18.2	18.1	18.0	18.0	17.9	17.7
25	17.7	17.6	17.6	17.5	17.4	17.3	17.2	17.2	17.1	17.0
26	16.9	16.9	16.8	16.7	16.6	16.6	16.5	16.4	16.4	16.3
27	16.2	16.1	16.1	16.0	15.9	15.9	15.8	15.7	15.7	15.6
28	15.5	15.5	15.4	15.3	15.3	15.2	15.2	15.1	15.0	15.0
29	14.9	14.8	14.8	14.7	14.7	14.6	14.5	14.5	14.4	14.4
30	14.3	14.3	14.2	14.1	14.1	14.0	14.0	13.9	13.9	13.8
31	13.8	13.7	13.6	13.6	13.5	13.5	13.4	13.4	13.3	13.3
32	13.2	13.2	13.1	13.1	13.0	13.0	12.9	12.9	12.8	12.8
33	12.7	12.7	12.6	12.6	12.5	12.5	12.4	12.4	12.3	12.3
34	12.3	12.2	12.2	12.1	12.1	12.0	12.0	11.9	11.9	11.8
35	11.8	11.8	11.7	11.7	11.6	11.6	11.5	11.5	11.5	11.4
36	11.4	11.3	11.3	11.2	11.2	11.2	11.1	11.1	11.0	11.0
37	11.0	10.9	10.9	10.8	10.8	10.8	10.7	10.7	10.7	10.6
38	10.6	10.5	10.5	10.5	10.4	10.4	10.4	10.3	10.3	10.2
39	10.2	10.2	10.1	10.1	10.1	10.0	10.0	10.0	9.9	9.9
40	9.8	9.8	9.8	9.7	9.7	9.7	9.6	9.6	9.6	9.5
41	9.5	9.5	9.4	9.4	9.4	9.3	9.3	9.3	9.2	9.2
42	9.2	9.1	9.1	9.1	9.1	9.0	9.0	9.0	8.9	8.9
43	8.9	8.8	8.8	8.8	8.7	8.7	8.7	8.6	8.6	8.6
44	8.6	8.5	8.5	8.5	8.4	8.4	8.4	8.4	8.3	8.3
45	8.3	8.2	8.2	8.2	8.2	8.1	8.1	8.1	8.0	8.0
46	8.0	8.0	7.9	7.9	7.8	7.8	7.8	7.8	7.8	7.8
47	7.7	7.7	7.7	7.6	7.6	7.6	7.5	7.5	7.5	7.5
48	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.2	7.2
49	7.2	7.2	7.1	7.1	7.1	7.1	7.0	7.0	7.0	7.0
50	6.9	6.9	6.9	6.9	6.8	6.8	6.8	6.8	6.7	6.7
51	6.7	6.7	6.6	6.6	6.6	6.6	6.6	6.5	6.5	6.5
52	6.5	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3

Table B-15. Windspeed Table for Low-Level Winds, Pilot Balloon Techniques—Continued
(Argument for entry is vertical angle to nearest tenth degree.)

	Elevation Angle of Balloon in Degrees and Tenths of a Degree									
Degrees	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Windspeed (miles per hour)									
53	6.2	6.2	6.2	6.2	6.1	6.1	6.1	6.1	6.1	6.0
54	6.0	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.8	5.8
55	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.6	5.6	5.6
56	5.6	5.6	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4
57	5.4	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2
58	5.2	5.1	5.1	5.1	5.1	5.1	5.0	5.0	5.0	5.0
59	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.8	4.8	4.8
60	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.6	4.6	4.6
61	4.6	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.4
62	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.3	4.2	4.2
63	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1
64	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9
65	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7
66	3.7	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.5
67	3.5	3.5	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4
68	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2	3.2
69	3.2	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.0	3.0
70	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9
71	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7
72	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.5
73	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4
74	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2
75	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1
76	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9
77	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8
78	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6
79	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5
80	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3
81	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2
82	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0
83	1.0	1.0	1.0	1.0	1.0	.9	.9	.9	.9	.9
84	.9	.9	.8	.8	.8	.8	.8	.8	.8	.7
85	.7	.7	.7	.7	.7	.6	.6	.6	.6	.6
86	.6	.6	.6	.5	.5	.5	.5	.5	.5	.5
87	.4	.4	.4	.4	.4	.4	.4	.3	.3	.3
88	.3	.3	.3	.3	.2	.2	.2	.2	.2	.2
89	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0

Table B-16. Wind Correction Components for a 1-Mile-Per-Hour-Wind, Pilot Balloon Technique

