NATO STANDARDIZATION AGENCY
AGENCE OTAN DE NORMALISATION

5 February 2007

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See CNAD AC/225 STANAG distribution

STANAG 4119 JAS (EDITION 2) – ADOPTION OF A STANDARD CANNON ARTILLERY FIRING TABLE FORMAT

Reference:
A. PFP(NAAG)D(2006)0001. dated 27 January 2006 (Ratification Draft)
B. MAS(ARMY)(72)235, dated 29 March 2007

1. The enclosed NATO Standardization Agreement, which has been ratified by nations as reflected in the **NATO Standardization Document Database (NSDD)**, is promulgated herewith.

2. The reference listed above is to be destroyed in accordance with local document destruction procedures.

ACTION BY NATIONAL STAFFS

3. National staffs are requested to examine **their ratification status of the STANAG** and, if they have not already done so, advise the Defence Investment Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

J. MAJ
Major General, POL(A)
Director, NSA

Enclosure:
STANAG 4119 (Edition 2)

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STANAG 4119
(Edition 2)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: **ADOPTION OF A STANDARD CANNON ARTILLERY FIRING TABLE FORMAT**

Promulgated on 5 February 2007

J. MAJ
Major General, POL(A)
Director, NSA

RECORD OF AMENDMENTS

NO	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director NATO Standardization Agency under the authority vested in him by the NATO Standardization Organisation Charter.

2. No departure may be made from the agreement without informing the tasking authority in the form of a reservation. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

4. Ratification, implementation and reservation details are available on request or through the NSA websites (internet http://nsa.nato.int; NATO Secure WAN http://nsa.hq.nato.int).

FEEDBACK

5. Any comments concerning this publication should be directed to NATO/NSA – Bvd Leopold III - 1110 Brussels - BE.

REQUIREMENTS FOR THE DEVELOPMENT AND FORMATTING OF TABULAR FIRING TABLES

ANNEXES:

A -	Principles	
B -	Definitions	
C -	Description	
D -	Terminology and Symbols	
E -	Weapon Characteristics	
F -	Charge Selection Table	
G -	Table A	Line Numbers of Ballistic Meteorological Message
H -	Table B	Complementary Range and MET Line number
I -	Table C	Wind Components
J -	Table D	Ballistic Air Temperature and Ballistic Air Density Corrections
K -	Table E	Propellant Temperature
L -	Table F(i)	Basic Data and Corrections to Bearing
M -	Table F(ii)	Corrections to Range for Non-standard Conditions
N -	Table F(iii)	Corrections for Rocket-Assist Motor and Base-Bleed Unit Propellant Temperatures
O -	Table G	Supplementary Data
P -	Table H	Rotation of the Earth – Range
Q -	Table I	Rotation of the Earth – Azimuth
R -	Table J	Corrections to Fuze Setting for Non-standard Conditions
S -	Table K	Data for Alternative Fuzes
T -	Format of Tables for Illuminating Projectiles	
U -	Format of Tables for Cargo Projectiles	
V -	Format for Abridged Firing Table	

RELATED DOCUMENTS:

STANAG 4044	International Civil Aviation Organization (ICAO) Standard Atmosphere
STANAG 4355	Modified Point Mass Trajectory Model
STANAG 4061	Adoption of a Standard Ballistic Meteorological Message
STANAG 4144	Procedures to Determine the Fire Control Inputs for use in Indirect Fire Control Systems
STANAG 4367	Thermodynamic Interior Ballistic Model with Global Parameters
STANAG 4425	NATO Indirect Fire Ammunition Interchangeability – 155 mm Artillery Ammunition (AOP-29)
STANAG 4500	Procedures to Determine Field Artillery Muzzle Velocity Management Interchangeability and Prediction
STANAG 4537	NATO Armament Ballistic Kernel (AOP-37)
AAP-6	NATO Glossary of Terms and Definitions

AIM

1. The aim of this agreement is to describe standardized requirements for the development and publication of tabular firing tables for artillery and appropriate mortar cartridges in both complete and abridged formats.

AGREEMENT

2. In adopting this agreement, nations agree to develop tabular firing tables for surface to surface weapons as described below and to publish these tables in the formats described in annexes E to V.

DETAILS OF THE AGREEMENT

Background

3. Tabular Firing Tables (TFTs) have been used for at least 100 years to calculate the quadrant elevation (QE), bearing and fuze setting used in firing a projectile being used to engage targets at a specified range from a gun position. Using a format established by the 1930s, TFTs allow for the standardized calculation of the required gun orders based on the projectile muzzle velocity, projectile weight, projectile ballistic characteristics, atmospheric conditions, and the difference in elevation between gun and target positions. Use of a standardized format allows for the exchange of TFTs between national artillery staffs. TFTs are safety-critical as an error in them can result in a projectile impacting a considerable distance from the intended location.

4. The format of TFTs was established prior to the advent of digital computers and was intended to allow for their use by gunners in carrying out manual calculations of artillery fire-control solutions. With the general use of computer software to determine fire-control solutions, the role of TFTs has changed to one of manual backup for software-based fire-control solutions. TFTs are also employed to support exchanges of weapons, cartridges, and fire-control data between nations.

5. The intent of this STANAG is to describe the application of the reference STANAGs to the development of TFTs in both complete and abridged formats, computed using the NATO Modified Point Mass (MPM) trajectory model (STANAG 4355). Included are descriptions of the format of each table and definitions for the terminology employed.

Use and Development of Tabular Firing Tables

6. The intent of TFTs is to provide, through a manual, non-software-based process, accurate fire-control solutions for specified conditions. Use of the full-format tables

requires specialist training; the abridged format tables may be used without specialist training. Each table is generated using a stand-alone algorithm and Fire Control Input (FCI) data obtained in accordance with STANAG 4144. It is important to note that the fire-control solutions obtained are accurate for statistical groups of rounds and not for single rounds.

7. Trajectories are computed using the NATO MPM trajectory model (STANAG 4355) with use of the NATO Armament Ballistic Kernel (NABK - STANAG 4537) being recommended, although not essential. TFTs may be generated for all projectiles whose trajectories may be computed using the MPM model. The formats provided below are, however, only applicable to artillery and mortar weapon systems.

Probable Errors

8. An important component of a fire-control solution is the probable error (PE) associated with it. The term ‘probable error’ is defined in AAP-6 as “the error in range, deflection or in radius, which a weapon may be expected to exceed as often as not”. It is important to note that the PE is a measure of the variance of the fall-of-shot around the mean point of impact, and not of the uncertainty in the impact location of the first round fired. The PE values provided in the tabular firing tables must, for weapon/cartridges included in the NABK, be compatible with the PE terms in the NABK database.

Abridged Format Firing Tables

9. A single abridged-format table (annex V) may be prepared for standard meteorological conditions (the ICAO Standard Atmosphere), standard muzzle velocity with a propellant at 21 degrees Celsius, and standard projectile weight. For the specified standard conditions, fire-control solutions obtained using this table will have the same accuracy as those obtained using the complete-format tables. Abridged-format tables may be used for safety checks of software-based fire-control solutions, preparation of safety templates, and engineering analyses of gun system ballistics.

Graphical Firing Tables

10. Nations may employ graphical firing tables prepared to national formats. While these tables must be produced using the NATO MPM trajectory model and FCIs obtained using STANAG 4144, fire-control data will not, however, be exchanged using graphical firing tables.

Existing Tabular Firing Tables

11. All TFTs approved for national use prior to promulgation of this agreement may be used for the exchange of fire-control data between nations. Wherever possible, nations shall endeavour to ensure compatibility between these TFTs and cartridge FCIs in the NABK database.

Language of Tabular Firing Tables

12. Tabular firing tables may be prepared in English, French, or a national language. If prepared in a language other than English or French, a glossary of the annex D terms shall be prepared providing the English and French equivalents.

Calculation of Solutions for Illuminating Projectiles

13. Corrections for non-standard conditions are not required in obtaining solutions for illuminating projectiles. The ranges to fuze function and projectile functioning, respectively, must be provided if they are different.

Calculation of Fire-Control Solutions for Cargo (Submunition) Projectiles

14. Fire-control solutions for cargo projectiles are obtained using one of two table format options described in annex U. The first option involves starting with the quadrant elevation obtained using the Part 1 tables for the reference projectile, including corrections for non-standard conditions. The second option requires use of Table F(ii) to correct the fire-control solution for non-standard conditions.

Correction to Solutions to account for the Effect of Surface Winds to Submunition Trajectories

15. Nations may employ the format of Table U to calculate the trajectories of the ejected submunitions, including the effect of near-surface wind, or use a less precise technique to estimate the mean impact location of the ejected submunitions.

General Requirements for Firing Table Formats

16. Nations may change the fonts and other details of the formats of the firing tables, as presented in annexes to this agreement, so long as procedures for their use, location of rows and columns on the page, and other functional features will not be affected.

PRINCIPLES

STANDARD CONDITIONS

1. The standard atmospheric conditions for which the firing table is constructed are those of the ICAO Standard Atmosphere as described in the Manual of the ICAO Standard Atmosphere (STANAG 4044; see also STANAG 4061).

2. The earth is a homogeneous sphere. The Coriolis force is zero.

3. Gravity acts along the vertical and has the value given in the Manual of the ICAO Standard Atmosphere. A latitude of 45 degrees is used for all calculations.

4. Unless otherwise stated the reference altitude will be the zero altitude of the map system in use.

5. The motion of a projectile is represented by a mathematical model that utilizes established aerodynamic functions, fitting factors and other parameters associated with the projectile and atmosphere, as described in STANAG 4355. The aerodynamic functions for a particular projectile have given tabulated values which, in general, vary with Mach number, as described in AOP-37.

6. The parameters used in calculating projectile trajectories are determined from firings conducted in accordance with STANAG 4144.

7. A pre-assigned standard muzzle velocity is used.

NON-STANDARD CONDITIONS

8. Allowances are to be given for the following non-standard atmospheric conditions, described in the meteorological message format of STANAG 4061:

   a. Density of the air.

   b. Temperature of the air (the effect due to change in Mach number only to be included; the effect due to change in density is to be included in a.).

   c. Wind.

9. Allowances for these and other non-standard conditions are to be made by means of corrections as described in Annex B.

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DEFINITIONS

1. The terms defined below are based on the concept of a curved earth and are generalized so that they may be used for any artillery weapon. They are derived from gunnery and ballistics procedures and are used in the preparation of tabular firing tables. Figures B-1 to B-4 illustrate the definitions of the trajectory-related terms presented below.

2. The trajectory is the curve described by the centre of gravity of the projectile. It is, in general, a three-dimensional curve. To simplify the description of its elements, the following assumptions are made:

    a. The trajectory is a two-dimensional curve lying in a vertical plane.

    b. The terms “projectile” and “target” are considered as points.

    c. The term “weapon” refers to the trunnions and the term “origin” refers to the muzzle.

3. **Definition of Lines**

(1)	Weapon Axis	The axis of the bore at the breech and taken as a straight line.
(2)	Muzzle Axis	The axis of the bore at the muzzle and taken as a straight line.
(3)	Line of Sight[(1)]	The straight line passing through the weapon or instrument and the target.
(4)	Line of Departure	The tangent to the trajectory at the commencement of free flight. In general this line should be deduced from elements measured at convenient points on the trajectory.

4. **Definition of Planes and Surfaces**

(5)	Vertical Plane	The plane containing the local gravity vector.
(6)	Horizontal Plane	The plane normal to the local gravity vector.
(7)	Vertical Plane of Sight	The vertical plane containing the line of sight.
(8)	Lateral Plane of Sight	The plane passing through the line of sight, at right angles to the vertical plane of sight.
(9)	Vertical Plane of Fire	The vertical plane containing the muzzle axis before firing.