Degrees	Range wind	Cross wind	Degrees	Degrees	Range wind	Cross wind	Degrees
0	T 1.00	R .00 L	360	59	T .52	R .86 L	301
1	T 1.00	R .02 L	359	60	T .50	R .86 L	300
2	T 1.00	R .03 L	358	61	T .48	R .87 L	299
3	T 1.00	R .05 L	357	62	T .47	R .88 L	298
4	T 1.00	R .07 L	356	63	T .45	R .89 L	297
5	T 1.00	R .09 L	355	64	T .44	R .90 L	296
6	T .99	R .10 L	354	65	T .42	R .91 L	295
7	T .99	R .12 L	353	66	T .41	R .91 L	294
8	T .99	R .14 L	352	67	T .39	R .92 L	293
9	T .99	R .16 L	351	68	T .37	R .93 L	292
10	T .98	R .17 L	350	69	T .36	R .93 L	291
11	T .98	R .19 L	349	70	T .34	R .94 L	290
12	T .98	R .21 L	348	71	T .33	R .95 L	289
13	T .97	R .22 L	347	72	T .31	R .95 L	288
14	T .97	R .24 L	346	73	T .29	R .96 L	287
15	T .96	R .26 L	345	74	T .28	R .96 L	286
16	T .96	R .28 L	344	75	T .26	R .97 L	285
17	T .96	R .29 L	343	76	T .24	R .97 L	284
18	T .95	R .31 L	342	77	T .22	R .97 L	283
19	T .95	R .33 L	341	78	T .21	R .98 L	282
20	T .94	R .34 L	340	79	T .19	R .98 L	281
21	T .93	R .36 L	339	80	T .17	R .98 L	280
22	T .93	R .37 L	338	81	T .16	R .99 L	279
23	T .92	R .39 L	337	82	T .14	R .99 L	278
24	T .91	R .41 L	336	83	T .12	R .99 L	277
25	T .91	R .42 L	335	84	T .10	R .99 L	276
26	T .90	R .44 L	334	85	T .09	R 1.00 L	275
27	T .89	R .45 L	333	86	T .07	R 1.00 L	274
28	T .88	R .47 L	332	87	T .05	R 1.00 L	273
29	T .87	R .48 L	331	88	T .03	R 1.00 L	272
30	T .87	R .50 L	330	89	T .02	R 1.00 L	271
31	T .86	R .52 L	329	90	T .00	R 1.00 L	270
32	T .85	R .53 L	328	91	H .02	R 1.00 L	269
33	T .84	R .54 L	327	92	H .03	R 1.00 L	268
34	T .83	R .56 L	326	93	H .05	R 1.00 L	267
35	T .82	R .57 L	325	94	H .07	R 1.00 L	266
36	T .81	R .59 L	324	95	H .09	R 1.00 L	265
37	T .80	R .60 L	323	96	H .10	R .99 L	264
38	T .79	R .62 L	322	97	H .12	R .99 L	263
39	T .78	R .63 L	321	98	H .14	R .99 L	262
40	T .77	R .64 L	320	99	H .16	R .99 L	261
41	T .75	R .66 L	319	100	H .17	R .98 L	260
42	T .74	R .67 L	318	101	H .19	R .98 L	259
43	T .73	R .68 L	317	102	H .21	R .98 L	258
44	T .72	R .69 L	316	103	H .22	R .97 L	257
45	T .71	R .71 L	315	104	H .24	R .97 L	256
46	T .69	R .72 L	314	105	H .26	R .97 L	255
47	T .68	R .73 L	313	106	H .28	R .96 L	254
48	T .67	R .74 L	312	107	H .29	R .96 L	253
49	T .66	R .75 L	311	108	H .31	R .95 L	252
50	T .64	R .77 L	310	109	H .33	R .95 L	251
51	T .63	R .78 L	309	110	H .34	R .94 L	250
52	T .62	R .79 L	308	111	H .36	R .93 L	249
53	T .60	R .80 L	307	112	H .37	R .93 L	248
54	T .59	R .81 L	306	113	H .39	R .92 L	247
55	T .57	R .82 L	305	114	H .41	R .91 L	246
56	T .56	R .83 L	304	115	H .42	R .91 L	245
57	T .54	R .84 L	303	116	H .44	R .90 L	244
58	T .53	R .85 L	302	117	H .45	R .89 L	243

Note. When entering the table from the left (right), use the letter preceding (following) the cross wind correction component.