(10)	Vertical Plane of Departure	The vertical plane containing the line of departure.
(11)	Level Surface	The level surface of a reference point is the surface of a sphere tangential to the horizontal plane through the reference point with a radius equal to the mean radius of the Earth plus the altitude of the reference point. The radius of the Earth is taken to be 6356766 m.

5. **Definitions of Vertical Distances**

(12)	Height	The distance measured along the local vertical line between a reference level surface and a given point.
(13)	Altitude	The height of a point with respect to mean sea level, as given by the map system in use.

6. **Definitions of Particular Points of the Trajectory**

(14)	Vertex	The point on a trajectory at which the vertical component of velocity is zero.
(15)	Point of Graze (Point of Fall)	The point of intersection between the trajectory and the weapon level surface.
(16)	Point of Impact	The point at which a projectile first strikes an object.
(17)	Zero Target	The vertical projection of a target on the weapon level surface.

7. **Definitions of Distances**

(18)	Slant Distance	The distance between two points measured along the straight line joining them.
(19)	Horizontal Distance	The horizontal distance of a point B from a point A is the orthogonal projection of the slant distance between A and B on the horizontal plane through A.
(20)	Level Distance	The level distance of a point B from a point A is the distance, measured along the great circle between A and the orthogonal projection of B on the level surface through A (in particular the level distance from the weapon (A) to a point (B) on the trajectory).
(21)	Range	The level distance from the weapon to the level point or the start point for determining a fire-control solution using tabular firing tables.

(22)	Map Range	The value of the level distance furnished by the map grid in use.
(23)	Range for no Fuze Function	The range from the weapon to the impact location when the fuze fails to function.
(24)	Range for no rocket motor or base-burn function	The range from the weapon to the impact location when the rocket motor or base-burn unit fails to function.
(25)	Range to mean submunition impact location	The range from the weapon to the mean point of impact of the submunitions ejected from a cargo projectile.
(26)	Range to canister impact	The range from the weapon to the point of impact of the empty canister.

8. **Definitions of Angles**

(27)	Angle of Sight	The vertical acute angle measured from the horizontal plane passing through the weapon or instrument to the line of sight.
(28)	Angular Height Difference	The angular height difference of a point B from a point A is the angle, the tangent of which is the altitude of B minus the altitude of A divided by the level distance of B from A.
(29)	Elevation	The vertical acute angle measured from the horizontal plane passing through a weapon or instrument to its axis.
(30)	Firing Table Elevation	The elevation at which the gun is required to be laid under standard firing table conditions to achieve the objective stated in the firing table.
(31)	Tangent Elevation	The vertical component of the acute angle measured from the line of sight to the weapon axis.
(32)	Angle of Departure	The vertical acute angle measured from the horizontal plane passing through the weapon to the line of departure.
(33)	Angle of Projection	The vertical component of the acute angle measured from the line of sight to the line of departure.
(34)	Jump	The vertical component of the acute angle measured from the muzzle axis before firing to the line of departure.
(35)	Droop	The vertical component of the acute angle measured from the weapon axis to the muzzle axis.
(36)	Lateral Jump or Throw-off	The lateral component of the acute angle measured in the horizontal plane from the muzzle axis before firing to the line of departure.
(37)	Quadrant Elevation	The elevation at which the gun is required to be laid under the prevailing conditions to achieve the desired objective.
(38)	Correction for Angular Height Difference	The angular value which should be added to the quadrant elevation corresponding to the zero target, to correct for the angular height difference between the target and the weapon.

(39)	Inclination of the Trajectory	The vertical acute angle measured from the local horizontal plane passing through a given point on the trajectory to the orientated tangent to the trajectory at this point.
(40)	Angle of Fall (Angle of Descent)	The inclination of the trajectory at the level point; the sign being positive.
(41)	Angle of Incidence	The acute angle between the normal to the plane tangential to the surface struck and the tangent to the trajectory at the point of impact.
(42)	Angle of Impact	The complement of the angle of incidence.
(43)	Projectile Deflection	The horizontal angle measured from the vertical plane of fire to the vertical plane through the weapon and containing a specified point along the trajectory.
(44)	Drift	That part of projectile deflection due to axial spin.

9. **Definitions of Other Terms**

(45)	Time of Flight	The time taken by a projectile to travel between the origin and a specified point on a trajectory.
(46)	Muzzle Velocity	A velocity at the muzzle deduced by extrapolation from the velocity of a projectile measured at a convenient point on its trajectory.
(47)	Probable Error	The error in range, deflection or in radius, which a weapon may be expected to exceed as often as not (AAP-6).
(48)	Fork	Fork is a change in elevation in mils necessary to move the mean point of impact four times the probable error in range on the level surface.
(49)	Perturbation	Any difference between a non-standard and a standard condition is a perturbation.
(50)	Effect	Any change in the magnitude of a function (elevation, level distance, height, time of flight etc.) due to one or more perturbations (muzzle velocity, wind, density, etc.) with fixed values for two independent variables (level distance and height, elevation and height, etc.), e.g. the change in time of flight due to a perturbation in density for fixed values of elevation and height.
(51)	Corrections	Any change in the magnitude of a function that is required to compensate for one or more effects in order to achieve a desired objective.
(52)	Standard Trajectory	A trajectory obtained by calculation under standard firing table conditions with given fitting factors and aerodynamic coefficient variations.

(53)	Perturbed Trajectory	A trajectory obtained by calculation under perturbed meteorological and ballistic conditions with given fitting factors and aerodynamic coefficient variations.
(54)	Realized Trajectory	The mean of the trajectories obtained by firing a limited number of rounds with the same firing data on one occasion under effectively the same meteorological and ballistic conditions with a given weapon and given ammunition.
(55)	Ideal Trajectory	The mean trajectory which would be obtained by firing an infinite number of rounds with the same firing data under the same meteorological and ballistic conditions with a given weapon and given ammunition.
(56)	Height of Burst	The height above the ground surface at the start of functioning of a time-fuzed projectile
(57)	Time to Burst	The time after muzzle exit at the start of functioning of a time-fuzed projectile
(58)	Range to Burst	The range from the muzzle at the start of functioning of a time-fuzed projectile

10. **Miscellaneous**

	Met Datum Plane	The reference plane for the meteorological message data.

Notes:

1. In tabular firing tables the terms ‘site’ and ‘sight’ are used interchangeably.

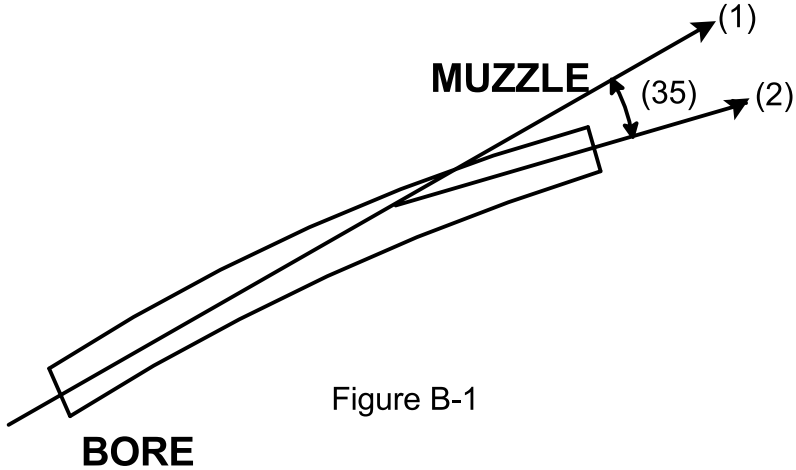

Figure B-1

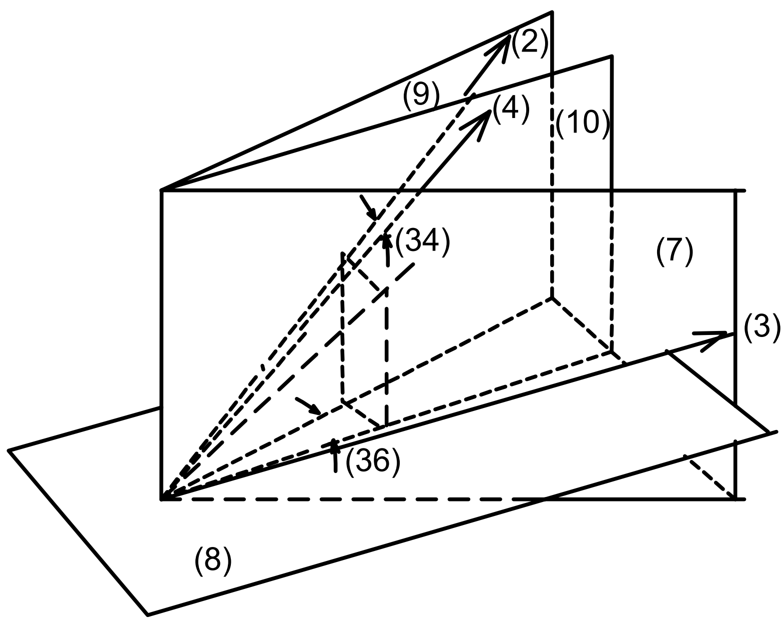

Figure B-2

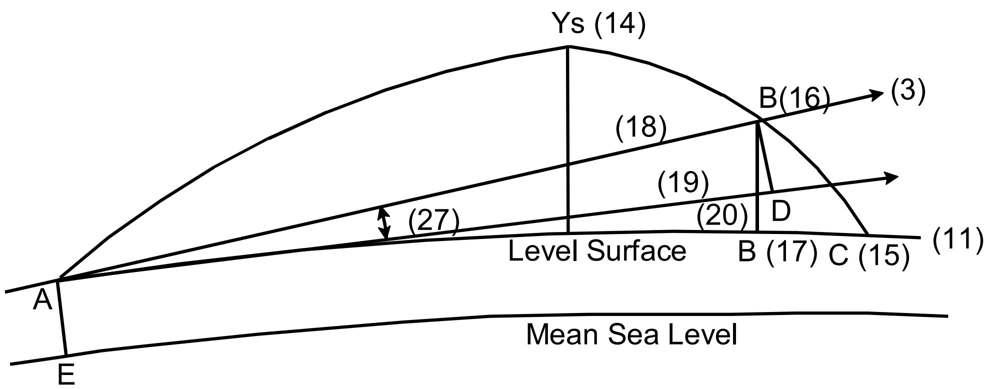

Figure B-3

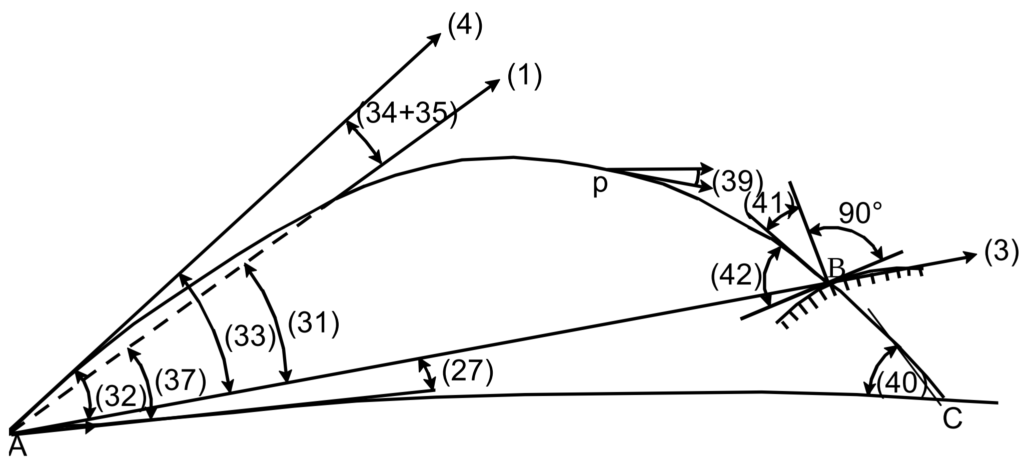

Figure B-4

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DESCRIPTION

Complete format Tabular Firing Tables shall conform to the conditions specified below. Abridged format firing tables for each charge system shall be prepared in the format of Annex V.

a. **Dimensions**

The overall width and length of the firing table should be approximately that of the international paper size A5 i.e. 148mm × 210mm.

b. **Layout**

(1) Indexing is to be provided to give easy access to charge and other sections.
(2) Conventional algebraic signs are to be used throughout the tables.
(3) Values with negative signs should be printed in red italics in those tables specified in paragraph c.(3) below.
(4) Shading and distinctive markings are to be used in those tables specified in paragraph c.(3) below.

c. **Contents**

(1) Title page

The title page is to contain the following information:

(a) Nomenclature of the cannon.