Table B-16. Wind Correction Components for a 1-Mile-Per-Hour-Wind, Pilot Balloon Technique—Continued

Degrees	Range wind	Cross wind	Degrees	Degrees	Range wind	Cross wind	Degrees
118	H .47	R .88 L	242	150	H .87	R .50 L	210
119	H .48	R .87 L	241	151	H .87	R .48 L	209
120	H .50	R .87 L	240	152	H .88	R .47 L	208
121	H .52	R .86 L	239	153	H .89	R .45 L	207
122	H .53	R .85 L	238	154	H .90	R .44 L	206
123	H .54	R .84 L	237	155	H .91	R .42 L	205
124	H .56	R .83 L	236	156	H .91	R .41 L	204
125	H .57	R .82 L	235	157	H .92	R .39 L	203
126	H .59	R .81 L	234	158	H .93	R .37 L	202
127	H .60	R .80 L	233	159	H .93	R .36 L	201
128	H .62	R .79 L	232	160	H .94	R .34 L	200
129	H .63	R .78 L	231	161	H .95	R .33 L	199
130	H .64	R .77 L	230	162	H .95	R .31 L	198
131	H .66	R .75 L	229	163	H .96	R .29 L	197
132	H .67	R .74 L	228	164	H .96	R .28 L	196
133	H .68	R .73 L	227	165	H .97	R .26 L	195
134	H .69	R .72 L	226	166	H .97	R .24 L	194
135	H .71	R .71 L	225	167	H .97	R .22 L	193
136	H .72	R .69 L	224	168	H .98	R .21 L	192
137	H .73	R .68 L	223	169	H .98	R .19 L	191
138	H .74	R .67 L	222	170	H .98	R .17 L	190
139	H .75	R .66 L	221	171	H .99	R .16 L	189
140	H .77	R .64 L	220	172	H .99	R .14 L	188
141	H .78	R .63 L	219	173	H .99	R .12 L	187
142	H .79	R .62 L	218	174	H .99	R .10 L	186
143	H .80	R .60 L	217	175	H 1.00	R .09 L	185
144	H .81	R .59 L	216	176	H 1.00	R .07 L	184
145	H .82	R .57 L	215	177	H 1.00	R .05 L	183
146	H .83	R .56 L	214	178	H 1.00	R .03 L	182
147	H .84	R .54 L	213	179	H 1.00	R .02 L	181
148	H .85	R .53 L	212	180	H 1.00	R .00 L	180
149	H .86	R .52 L	211				

Table B-17. Quadrant Elevation for Piece-Crest Ranges to 5,000 Meters

Piece-crest range (meters)	Quadrant elevation (mils)	
	M289 launcher FTR 762-A-2	M289 launcher FTR 762-B-2
1000	48	42
2000	85	78
3000	117	107
4000	143	130
5000	165	148
	M386 launcher FTR 762-E-1	M386 launcher FTR 762-F-1
1000	54	61
2000	102	111
3000	137	147
4000	161	172
5000	177	189
	M33 launcher FTR 762-C-1	M33 launcher FTR 762-D-1
1000	54	61
2000	102	111
3000	137	147
4000	161	172
5000	177	189

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
VERNE L. BOWERS,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-11 requirements for FA Honest John/Little John Rocket Gunnery.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—714-214/500

s/s

CHAPTER 4

FIRE DIRECTION USING THE M18 GUN DIRECTION COMPUTER (FADAC)

4-1. Current Procedures

See FM 6-3-2 (Operation of the Gun Direction Computer M18, Rocket Application).

4-2. STANAG 4082 Modification

a. When the FDC receives a meteorological message which has been produced under the provisions of STANAG 4082, it will be necessary to use a short addendum tape, part number 8213315-104. This addendum tape modifies the current tape to use the pressure-temperature (STANAG 4082) computer met message.

b. The addendum tape is loaded into the computer by means of the AN/GSQ-64 signal data reproducer *after* the main program, part number 8213315-18, has been loaded. Program test 1 will then result in a display of 2 00000 00011 10762. Program test 1 should always be performed and the display checked to insure that the program is correct for the met being used. Normal display if the addendum tape has not been entered into the computer is 2 00000 00000 00762.

c. Detailed operating procedures for using the addendum tape are as follows:

(1) Use only with a met message which conforms to STANAG 4082.

(2) Enter the Honest John program tape.

(3) Determine the check sum by running program test number 1. Display is 2 00000 00000 00762 if properly entered.

(4) Enter the addendum tape.

(5) Determine the check sum by running program test number 1. Display is 2 00000 00011 10762 if properly entered.

Note: The STANAG 4082 met may be readily identified by comparing the last three digits in the ID line with the last three digits in the 00 line. If the last three digits in both lines are identical, the message is in conformance with STANAG 4082.

3000015693