(b) List of appropriate ammunition.

(c) Standard conditions on which the data are based.

(d) Table of contents.

(2) Introduction

The introduction is to contain the following information:

(a) A list of symbols and abbreviations used in the firing tables. NATO approved symbols are to be used where possible (see annex D for terminology and symbols).

(b) Details of weapon characteristics (see annex E).

(c) A table of projectile/fuze combinations and weights, obtained from AOP-29.

(d) A table of equivalent full charge service rounds.

(e) A table of wear data.

(f) A charge selection table (see annex F).

(g) Details of the drag and ballistic coefficients used in the construction of the tables or reference to documents containing such information.

(h) Details of the values of the perturbations used in the calculation of the bilinear corrections given in the tables.

(i) Other information according to national preferences

(3) Part 1 Tables

The Part 1 tables, titled “Tables for the Reference Projectile”, contain Tables A to K. These tables give data for each charge for the principal projectile of a family (usually high explosive HE).

The title page of each section containing the tables for a given charge should give the standard muzzle velocity for which the tables are constructed, the appropriate jump and any other relevant information such as limitation on elevation.

The Part 1 tables are:

TABLE A MET Line Number as a function of Quadrant Elevation (see annex G)

TABLE B Complementary Range (or Complementary Elevation) and MET Line Number (see annex H)

Correction to range (or elevation) for difference in altitude of target and gun, and MET Line Number to be used. For the definition of MET Line Number see STANAG 4061. The limits of “Difference in Altitude of Target and Gun" shown in the Annex may be changed according to national preference. Also the number of lines in each block of data in this and other tables shown in the annexes is a matter of national preference. Both the sign and value of negative numbers should be printed in red italics. A distinctive marking is to be used to separate MET Line Numbers and a different distinctive marking to separate data for low angle from that for high angle.

TABLE C Wind Components (see annex I)

Cross and range wind components of a one-knot wind.

TABLE D Ballistic Air Temperature and Ballistic Air Density Correction (see annex J)

Corrections to ballistic temperature and ballistic density to compensate for the difference in altitude between battery and meteorological datum plane (MDP).

TABLE E Propellant Temperature (see annex K).

Effects on muzzle velocity due to propellant temperature. Both the sign and value of negative numbers should be printed in red italics.

TABLE F Basic Data and Corrections (see annexes L, M and N)

Basic data for standard conditions and corrections to bearing are given in Table F(i) and corrections to range for non-standard conditions in Tables F(ii) and F (iii) for rocket-assist and base-bleed projectiles. Each page of Table F(ii) should appear opposite the corresponding page of Table F(i). Both the sign and value of negative numbers should be printed in red italics. Columns indicated by shading in the example at annex M are to be distinctively marked. A distinctive marking is to be used to separate the data for low angle and high angle fire.

TABLE G Supplementary Data (see annex O)

Probable errors and other terminal data. Both the sign and value of negative numbers should be printed in red italics. A distinctive marking is to be used to separate data for low angle and high angle fire.

TABLE H Rotation of the Earth - Range (see annex P)

Correction to range to compensate for the rotation of the earth. A distinctive marking is to be used to separate data for low angle and high angle fire.

TABLE I Rotation of the Earth - Bearing (see annex Q)

Corrections to bearing to compensate for the rotation of the earth. Tables for each 10 degrees of latitude up to 70 degrees are to be given. A distinctive marking is to be used to separate data for low angle and high angle fire.

TABLE J Corrections to Fuze Setting for non-standard conditions (see annex R)

Correction for non-standard conditions to be applied to the fuze setting corresponding to the corrected elevation. Both the sign and value of negative numbers should, if possible, be printed in red. Columns indicated by shading in the example at annex R are to be distinctively marked.

TABLE K Data for alternative Fuzes (see annex S)

Fuze settings or correction for alternative fuses. Both the sign and value of negative numbers should be printed in red italics.

(4) Part 2 Tables

Data for other types of projectile, having ballistics differing from the principal projectiles is included in Part 2 of the tabular tables, titled “Additional tables for specific projectiles”. Firing Data for illuminating shells, where these are to be included, should be given in Part 2 in the form shown in the example given in annex T. Columns indicated by shading in the example at annex T are to be distinctively marked. Firing data for cargo (submunition) projectiles are to be provided in one of the two format options described in annex U.

(5) Appendices

(a) Other information, such as Trajectory Charts and a World Time Zone Map, which may be required according to national preference, should normally be included in appendices but may be added to particular tables where more appropriate.

(b) If, in the case of a radically different weapon or ammunition, it is impracticable to use the standard format described in paragraph 1, the developing country may modify the format as necessary. The modified format should conform, as closely as possible, to the standard.

TERMINOLOGY AND SYMBOLS

English	Français	Symbol
Accuracy	Justesse	j (subscript)
Altitude	Altitude	ALT
Angle	Angle	A
Angle of Bearing	Azimut, Gisement	A_{BG}
Angle of Departure	Angle de projection (départ)	A_o
Angle of Elevation (Firing Table Elevation)	Angle de hausse Hausse des tables	A_E
Angle of Fall (Angle of Descent)	Angle de chute	A_ω
Angle of Jump	Angle de relèvement	A_j
Angle of Projection	Angle de projection	A_p
Angle of Sight (Site)	Angle de site	A_S
Angle of Tangent Elevation	Angle de hausse	A_{TE}
Ballistic	Balistique	B (subscript)
Ballistic Air Temperature	Température balistique (de l'air)	T_B
Ballistic Air Density	Densité balistique (de l'air)	D_B
Ballistic Wind	Vent balistique	W_B
Base Detonating	Fusée de culot	BD
Bearing	Azimut, Gisement	BG (subscript)
Burst	Éclatement	b (subscript)
Change	Variation	Δ
Charge	Charge	CH
Complementary Angle of Site	Angle complémentaire de site	A_{CS}
Complementary Range	Correction complémentaire de site (distance)	$\Delta_C X_{CS}$
Concrete Piercing	Anti-béton	CP
Correction	Correction	C (subscript)
Cross	Latéral	Z (subscript)

English	Français	Symbol
Cross Wind	Vent latéral	W_Z
Decrease	Diminution	DEC
Deflection	Déviation latérale	DEF
Degree Centigrade	Degré centigrade	°C
Degree Fahrenheit	Degré Fahrenheit	°F
Degrees	Degrés	DEG
Density (Air)	Densité (de l'air)	D
Distance at a given level (Range)	Portée	X
Drift	Dérivation	A_d
Effect	Effet (Altération)	EF (subscript)
Following Wind (or Tail Wind)	Vent Arrière	$\underline{W}$
Fork	Fourchette	F
Fuze Setting	Event	FS
Head Wind	Vent debout	$\overline{W}$
Height	Dénivelée	Y
Inches	Not Used (Pouce)	IN
Increase	Augmentation	INC
Jump	Relèvement	A_J
Kilogram	Kilogramme	KG
Knot	Nœud	KT
Latitude	Latitude	La
Left	Gauche	L
Length	Plus	+
Less	Moins	-
Line Number	Numéro de ligne	LN
Loss	Diminution	-

English	Français	Symbol
Low Level Wind	Vent de surface	W_s
Mass	Masse	MASS
Maximum Ordinate (Vertex Height)	Flèche	Y_s
Mechanical Time	Mécanique à temps	MT
Mechanical Time & Super Quick	Mécanique à temps et instantanée	MTSQ
Meteorological	Météorologique	MET
Meteorological Datum Plane	Niveau de la station météorologique	MDP
Meter (metre)	Mètre	M
Meter (metre) per second	Mètre par seconde	M/S
Mil	Millième	MIL
More	Plus	+
Muzzle Velocity	Vitesse initiale	V_o
NATO	OTAN	NATO/OTAN
North	Nord	N
Origin	Origine	o (subscript)
Percent	Pourcent	%
Perturbation	Perturbation	Δ
Pound	Not used (Livre)	LB
Precision (Consistency)	Précision	p (subscript)
Pressure	Pression	P
Probable Error	Écart probable	E
Projectile	Projectile	PROJ
Projectile Deflection	Déviation latérale du projectile	DEF_{PROJ}
Projectile Mass	Masse du projectile	m_{PROJ}
Propellant	Poudre propulsive	pp
Propellant Temperature	Température de la poudre	T_{pp}

English	Français	Symbol
Propellant Mass	Masse de la poudre	m_{pp}
Quadrant Elevation	Angle au Niveau (Angle d'inclinaison)	A_{QE}
Range	Portée	X
Range for no function of rocket motor or base-burn	Portée en cas du non-fonctionnement du moteur roquette ou du culot à réduction de traînée	$X_{NO\text{-}MOT}$
Range for no fuze function	Portée en cas du non-fonctionnement de la fusée	$X_{NO\text{-}FUZE}$
Range Wind	Vent longitudinal	W_X
Right	Droit	R
Rise	Plus	+
Rotation of the Earth	Vitesse de rotation de la terre	ROT
Second	Seconde	S
Shorten	Moins	-
Slant Range	Distance oblique (suivant le site)	SR
South	Sud	S
Square	Carreau	SQ (□)
Standard	Standard	STD
Surface Air Pressure	Pression au Sol	P_o
Tail Wind (or Following Wind)	Vent arrière	$\underline{W}$
Tangent Elevation	Angle de hausse	A_{TE}
Target	Objectif	TGT
Temperature	Température	T
Terminal (fall)	De chute	ω (subscript)
Time of Flight	Durée de trajet (temps de vol)	TOF
Total Angle of Site	Angle de site total	A_{TS}
Travel Time	Temps de passage	TT
Variable Time	de proximité	VT
Variation	Variation	Δ

English	Français	Symbol
Velocity	Vitesse	V
Velocity at Graze (Remaining Velocity)	Vitesse au point de chute (vitesse restante)	V_ω
Vertex	Sommet	s (subscript)
(Vertex Height) Maximum Ordinate	Flèche	Y_s
Wind	Vent	W

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WEAPON CHARACTERISTICS

A table is to be provided with essential information on the weapon, the reference projectile and the reference fuze. An example of such a table is shown below.

CANNON	M111
CARRIAGE	Howitzer, M123456 Series
CALIBRE	155 MM
TWIST AT THE MUZZLE	1 turn in 20 calibres
LENGTH OF RIFLING	6000 MM
TOTAL TRAVERSE	6400 MIL
MAXIMUM ELEVATION	1300 MIL
MINIMUM ELEVATION	-32 MIL
CHANGE IN ELEVATION FOR ONE TURN OF ELEVATING HANDWHEEL	6 MIL
REFERENCE PROJECTILE	HE M333
MASS OF REFERENCE PROJECTILE	42.415 KG
MASS FOR ONE-SQUARE CORRECTION	0.513 KG
REFERENCE FUZE	PD M888
MASS OF REFERENCE FUZE	0.785 KG

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CHARGE SELECTION TABLE

The charge selection table provides the probable error in range when firing single lots of propellant. The purpose of the table is to allow for selection of the charge providing the lowest probable error in range for the desired range to target (shaded cells).

CHARGE SELECTION TABLE

RANGE (X)	PROBABLE ERROR IN RANGE (E_X) CHARGE (CH)						
	1	2	3	4	5	6	7
M	M	M	M	M	M	M	M
1000	5	5	5	6	5	4	3
2000	9	11	9	12	10	7	6
3000	14	15	13	18	15	10	9
4000		20	18	23	20	13	11
5000			23	29	24	16	13
6000				34	30	19	15
7000					35	21	17
8000						24	19
9000						26	21
10000							23
11000							25

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TABLE A – LINE NUMBERS OF BALLISTIC METEOROLOGICAL MESSAGE

Table A gives the line numbers of the ballistic meteorological message (STANAG 4061) as a function of quadrant elevation. The line numbers correspond to predetermined standard heights. If quadrant elevation is known, or can be reasonably inferred, Table A should be used for line number determination. Otherwise, line numbers may be obtained from Table B as a function of range and height of target above the gun.

TABLE A
LINE NUMBERS OF BALLISTIC METEOROLOGICAL MESSAGE

PROJ, HE, M111 **CHARGE 5**
FUZE, PD, M222 **V_0 = 317.2 M/S**

QUADRANT ELEVATION (A_{QE})	LINE NUMBER (LN)
MIL	
0.0 - 146.1	0
146.2 - 281.0	1
281.1 - 424.6	2
424.7 - 567.6	3
567.7 - 695.1	4
695.2 - 878.0	5
878.1 - 1143.6	6
1143.7 – 1244.9	7

NOTE - WHEN THE PROJECTILE MUST HIT THE TARGET ON THE ASCENDING BRANCH OF THE TRAJECTORY, USE HEIGHT OF TARGET IN METERS TO ENTER THE TABLE ON PAGE[1] …….. TO DETERMINE THE LINE NUMBER

[1] The page number depends upon the specific firing table.

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TABLE B - COMPLEMENTARY RANGE AND MET LINE NUMBER

Table B has the range corrections corresponding to the complementary angle of sight, and line numbers of the meteorological message. The range corrections are tabulated as a function of range and height of target above the gun. For a target at some height other than zero, the complementary range correction is added to the map range to obtain a range to be used for entering Table F. The line number is tabulated in the margin of the table. Each particular line number is applicable to all target points lying between the thick dividing lines containing that number.

TABLE B
COMPLEMENTARY RANGE AND MET LINE NUMBER

CHANGE IN RANGE, IN METERS,
TO CORRECT FOR COMPLEMENTARY ANGLE OF SITE
LINE NUMBERS OF BALLISTIC METEOROLOGICAL MESSAGE
($\Delta_c X_{CS}$ and LN)

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

LINE NUMBER (LN)	RANGE (X)	DIFFERENCE IN ALTITUDE OF TARGET AND GUN IN METERS (ΔALT TGT – GUN)								
	M	-400	-300	-200	-100	0	100	200	300	
	0					0				
	100					0				
	200					0				
	300					0	4	4		
	400					0	4	4	5	
	500			-2		0	4	4	5	
	600			-4	-1	0	5	6	5	
	700		-8	-5	-2	0	5	7	6	
	800		-9	-6	-3	0	5	9	9	
	900	-14	-11	-7	-3	0	6	10	12	
	1000	-16	-12	-8	-4	0	7	11	14	
	1100	-18	-14	-9	-4	0	7	12	17	
00	1200	-20	-15	-10	-5	0	8	14	19	01
	1300	-22	-17	-11	-5	0	8	15	21	
	1400	-24	-18	-12	-5	0	9	17	23	
	1500	-26	-20	-13	-6	0	10	18	26	
	1600	-28	-21	-14	-6	0	11	19	28	
	1700	-30	-23	-15	-7	0	12	21	30	
	1800	-32	-24	-16	-7	0	12	22	32	
	1900	-34	-25	-17	-7	0	13	24	35	
	2000	-36	-27	-17	-7	0	14	26	37	
	2100	-38	-28	-18	-8	0	15	27	39	
	2200	-39	-30	-19	-8	0	16	29	35	
	2300	-41	-31	-20	-8	0	17	21	29	
	2400	-43	-32	-21	-8	0	13	25	31	
	2500	-45	-34	-21	-9	0	13	26	34	
		00					01			

TABLE B
COMPLEMENTARY RANGE AND MET LINE NUMBER

CHANGE IN RANGE, IN METERS,
TO CORRECT FOR COMPLEMENTARY ANGLE OF SITE
LINE NUMBERS OF BALLISTIC METEOROLOGICAL MESSAGE
($\Delta_c X_{CS}$ and LN)

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

DIFFERENCE IN ALTITUDE OF TARGET AND GUN IN METERS (ΔALT TGT – GUN)							RANGE (X)	LINE NUMBER (LN)
400	500	600	700	800	900	1000	M	
							0	03
							100	
							200	
							300	
5							400	
6	7	8	10	13	16		500	
7	10	11	14	18	21	23	600	
9	13	14	18	22	26	28	700	
11	15	17	22	26	31	33	800	
13	18	21	26	30	35	49	900	
15	21	25	30	34	40	54	1000	
17	23	28	33	38	45	60	1100	
19	26	31	37	42	50	66	1200	
21	28	34	41	46	56	71	1300	
23	31	37	45	50	61	76	1400	
25	34	40	49	54	66	82	1500	
27	37	43	54	59	71	87	1600	
29	40	47	58	63	76	92	1700	
31	42	50	62	67	80	97	1800	
33	44	53	66	71	85	102	1900	
35	47	56	70	75	90	107	2000	
37	50	59	75	79	96	113	2100	
39	53	62	79	84	100	118	2200	
41	56	65	83	89	105	123	2300	
43	58	68	87	93	109	128	2400	
45	61	70	91	98	114	133	2500	
02				03				

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TABLE C - WIND COMPONENTS

Table C has the components of a one knot wind, blowing from the chart direction, divided into two components: the cross wind, perpendicular to the plane of fire, and the range wind, parallel to the plane of fire. These components are to be multiplied by the wind speed from the appropriate line of the meteorological message to obtain the total cross and range wind to be used in a particular fire mission.

As shown on the next pages, there are two alternative forms for Table C:

- Alternative 1 ; see page I – 2
- Alternative 2 ; see page I – 3

TABLE C
WIND COMPONENTS
COMPONENTS OF A ONE-KNOT WIND

PROJ, HE, M111 **CHARGE 5**
FUZE, PD, M222 **V_0 = 317.2 M/S**

CHART DIRECTION OF WIND	CROSS WIND (W_Z)	RANGE WIND (W_X)	CHART DIRECTION OF WIND	CROSS WIND (W_Z)	RANGE WIND (W_X)
MIL	KT	KT	MIL	KT	KT
0	0	H1.00	3200	0	T1.00
100	R0.10	H0.99	3300	L0.10	T0.99
200	R0.20	H0.98	3400	L0.20	T0.98
300	R0.29	H0.96	3500	L0.29	T0.96
400	R0.38	H0.92	3600	L0.38	T0.92
500	R0.47	H0.88	3700	L0.47	T0.88
600	R0.56	H0.83	3800	L0.56	T0.83
700	R0.63	H0.77	3900	L0.63	T0.77
800	R0.71	H0.71	4000	L0.71	T0.71
900	R0.77	H0.63	4100	L0.77	T0.63
1000	R0.83	H0.56	4200	L0.83	T0.56
1100	R0.88	H0.47	4300	L0.88	T0.47
1200	R0.92	H0.38	4400	L0.92	T0.38
1300	R0.96	H0.29	4500	L0.96	T0.29
1400	R0.98	H0.20	4600	L0.98	T0.20
1500	R0.99	H0.10	4700	L0.99	T0.10
1600	R1.00	0	4800	L1.00	0
1700	R0.99	T0.10	4900	L0.99	H0.10
1800	R0.98	T0.20	5000	L0.98	H0.20
1900	R0.96	T0.29	5100	L0.96	H0.29
2000	R0.92	T0.38	5200	L0.92	H0.38
2100	R0.88	T0.47	5300	L0.88	H0.47
2200	R0.83	T0.56	5400	L0.83	H0.56
2300	R0.77	T0.63	5500	L0.77	H0.63
2400	R0.71	T0.71	5600	L0.71	H0.71
2500	R0.63	T0.77	5700	L0.63	H0.77
2600	R0.56	T0.83	5800	L0.56	H0.83
2700	R0.47	T0.88	5900	L0.47	H0.88
2800	R0.38	T0.92	6000	L0.38	H0.92
2900	R0.29	T0.96	6100	L0.29	H0.96
3000	R0.20	T0.98	6200	L0.20	H0.98
3100	R0.10	T0.99	6300	L0.10	H0.99
3200	0	T1.00	6400	0	H1.00

TABLE C
WIND COMPONENTS
COMPONENTS OF A ONE-KNOT WIND

PROJ, HE, M111 | **CHARGE 5**
FUZE, PD, M222 | **V_0 = 317.2 M/S**

CHART DIRECTION OF WIND	CROSS WIND (W_Z) (R)	RANGE WIND (W_X) ($\overline{W}$)	($\underline{W}$)	CHART DIRECTION OF WIND	CROSS WIND (W_Z) (L)	RANGE WIND (W_X) ($\overline{W}$)	($\underline{W}$)
MIL	KT	KT	KT	MIL	KT	KT	KT
0	0.00	1.00		3200	0.00		1.00
100	0.10	0.99		3300	0.10		0.99
200	0.20	0.98		3400	0.20		0.98
300	0.29	0.96		3500	0.29		0.96
400	0.38	0.92		3600	0.38		0.92
500	0.47	0.88		3700	0.47		0.88
600	0.56	0.83		3800	0.56		0.83
700	0.63	0.77		3900	0.63		0.77
800	0.71	0.71		4000	0.71		0.71
900	0.77	0.63		4100	0.77		0.63
1000	0.83	0.56		4200	0.83		0.56
1100	0.88	0.47		4300	0.88		0.47
1200	0.92	0.38		4400	0.92		0.38
1300	0.96	0.29		4500	0.96		0.29
1400	0.98	0.20		4600	0.98		0.20
1500	1.00	0.10		4700	0.99		0.10
1600	1.00	0.00		4800	1.00		0.00
1700	1.00		0.10	4900	1.00	0.10	
1800	0.98		0.20	5000	0.98	0.20	
1900	0.96		0.29	5100	0.96	0.29	
2000	0.92		0.38	5200	0.92	0.38	
2100	0.88		0.47	5300	0.88	0.47	
2200	0.83		0.56	5400	0.83	0.56	
2300	0.77		0.63	5500	0.77	0.63	
2400	0.71		0.71	5600	0.71	0.71	
2500	0.63		0.77	5700	0.63	0.77	
2600	0.56		0.83	5800	0.56	0.83	
2700	0.47		0.88	5900	0.47	0.88	
2800	0.38		0.92	6000	0.38	0.92	
2900	0.29		0.96	6100	0.29	0.96	
3000	0.20		0.98	6200	0.20	0.98	
3100	0.10		0.99	6300	0.10	0.99	
3200	0.00		1.00	6400	0.00	1.00	

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TABLE D - BALLISTIC AIR TEMPERATURE AND BALLISTIC AIR DENSITY CORRECTIONS

Table D lists the corrections to be added to the ballistic air temperature and the ballistic air density to compensate for the difference in altitude between the firing battery and the meteorological datum plane (MDP).

As shown on the next pages, there are two alternative forms for Table D:

- Alternative 1 ; see page J – 2
- Alternative 2 ; see page J – 3

TABLE D
BALLISTIC AIR TEMPERATURE AND BALLISTIC AIR DENSITY CORRECTIONS

CORRECTIONS TO TEMPERATURE (T_B) AND DENSITY (D_B), IN PERCENT, TO COMPENSATE FOR THE DIFFERENCE IN ALTITUDE, IN METERS, BETWEEN THE GUN AND THE MET DATUM PLANE (MDP)

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

ΔALT (GUN-MDP)		0	+10-	+20-	+30-	+40-	+50-	+60-	+70-	+80-	+90-
0	$\%\Delta_C T_B$	0.0	0.0	0.0	-0.1+	-0.1+	-0.1+	-0.1+	-0.2+	-0.2+	-0.2+
	$\%\Delta_C D_B$	0.0	-0.1+	-0.2+	-0.3+	-0.4+	-0.5+	-0.6+	-0.7+	-0.8+	-0.9+
+100-	$\%\Delta_C T_B$	-0.2+	-0.2+	-0.3+	-0.3+	-0.3+	-0.3+	-0.4+	-0.4+	-0.4+	-0.4+
	$\%\Delta_C D_B$	-1.0+	-1.1+	-1.1+	-1.2+	-1.3+	-1.4+	-1.5+	-1.6+	-1.7+	-1.8+
+200-	$\%\Delta_C T_B$	-0.5+	-0.5+	-0.5+	-0.5+	-0.5+	-0.6+	-0.6+	-0.6+	-0.6+	-0.7+
	$\%\Delta_C D_B$	-1.9+	-2.0+	-2.1+	-2.2+	-2.3+	-2.4+	-2.5+	-2.6+	-2.7+	-2.8+
+300-	$\%\Delta_C T_B$	-0.7+	-0.7+	-0.7+	-0.7+	-0.8+	-0.8+	-0.8+	-0.8+	-0.9+	-0.9+
	$\%\Delta_C D_B$	-2.8+	-2.9+	-3.0+	-3.1+	-3.2+	-3.3+	-3.4+	-3.5+	-3.6+	-3.7+

NOTES -
1. **ΔALT IS GUN HEIGHT ABOVE OR BELOW THE MDP.**
2. **IF ABOVE THE MDP, USE THE SIGN BEFORE THE NUMBER.**
3. **IF BELOW THE MDP, USE THE SIGN AFTER THE NUMBER.**

TABLE D - BALLISTIC AIR TEMPERATURE AND BALLISTIC AIR DENSITY CORRECTIONS

CORRECTIONS TO TEMPERATURE (T_B) AND DENSITY (D_B), IN PERCENT,
TO COMPENSATE FOR THE DIFFERENCE IN ALTITUDE,
IN METERS, BETWEEN THE GUN AND THE MET DATUM PLANE (MDP)

PROJ, HE, M111 | **CHARGE 5**
FUZE, PD, M222 | **V_0 = 317.2 M/S**

DIFFERENCE IN ALTITUDE BETWEEN GUN AND MET DATUM PLANE (ΔALT(GUN-MDP))	PERCENTAGE CORRECTION TO TEMPERATURE ($\%\Delta_C T_B$)	PERCENTAGE CORRECTION TO DENSITY ($\%\Delta_C D_B$)
0	0.0	0.0
+10	0.0	-0.1
+20	0.0	-0.2
+30	-0.1	-0.3
+40	-0.1	-0.4
+50	-0.1	-0.5
+60	-0.1	-0.6
+70	-0.2	-0.7
+80	-0.2	-0.8
+90	-0.2	-0.9
+100	-0.2	-1.0
+110	-0.2	-1.1
+120	-0.3	-1.1
+130	-0.3	-1.2
+140	-0.3	-1.3
+150	-0.3	-1.4
+160	-0.4	-1.5
+170	-0.4	-1.6
+180	-0.4	-1.7
+190	-0.4	-1.8
+200	-0.5	-1.9
+210	-0.5	-2.0
+220	-0.5	-2.1
+230	-0.5	-2.2
+240	-0.5	-2.3
+250	-0.6	-2.4
+260	-0.6	-2.5
+270	-0.6	-2.6
+280	-0.6	-2.7
+290	-0.7	-2.8
+300	-0.7	-2.8
+310	-0.7	-2.9
+320	-0.7	-3.0
+330	-0.7	-3.1
+340	-0.8	-3.2
+350	-0.8	-3.3
+360	-0.8	-3.4
+370	-0.8	-3.5
+380	-0.9	-3.6
+390	-0.9	-3.7
+400	-0.9	-3.8

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TABLE E - PROPELLANT TEMPERATURE

Table E gives the changes in muzzle velocity produced by variations in the propellant temperature. Whenever possible, the temperature of the propellant itself should be taken, rather than assuming that it is the same as air temperature. The velocity effect obtained from this table is converted to a range correction by use of columns 10 or 11 in Table F(ii).

TABLE E
PROPELLANT TEMPERATURE

EFFECT ON MUZZLE VELOCITY BY PROPELLANT TEMPERATURE

PROJ, HE, M111 | **CHARGE 5**
FUZE, PD, M222 | **V_0 = 317.2 M/S**

PROPELLANT TEMPERATURE (T_{pp})	EFFECT ON MUZZLE VELOCITY (ΔV_0)	PROPELLANT TEMPERATURE (T_{pp})	EFFECT ON MUZZLE VELOCITY (ΔV_0)
ºC	M/S	ºF	M/S
-50	-9.5	-60	-9.7
-45	-8.7	-50	-8.8
-40	-8.0	-40	-8.0
-35	-7.3	-30	-7.2
-30	-6.6	-20	-6.4
-25	-5.9	-10	-5.7
-20	-5.2	0	-4.9
-15	-4.5	10	-4.2
-10	-3.9	20	-3.4
-5	-3.2	30	-2.7
0	-2.6	40	-2.0
5	-1.9	50	-1.3
10	-1.3	60	-0.6
15	-0.7	70	0.0
20	-0.1	80	0.7
25	0.5	90	1.3
30	1.0	100	1.9
35	1.6	110	2.5
40	2.2	120	3.2
45	2.7	130	3.8
50	3.3	140	4.3
55	3.8		
60	4.3		

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TABLE F(i) - BASIC DATA AND CORRECTIONS TO BEARING

Table F is a compilation of the data required for the solution of the gunnery problem. The data are arranged in nine and eleven columns in Tables F(i) and F(ii) respectively, each of which gives values for the various quantities as functions of the range tabulated in the first column of each table. Since all of these quantities have been computed for a target at the point of graze, Table F applies primarily to targets at the same altitude as the gun. In it may be found sufficient information to produce a burst on a target at the point of graze. For targets above or below the point of graze, Table F is entered with a range first determined from Table B.

Following is an explanation of the contents of each column of Tables F(i).

Column 1 – Range

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to a target at the point of graze.

Column 2 – Quadrant Elevation

The angle of the gun in the vertical plane required to reach the range tabulated in column 1 in standard conditions. The maximum elevation shown represents the highest angle at which predictable projectile flight is possible under standard conditions of meteorology and material. This number varies with non-standard conditions of meteorology and material and is particularly sensitive to changes in range wind.

Column 3 – Fuze Setting for Graze Burst

Numbers to be set on fuzes that will produce a graze burst at the point of graze when firing under standard conditions. This setting will produce a burst at the time of flight listed in column 7.

Column 4 – Correction to Fuze Setting to Change Height of Burst down by 10 meters

The adjustment to fuze setting required to decrease the height of burst 10 meters. To increase the height of burst 10 meters, change the sign of the value given in the table.

Column 5 – Effect on Range for Increase of 1 MIL in Quadrant Elevation

The change in range corresponding to a one MIL increase in the quadrant elevation.

Column 6 – Fork

The change in the angle of elevation necessary to produce a change in range at the point of graze equivalent to four probable errors in range.
.

Column 7 – Time of Flight

The projectile travel time, under standard conditions, from the muzzle to the point of graze at the range in column 1.

Columns 8-9 – Corrections to Bearing

The angular changes in the horizontal plane necessary to compensate for a departure of the projectile from the vertical plane of fire. Any deviation of the projectile from the vertical plane of fire is considered a deflection effect. The corrections tabulated in columns 8 and 9 are used in determining the change in the traverse angle needed to offset the effects of drift and cross wind, two of the phenomena which create a deflection effect. Although drift exists in a standard trajectory, it is assumed, for simplicity, to be a deflection effect. The correction for drift is to the left (right) for tubes with clockwise (counterclockwise) rifling. Most tubes have clockwise rifling.

Column 8 – Correction to Bearing for Drift

Because of the right hand twist of the barrel, the drift of the projectile is to the right of the vertical plane of fire. This drift must be compensated for by a correction to the left.

Column 9 – Correction to Bearing for One Knot Cross Wind

Ballistic cross wind components may be from either the right or left, and the weapon must be traversed into the cross wind to compensate for the deflection effect (to the right for a cross wind blowing from the right of the plane of fire, to the left for a cross wind blowing from the left). In the wind components (Table C), the directions of the bearing corrections (right and left) are indicated by the letters R and L.

TABLE F (i)
BASIC DATA AND CORRECTIONS TO BEARING

PROJ, HE, M111 **CHARGE 5**
FUZE, PD, M222 **V_0 = 317.2 M/S**

1	2	3	4	5	6	7	8	9
RANGE	QUADRANT ELEVATION FOR STANDARD CONDITIONS	FUZE SETTING FOR GRAZE BURST	CORRECTION TO FUZE SETTING TO CHANGE HEIGHT OF BURST DOWN BY 10M	EFFECT ON RANGE FOR INCREASE OF ONE MIL IN ELEVATION	FORK	TIME OF FLIGHT	CORRECTIONS TO BEARING ($\Delta_C A_{BG}$)	
							DRIFT (CORRECTION TO LEFT)	1 KNOT CROSSWIND
(X)	(A_{QE})	(FS)	($\Delta_C FS$/ -10M Y_b)	(ΔX/ 1 MIL A_{QE})	(F)	(TOF)	(A_d)	(1KT W_z)
M	MIL			M	MIL	S	MIL	MIL
0	0.0				0	0.0	0.0	0.00
100	5.1	0.3	1.24		0	0.3	0.1	0.00
200	10.0	0.7	1.10		0	0.7	0.2	0.00
300	15.0	1.1	0.97		0	1.1	0.3	0.00
400	20.1	1.3	0.93	20	0	1.3	0.2	0.02
500	25.2	1.6	0.84	19	0	1.6	0.3	0.02
600	30.4	1.9	0.77	19	1	1.9	0.3	0.03
700	35.6	2.3	0.70	19	1	2.3	0.4	0.03
800	40.9	2.6	0.64	19	1	2.6	0.4	0.04
900	46.1	2.9	0.59	19	1	2.9	0.5	0.04
1000	51.5	3.3	0.55	19	1	3.3	0.5	0.05
1100	56.8	3.6	0.51	19	1	3.6	0.6	0.05
1200	62.2	3.9	0.47	18	1	3.9	0.7	0.06
1300	67.7	4.3	0.44	18	1	4.3	0.7	0.06
1400	73.2	4.6	0.41	18	1	4.6	0.8	0.06
1500	78.8	5.0	0.39	18	2	5.0	0.8	0.07
1600	84.3	5.3	0.37	18	2	5.3	0.9	0.07
1700	90.0	5.6	0.35	18	2	5.6	1.0	0.08
1800	95.7	6.0	0.33	17	2	6.0	1.1	0.08
1900	101.4	6.3	0.31	17	2	6.3	1.1	0.09
2000	107.2	6.7	0.30	17	2	6.7	1.2	0.09
2100	113.1	7.1	0.28	17	3	7.1	1.3	0.09
2200	118.9	7.4	0.27	17	3	7.4	1.3	0.10
2300	124.9	7.8	0.26	17	3	7.8	1.4	0.10
2400	130.9	8.1	0.25	17	3	8.1	1.5	0.11
2500	136.7	8.5	0.24	17	3	8.5	1.6	0.11

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TABLE F(ii) - CORRECTIONS TO RANGE FOR NON-STANDARD CONDITIONS

Table F is a compilation of the data required for the solution of the gunnery problem. The data are arranged in nine and eleven columns in Tables F(i) and F(ii) respectively, each of which gives values for the various quantities as functions of the range tabulated in the first column of each table. Since all of these quantities have been computed for a target at the point of graze, Table F applies primarily to targets at the same altitude as the gun. In it may be found sufficient information to produce a burst on a target at the point of graze. For targets above or below the point of graze, Table F is entered with a range first determined from Table B.

Following is an explanation of the contents of each column of Tables F(ii).

Column 1 – Range

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to a target at the point of graze.

Column 10-19 – Correction Factors

Corrections to range to compensate for the effects of non-standard conditions. Although the corrections given in column 10 to 19 are tabulated for a unit decrease and a unit increase in the non-standard conditions, they are actually mean values based on an expected decrease and increase in the non-standard conditions. The columns of corrections for an increase in the non-standard conditions are shaded to aid in identification. A tail wind is considered to be an increase in wind for this purpose.

Columns 10/11 –Range Correction for a Decrease (Increase) of one Metre per Second in Muzzle Velocity

Corrections to range to compensate for variations from the standard muzzle velocity that appears on the title page for each charge.

Columns 12/13 –Range Correction for a Head Wind (Tail Wind) of One Knot

In computing a standard trajectory it is assumed that no wind is blowing. Columns 12/13 give the corrections to range to compensate for the effect of the longitudinal wind (Head Wind or Tail Wind, denoted H and T, or by $\overline{W}$ and $\underline{W}$ in the alternative table, in Table C, respectively).

Columns 14/15 –Range Correction for a Decrease (Increase) of one Percent in Air Temperature

The drag that a projectile encounters is a function of Mach Number (ratio of the velocity of the projectile to the speed of sound). The drag varies appreciably with Mach Number, particularly for transonic flight. Since the speed of sound is a function of air temperature, it follows that changes in air temperature will change the Mach Number, thereby changing the drag and consequently the range. This effect is sometimes called the elasticity effect. It should not be confused with the distinctly separate effect which air temperature produces through its influence on air density.

The elevation tabulated in column 1 is computed in an ICAO standard atmosphere. The real temperature at any given height is recorded and transmitted as a percent of the standard absolute temperature for that height. Columns 14/15 allow to take into account the effect of a decrease (increase) of one percent in air temperature.

Columns 16/17 –Range Correction for a Decrease (Increase) of one Percent in Air Density

Air density affects the drag exerted upon the projectile. Therefore, changes in air density will change the drag and consequently the range.

The elevation tabulated in column 1 is computed in an ICAO standard atmosphere. The real air density at any given height, computed from the real air temperature and air pressure recorded at that height, is transmitted as a percent of the standard absolute density for that height. Columns 16/17 allow to take into account the effect of a decrease (increase) of one percent in air density.

Columns 18/19 – Range Correction for a Decrease (Increase) of one Square in Projectile Mass

The elevation tabulated in column 1 is computed for the standard projectile mass. A decrease in projectile mass increases the muzzle velocity, the effect of which is to increase the range. But it also decreases the ballistic coefficient, the effect of which is to decrease the range. The combined effect may be either an increase or a decrease in range depending upon which individual effect is dominant. Under certain conditions these two effects tend to cancel each other.

TABLE F (ii)
CORRECTIONS TO RANGE FOR NON-STANDARD CONDITIONS

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

1	10	11	12	13	14	15	16	17	18	19
RANGE	RANGE CORRECTIONS ($\Delta_c X$)									
(X)	MUZZLE VELOCITY (V_0) (1 M/S)		RANGE WIND (W_X) (1 KT)		BALLISTIC AIR TEMPERATURE (T_B) (1%)		BALLISTIC AIR DENSITY (D_B) (1%)		PROJ MASS (2 SQ STD) (1 SQ)	
	DEC (-)	INC (+)	HEAD ($\overline{W}$)	TAIL ($\underline{W}$)	DEC (-)	INC (+)	DEC (-)	INC (+)	DEC (-)	INC (+)
M	M	M	M	M	M	M	M	M	M	M
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
100	0.7	-0.7	0.1	0.0	0.1	0.0	0.0	0.0	-2	2
200	1.4	-1.5	0.1	0.0	0.2	0.0	0.0	0.0	-3	3
300	2.1	-2.2	0.1	0.0	0.3	-0.1	-0.1	0.1	-4	4
400	2.4	-2.4	0.2	-0.1	0.4	-0.1	-0.1	0.1	-4	4
500	2.9	-3.0	0.2	-0.1	0.5	-0.2	-0.1	0.1	-5	5
600	3.5	-3.5	0.3	-0.1	0.6	-0.3	-0.1	0.1	-6	6
700	4.0	-4.1	0.4	-0.1	0.8	-0.3	-0.2	0.2	-7	7
800	4.5	-4.6	0.5	-0.2	1.0	-0.4	-0.2	0.2	-8	8
900	5.1	-5.1	0.6	-0.2	1.2	-0.5	-0.3	0.3	-8	8
1000	5.6	-5.6	0.7	-0.3	1.4	-0.6	-0.4	0.4	-9	9
1100	6.1	-6.0	0.8	-0.3	1.7	-0.7	-0.4	0.4	-10	10
1200	6.6	-6.5	1.0	-0.4	1.9	-0.8	-0.5	0.5	-11	11
1300	7.1	-7.0	1.1	-0.4	2.1	-1.0	-0.6	0.6	-11	11
1400	7.6	-7.4	1.2	-0.5	2.4	-1.1	-0.7	0.7	-12	12
1500	8.1	-7.9	1.3	-0.5	2.7	-1.2	-0.8	0.7	-12	13
1600	8.5	-8.3	1.5	-0.6	2.9	-1.3	-0.9	0.8	-13	13
1700	9.0	-8.7	1.6	-0.7	3.2	-1.4	-1.0	0.9	-14	14
1800	9.5	-9.2	1.7	-0.7	3.5	-1.6	-1.1	1.0	-14	15
1900	10.0	-9.6	1.9	-0.8	3.8	-1.7	-1.2	1.2	-15	15
2000	10.4	-10.0	2.0	-0.9	4.1	-1.8	-1.3	1.3	-15	16
2100	10.9	-10.4	2.2	-0.9	4.3	-2.0	-1.4	1.4	-16	16
2200	11.3	-10.8	2.3	-1.0	4.6	-2.1	-1.6	1.5	-16	17
2300	11.8	-11.2	2.5	-1.1	4.9	-2.2	-1.7	1.6	-17	17
2400	12.2	-11.6	2.6	-1.2	5.2	-2.4	-1.8	1.8	-17	18
2500	12.7	-12.0	2.8	-1.2	5.5	-2.5	-2.0	1.9	-18	18

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TABLE F(iii) - CORRECTIONS FOR ROCKET-ASSIST MOTOR AND BASE-BLEED UNIT PROPELLANT TEMPERATURES

Table F(iii) contains the corrections in range to compensate for variations in the propellant temperature of the base bleed unit or rocket motor.

Temperatures are expressed in degrees Celsius (°C) and degrees Fahrenheit (°F) as present thermometers use either Celsius or Fahrenheit scales. For historical reasons the reference temperature is set to 70°F.

TABLE F(iii)
CORRECTIONS IN RANGE, IN METERS, TO COMPENSATE FOR VARIATIONS IN PROPELLANT TEMPERATURE OF THE BASE BLEED UNIT OR ROCKET MOTOR
(Δ_c X)

PROJ, HE, M333 | **CHARGE 7**
FUZE, PD, M222 | **V_0 = 715.0 M/S**

RANGE (X)	PROPELLANT TEMPERATURE (T_{pp})							
M	-40°F	-30°F	-20°F	-10°F	0°F	10°F	20°F	30°F
0	0	0	0	0	0	0	0	0
1000	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
3000	0	0	0	0	0	0	0	0
4000	0	0	0	0	0	0	0	0
5000	9	9	9	9	9	8	7	6
6000	104	98	91	83	74	65	55	44
7000	219	200	180	160	139	119	98	78
8000	295	266	238	220	182	154	127	100
9000	339	305	272	239	207	175	144	113
10000	361	325	289	254	219	185	152	120
11000	368	331	294	258	223	189	155	122
12000	365	328	292	256	221	187	154	121
13000	358	321	286	251	217	184	151	119
14000	350	315	280	246	213	181	149	117
15000	344	309	276	242	210	178	146	116
16000	339	305	272	239	207	176	145	115
17000	335	301	268	236	205	174	143	114
18000	331	298	266	234	203	173	143	113
19000	327	295	262	232	201	171	141	112
20000	322	290	259	229	199	169	140	112
	-40°C	-34.4°C	-28.9°C	-23.3°C	-17.8°C	-12.2°C	-6.7°C	-1.1°C

TABLE F(iii)
CORRECTIONS IN RANGE, IN METERS, TO COMPENSATE FOR VARIATIONS IN PROPELLANT TEMPERATURE OF THE BASE BLEED OR ROCKET MOTOR
(Δ_cX)

PROJ, HE, M333 | **CHARGE 7**
FUZE, PD, M222 | **V_0 = 715.0 M/S**

RANGE (X) M	PROPELLANT TEMPERATURE (T_{pp})							
	40°F	50°F	60°F	70°F	80°F	90°F	100°F	110°F
0				0				
1000	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
3000	0	0	0	0	0	0	0	0
4000	0	0	0	0	0	0	0	0
5000	5	4	2	0	-2	-5	-7	-10
6000	34	22	11	0	-11	-22	-33	-43
7000	58	38	19	0	-18	-36	-53	-69
8000	74	49	24	0	-23	-45	-66	-86
9000	84	55	27	0	-26	-51	-75	-97
10000	89	58	29	0	-28	-54	-79	-104
11000	90	59	29	0	-28	-55	-81	-106
12000	90	59	29	0	-28	-55	-82	-107
13000	88	58	29	0	-28	-55	-81	-106
14000	87	58	28	0	-27	-54	-80	-106
15000	86	57	28	0	-27	-54	-80	-105
16000	85	56	28	0	-27	-54	-80	-105
17000	84	55	27	0	-27	-54	-80	-106
18000	84	55	28	0	-27	-54	-80	-106
19000	84	55	27	0	-27	-54	-80	-106
20000	82	55	27	0	-28	-54	-80	-106
	4.4°C	10.0°C	15.6°C	21.1°C	26.7°C	32.2°C	37.8°C	43.3°C

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TABLE G - SUPPLEMENTARY DATA

Tables G(i) and G(ii) provide probable error values and other trajectory information, respectively, for the ranges and quadrant elevations tabulated in Table F(i).

Column 1 – Range

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to a target at the point of graze.

Column 2 – Quadrant Elevation

The angle of the gun in the vertical plane required to reach the range tabulated in column 1 in standard conditions. The maximum elevation shown represents the highest angle at which predictable projectile flight is possible under standard conditions of meteorology and material. This number varies with non-standard conditions of meteorology and material and is particularly sensitive to changes in range wind.

Columns 3-7 – Probable Errors

The probable errors indicate the round to round variation of a single gun fired on a single occasion and the same propellant lot and do not reflect the variation of the mean of either a single gun fired on different occasions or different guns fired on the same occasion.

Column 3 – Probable Error in Range at Graze

A value which, when added to and subtracted from the expected range, will produce an interval, along the line of fire, that should contain 50 percent of the rounds fired. Variations in muzzle velocity, in angle of departure, and in total drag during flight all contribute to the probable error in range to impact.

Column 4 – Probable Error in Deflection at Graze

A value which, when added both to the right and to the left of the expected impact point, will produce an interval, perpendicular to the line of fire at the expected range, that should contain 50 percent of the rounds fired.

Column 5 – Probable Error in Height of Burst

A value which, when added to and subtracted from the expected height of burst, will produce a vertical interval that should contain 50 percent of the rounds fired. The factors that contribute to the probable error in height of burst are not only those that produce dispersion in range to impact, but also those factors that contribute to variations in the functioning of the time fuze.

Column 6 – Probable Error in Time to Burst

A value which, when added to and subtracted from the expected time to burst, will produce a time interval that should contain 50 percent of the rounds fired.

Column 7 – Probable Error in Range to Burst

A value which, when added to or subtracted from the expected range to burst, will produce and interval, along the line of fire that should contain 50 percent of the rounds fired. The factors that contribute to the probable error in range to burst are not only those that produce dispersion in range to impact, but also those factors that contribute to variations in the functioning of the time fuze.

Column 8 – Angle of Descent

The acute angle measured from the horizontal to a line tangential to the trajectory at the point of graze.

Column 9 – Cotangent of Angle of Descent

The trigonometric cotangent function of the angle of descent given in column 8.

Column 10 – Remaining Velocity

The speed of the projectile at the point of graze.

Column 11 – Vertex Height

The maximum height of a trajectory fired under standard conditions by a gun at sea level.

Columns 12/13 – Complementary Angle of Site for one MIL Angle of Site

The correction, which must be added algebraically to the actual angle of site to compensate for the non-rigidity of the trajectory. Use column 12 when the target is above the gun in altitude, column 13 when the target is below the gun.

Column 14 – Range for Non-functioning of Rocket Motor or Base Bleed Unit

The range that will be achieved if the on-board rocket motor or Base-Bleed Unit does not function.

TABLE G(i)
SUPPLEMENTARY DATA – PROBABLE ERRORS

PROJ, HE, M333 **CHARGE 7**
FUZE, PD, M222 **V_0 = 715.0 M/S**

1	2	3	4	5	6	7
RANGE	QUADRANT ELEVATION FOR STANDARD CONDITIONS	PROBABLE ERRORS				
				FUZE M555		
		RANGE	DEFLECTION	HEIGHT OF BURST	TIME TO BURST	RANGE TO BURST
(X)	(A_{QE})	(E_X)	(E_Z)	(E_{Yb})	(E_{tb})	(E_{Xb})
M	MIL	M	M	M	S	M
0	0.0	3	0	1	0.04	
500	22.1	3	0	1	0.04	
1000	47.3	4	1	1	0.04	11
1500	73.4	5	1	1	0.04	11
2000	102.5	7	1	2	0.04	11
2500	128.7	8	1	2	0.04	11
3000	155.3	10	2	2	0.04	11
3500	187.2	11	2	2	0.04	12
4000	221.5	13	2	2	0.04	12

TABLE G(ii)

SUPPLEMENTARY DATA – TRAJECTORY INFORMATION

PROJ, HE, M333 **CHARGE 7**
FUZE, PD, M222 **V_0 = 715.0 M/S**

1	8	9	10	11	12	13	14
RANGE	ANGLE OF DESCENT		REMAINING VELOCITY	VERTEX HEIGHT	COMPLEMENTARY ANGLE OF SITE (A_{CS}) FOR ANGLE OF SITE (A_S) OF		RANGE TO IMPACT (NO MOTOR FUNCTION)
	ANGLE	COTANGENT					
(X)	(A_ω)	(Cot A_ω)	(V_ω)	(Y_S)	+1 MIL	-1 MIL	(X_{NO-MOT})
M	MIL		M/S	M	MIL	MIL	M
0			701	0	0.000	0.000	0
500	0		715	0	0.000	0.000	450
1000	24	41.4	694	4	0.001	0.000	950
1500	50	19.9	672	7	0.002	*-0.002*	1400
2000	79	12.8	657	21	0.004	*-0.005*	1900
2500	109	9.2	631	35	0.009	*-0.009*	2350
3000	141	7.1	617	48	0.015	*-0.015*	2850
3500	175	5.7	593	71	0.023	*-0.023*	3300
4000	212	4.7	574	107	0.037	*-0.023*	3700

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J

TABLE H - ROTATION OF THE EARTH - RANGE

Table H gives the range corrections required to offset the effects on range produced by the rotation of the earth.

TABLE H
ROTATION OF THE EARTH - RANGE

CORRECTIONS TO RANGE, IN METERS, TO COMPENSATE FOR THE ROTATION OF THE EARTH
(Δ_c X)

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

RANGE (X)	AZIMUTH OF TARGET $(A_{BG})_{TGT}$ – MIL								
	0 3200	200 3000	400 2800	600 2600	800 2400	1000 2200	1200 2000	1400 1800	1600 1600
M	MIL	MIL	MIL	MIL	MIL	MIL	MIL	MIL	MIL
3000	0	-2+	-5+	-7+	-9+	-10+	-11+	-12+	-12+
3500	0	-3+	-5+	-8+	-10+	-11+	-13+	-13+	-14+
4000	0	-3+	-6+	-8+	-11+	-12+	-14+	-15+	-15+
4500	0	-3+	-6+	-9+	-11+	-14+	-15+	-16+	-16+
5000	0	-3+	-7+	-10+	-12+	-14+	-16+	-17+	-17+
5500	0	-4+	-7+	-10+	-13+	-15+	-17+	-18+	-18+
6000	0	-4+	-7+	-10+	-13+	-16+	-17+	-18+	-19+
6500	0	-4+	-7+	-11+	-13+	-16+	-17+	-19+	-19+
7000	0	-4+	-7+	-10+	-13+	-15+	-17+	-18+	-19+
7500	0	-3+	-7+	-10+	-12+	-14+	-16+	-17+	-17+
********	******	******	******	******	******	******	******	******	******
7500	0	-1+	-3+	-3+	-4+	-5+	-5+	-6+	-6+
7000	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
6500	-1+	0	+1-	+1-	+2-	+2-	+3-	+3-	+3-
6000	-1+	0	+2-	+3-	+4-	+5-	+6-	+6-	+7-
5500	-1+	+1-	+3-	+5-	+6-	+8-	+9-	+9-	+10-
5000	-1+	+1-	+4-	+6-	+8-	+10-	+11-	+12-	+13-
	3200 6400	3400 6200	3600 6000	3800 5800	4000 5600	4200 5400	4400 5200	4600 5000	4800 4800
	AZIMUTH OF TARGET $(A_{BG})_{TGT}$ – MIL								

NOTES
1. WHEN ENTERING FROM THE TOP USE THE SIGN BEFORE THE NUMBER.
2. WHEN ENTERING FROM THE BOTTOM USE THE SIGN AFTER THE NUMBER.
3. AZIMUTH IS MEASURED CLOCKWISE FROM NORTH
4. CORRECTIONS ARE FOR 0 DEGREES LATITUDE. FOR OTHER LATITUDES MULTIPLY CORRECTIONS BY THE FACTOR GIVEN BELOW

LATITUDE (DEG)	10	20	30	40	50	60	70
MULTIPLY BY	.98	.94	.87	.77	.64	.50	.34

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TABLE I - ROTATION OF THE EARTH - AZIMUTH

Table I gives the azimuth corrections required to offset the effects on deflection produced by the rotation of the earth. Tables are given for at least 0 to 70 degrees latitude, both north and south, with an interval of 10 degrees.

TABLE I
ROTATION OF THE EARTH- AZIMUTH

CORRECTIONS TO AZIMUTH, IN MILS, TO COMPENSATE FOR THE ROTATION OF THE EARTH
$(\Delta_c A_{BG})$

PROJ, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

50 DEGREES NORTH LATITUDE

RANGE (X)	AZIMUTH OF TARGET $(A_{BG})_{TGT}$ – MIL								
	0 6400	400 6000	800 5600	1200 5200	1600 4800	2000 4400	2400 4000	2800 3600	3200 3200
M	MIL	MIL	MIL	MIL	MIL	MIL	MIL	MIL	MIL
3000	L0.5R	L0.5R	L0.6R	L0.6R	L0.6R	L0.6R	L0.6R	L0.6R	L0.6R
3500	L0.6R	L0.6R	L0.6R	L0.7R	L0.7R	L0.7R	L0.7R	L0.7R	L0.7R
4000	L0.7R	L0.7R	L0.7R	L0.8R	L0.8R	L0.8R	L0.8R	L0.8R	L0.8R
4500	L0.8R	L0.8R	L0.8R	L0.9R	L0.9R	L0.9R	L0.9R	L1.0R	L1.0R
5000	L0.9R	L0.9R	L0.9R	L1.0R	L1.0R	L1.0R	L1.1R	L1.1R	L1.1R
5500	L1.0R	L1.0R	L1.1R	L1.1R	L1.1R	L1.2R	L1.2R	L1.2R	L1.3R
6000	L1.1R	L1.1R	L1.2R	L1.2R	L1.3R	L1.3R	L1.4R	L1.4R	L1.4R
6500	L1.3R	L1.3R	L1.3R	L1.3R	L1.4R	L1.5R	L1.6R	L1.6R	L1.6R
7000	L1.4R	L1.4R	L1.4R	L1.5R	L1.6R	L1.7R	L1.8R	L1.8R	L1.9R
7500	L1.5R	L1.5R	L1.6R	L1.7R	L1.8R	L1.9R	L2.1R	L2.2R	L2.2R
*******	*******	*******	******	******	******	******	*******	******	******
7500	L1.6R	L1.7R	L1.9R	L2.2R	L2.6R	L2.9R	L3.2R	L3.4R	L3.4R
7000	L1.5R	L1.6R	L1.9R	L2.3R	L2.7R	L3.2R	L3.5R	L3.8R	L3.9R
6500	L1.4R	L1.5R	L1.8R	L2.2R	L2.8R	L3.3R	L3.8R	L4.1R	L4.2R
6000	L1.2R	L1.3R	L1.6R	L2.2R	L2.8R	L3.5R	L4.0R	L4.4R	L4.6R
5500	L1.0R	L1.1R	L1.5R	L2.1R	L2.9R	L3.6R	L4.3R	L4.7R	L4.9R
5000	L0.7R	L0.9R	L1.3R	L2.0R	L2.9R	L3.8R	L4.5R	L5.1R	L5.3R
	3200 3200	2800 3600	2400 4000	2000 4400	1600 4800	1200 5200	800 5600	400 6000	0 6400
	AZIMUTH OF TARGET $(A_{BG})_{TGT}$ – MIL								

50 DEGREES SOUTH LATITUDE

NOTES
1. WHEN ENTERING FROM THE TOP USE THE SIGN BEFORE THE NUMBER.
2. WHEN ENTERING FROM THE BOTTOM USE THE SIGN AFTER THE NUMBER.
3. R DENOTES CORRECTION TO THE RIGHT, L TO THE LEFT.
4. AZIMUTH IS MEASURED CLOCKWISE FROM THE NORTH.

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TABLE J(i) - CORRECTIONS TO FUZE SETTING FOR NON-STANDARD CONDITIONS

Table J lists corrections to fuze settings to compensate for the effects of non-standard conditions. The data are arranged in eleven columns, each of which gives values for the various quantities as functions of the fuze settings tabulated in the first column. Since all of these quantities have been computed for a target at the point of graze, Table J applies primarily to targets at the same altitude as the gun. In it may be found sufficient information to produce a graze burst on a target at the point of graze. For targets above or below the point of graze,Table J is entered with a fuze setting determined from Table F. Although the corrections given in columns 2 to 11 are tabulated for a unit decrease and a unit increase in the non-standard conditions, they are actually mean values based on an expected decrease and increase in the non-standard conditions. A tail wind is considered to be an increase in wind for this purpose.

Below is a listing of the contents of Tables J(i) and J (ii). For a detailed explanation of columns 2 to 11 of Table J(i), see the explanation of columns 2 to 11 in Table F(ii). In these explanations, substitute ‘range corrections’ with ‘fuze setting corrections’. Table J(ii) provides the correction to the fuze setting for non-standard temperatures of a base-bleed unit or rocket motor.

Column 1 Fuze Setting

Columns 2/3 Fuze Setting Correction for a Decrease (Increase) of one Meter per Second in Muzzle Velocity

Columns 4/5 Fuze Setting Correction for a Head Wind (Tail Wind) of One Knot

Columns 6/7 Fuze Setting Correction for a Decrease (Increase) of one Percent in Air Temperature

Columns 8/9 Fuze Setting Correction for a Decrease (Increase) of one Percent in Air Density

Columns 10/11 Fuze Setting Correction for a Decrease (Increase) of one Square in Projectile Mass

TABLE J(i)
FUZE SETTING CORRECTION FACTORS
(Δ_c FS)

PROJ, HE, M111 **CHARGE 5**
FUZE, PD, M222 **V_0 = 317.2 M/S**

1	2	3	4	5	6	7	8	9	10	11
FUZE SETTING (FS)	FUZE SETTING CHANGES FOR									
	MUZZLE VELOCITY (V_0) (1 M/S)		RANGE WIND (W_X) (1 KT)		BALLISTIC AIR TEMPERATURE (T_B) (1%)		BALLISTIC AIR DENSITY (D_B) (1%)		PROJ MASS (2 SQ STD) (1 SQ)	
	DEC (-)	INC (+)	HEAD ($\overline{W}$)	TAIL ($\underline{W}$)	DEC (-)	INC (+)	DEC (-)	INC (+)	DEC (-)	INC (+)
0										
1										
2	-0.006	0.006	0.000	0.000	-0.001	0.000	0.000	0.000	0.010	-0.010
3	-0.009	0.009	-0.001	0.000	-0.001	0.001	0.000	0.000	0.015	-0.015
4	-0.012	0.011	-0.001	0.000	-0.002	0.001	0.000	0.000	0.019	-0.020
5	-0.014	0.014	-0.001	0.000	-0.003	0.001	0.001	-0.001	0.023	-0.024
6	-0.017	0.016	-0.002	0.001	-0.004	0.002	0.001	-0.001	0.027	-0.028
7	-0.020	0.019	-0.002	0.001	-0.006	0.002	0.001	-0.001	0.031	-0.032
8	-0.022	0.021	-0.003	0.001	-0.007	0.003	0.002	-0.002	0.035	-0.035
9	-0.025	0.023	-0.004	0.001	-0.008	0.004	0.002	-0.002	0.038	-0.039
10	-0.027	0.025	-0.004	0.002	-0.010	0.004	0.003	-0.002	0.041	-0.042
11	-0.029	0.028	-0.005	0.002	-0.011	0.005	0.003	-0.003	0.044	-0.046
12	-0.032	0.030	-0.005	0.002	-0.012	0.006	0.004	-0.003	0.047	-0.049
13	-0.034	0.032	-0.006	0.002	-0.014	0.006	0.004	-0.004	0.050	-0.052
14	-0.037	0.034	-0.006	0.003	-0.015	0.007	0.005	-0.005	0.053	-0.055
15	-0.039	0.036	-0.007	0.003	-0.017	0.007	0.005	-0.005	0.056	-0.058
16	-0.041	0.038	-0.008	0.003	-0.018	0.008	0.006	-0.006	0.059	-0.061
17	-0.044	0.040	-0.008	0.003	-0.019	0.008	0.007	-0.006	0.062	-0.064
18	-0.046	0.042	-0.009	0.004	-0.021	0.009	0.007	-0.007	0.064	-0.067
19	-0.049	0.044	-0.009	0.004	-0.022	0.009	0.008	-0.008	0.067	-0.069
20	-0.051	0.046	-0.010	0.004	-0.023	0.010	0.009	-0.009	0.070	-0.072
21	-0.053	0.049	-0.010	0.004	-0.024	0.010	0.010	-0.010	0.072	-0.075
22	-0.056	0.051	-0.011	0.005	-0.025	0.011	0.011	-0.010	0.075	-0.078
23	-0.058	0.053	-0.011	0.005	-0.026	0.011	0.012	-0.011	0.078	-0.080
24	-0.060	0.055	-0.011	0.005	-0.027	0.011	0.012	-0.012	0.081	-0.083
25	-0.063	0.057	-0.012	0.005	-0.028	0.012	0.013	-0.013	0.083	-0.085

TABLE J(ii)

CORRECTIONS TO FUZE SETTING TO COMPENSATE FOR VARIATIONS IN PROPELLANT TEMPERATURE OF THE BASE BLEED OR ROCKET MOTOR
(Δ_c FS)

PROJ, HE, M333 — **CHARGE 7**
FUZE, PD, M222 — **V_0 = 715.0 M/S**

FUZE SETTING (FS)	PROPELLANT TEMPERATURE (T_{pp})							
	-40°F	-30°F	-20°F	-10°F	0°F	10°F	20°F	30°F
55	1.005	0.839	0.674	0.509	0.361	0.212	0.102	0.088
56	1.027	0.841	0.694	0.520	0.375	0.217	0.103	0.089
57	1.048	0.843	0.704	0.531	0.379	0.221	0.104	0.090
58	1.070	0.860	0.727	0.542	0.383	0.226	0.105	0.091
59	1.091	0.884	0.739	0.553	0.389	0.230	0.102	0.093
60	1.113	0.925	0.745	0.565	0.396	0.236	0.115	0.094
61	1.136	0.934	0.755	0.576	0.401	0.241	0.115	0.096
62	1.156	0.956	0.764	0.586	0.412	0.244	0.116	0.097
63	1.177	0.983	0.771	0.596	0.423	0.247	0.116	0.099
64	1.199	0.997	0.779	0.608	0.430	0.252	0.117	0.101
65	1.222	1.020	0.820	0.620	0.437	0.257	0.117	0.103
66	1.242	1.041	0.835	0.629	0.446	0.260	0.118	0.104
67	1.263	1.067	0.851	0.638	0.455	0.264	0.118	0.107
68	1.285	1.084	0.866	0.648	0.468	0.267	0.119	0.113
69	1.308	1.102	0.880	0.660	0.470	0.271	0.119	0.118
70	1.331	1.111	0.891	0.671	0.476	0.276	0.119	0.124
71	1.355	1.131	0.901	0.682	0.476	0.281	0.120	0.125
72	1.378	1.161	0.915	0.694	0.476	0.286	0.120	0.128
73	1.401	1.193	0.936	0.707	0.476	0.292	0.121	0.131
74	1.425	1.201	0.953	0.720	0.476	0.297	0.121	0.135
75	1.451	1.213	0.973	0.733	0.521	0.301	0.121	0.139
76	1.477	1.225	1.002	0.745	0.529	0.305	0.124	0.139
77	1.503	1.237	1.006	0.757	0.536	0.310	0.127	0.140
78	1.528	1.285	1.026	0.769	0.544	0.316	0.120	0.140
79	1.552	1.294	1.036	0.782	0.557	0.322	0.125	0.141
80	1.579	1.316	1.056	0.796	0.562	0.328	0.138	0.142
	-40°C	-34.4°C	-28.9°C	-23.3°C	-17.8°C	-12.2°C	-6.7°C	-1.1°C

TABLE J(ii)
CORRECTIONS TO FUZE SETTING TO COMPENSATE FOR VARIATIONS IN PROPELLANT TEMPERATURE OF THE BASE BLEED OR ROCKET MOTOR
(Δ_c FS)

PROJ, HE, M333 | **CHARGE 7**
FUZE, PD, M222 | **V_0 = 715.0 M/S**

FUZE SETTING (FS)	PROPELLANT TEMPERATURE (T_{pp})							
	40°F	50°F	60°F	70°F	80°F	90°F	100°F	110°F
55	0.062	0.047	0.032	0.000	-0.012	-0.032	-0.062	-0.093
56	0.063	0.048	0.033	0.000	-0.012	-0.032	-0.062	-0.094
57	0.064	0.049	0.034	0.000	-0.013	-0.033	-0.063	-0.096
58	0.065	0.050	0.035	0.000	-0.013	-0.033	-0.063	-0.098
59	0.067	0.052	0.037	0.000	-0.014	-0.034	-0.064	-0.100
60	0.069	0.054	0.039	0.000	-0.011	-0.031	-0.061	-0.101
61	0.071	0.056	0.041	0.000	-0.015	-0.035	-0.065	-0.103
62	0.071	0.056	0.041	0.000	-0.016	-0.036	-0.066	-0.105
63	0.071	0.056	0.041	0.000	-0.017	-0.037	-0.067	-0.108
64	0.073	0.058	0.043	0.000	-0.017	-0.037	-0.067	-0.109
65	0.075	0.060	0.045	0.000	-0.016	-0.036	-0.066	-0.109
66	0.075	0.060	0.045	0.000	-0.016	-0.036	-0.066	-0.110
67	0.075	0.060	0.045	0.000	-0.017	-0.037	-0.067	-0.111
68	0.075	0.060	0.045	0.000	-0.018	-0.038	-0.068	-0.113
69	0.077	0.062	0.047	0.000	-0.018	-0.038	-0.068	-0.116
70	0.078	0.063	0.048	0.000	-0.019	-0.039	-0.069	-0.119
71	0.080	0.065	0.050	0.000	-0.021	-0.041	-0.071	-0.122
72	0.081	0.066	0.051	0.000	-0.021	-0.042	-0.072	-0.124
73	0.082	0.067	0.052	0.000	-0.021	-0.041	-0.071	-0.127
74	0.085	0.070	0.055	0.000	-0.022	-0.042	-0.072	-0.129
75	0.087	0.072	0.057	0.000	-0.023	-0.043	-0.073	-0.130
76	0.088	0.073	0.058	0.000	-0.024	-0.044	-0.074	-0.134
77	0.088	0.073	0.058	0.000	-0.026	-0.046	-0.076	-0.138
78	0.089	0.074	0.059	0.000	-0.027	-0.047	-0.077	-0.141
79	0.090	0.075	0.060	0.000	-0.029	-0.049	-0.079	-0.144
80	0.093	0.078	0.063	0.000	-0.028	-0.048	-0.078	-0.146
	4.4°C	10.0°C	15.6°C	21.1°C	26.7°C	32.2°C	37.8°C	43.3°C

TABLE K - DATA FOR ALTERNATIVE FUZES

Table K has corrections to fuze setting for the fuze used in Table F and Table J, to obtain fuze setting for another fuze.

TABLE K
DATA FOR ALTERNATIVE FUZES

CORRECTIONS TO FUZE SETTING OF FUZE, MTSQ, M111
FOR FUZE, MTSQ, M555A5
(Δ_c FS)

PROJ, HE, M111 **CHARGE 5**
FUZE, MTSQ, M555A5 **V_0 = 317.2 M/S**

FUZE SETTING (FS) FUZE M555		CORRECTIONS TO FUZE SETTING
FROM	TO	(Δ_c FS)
2.0	3.6	0.3
3.7	7.2	0.4
7.3	10.7	0.5
10.8	14.3	0.6
14.4	17.8	0.7
17.9	21.4	0.8
21.5	24.9	0.9
25.0	28.5	1.0
28.6	32.0	1.1
32.1	35.6	1.2
35.7	39.2	1.3
39.3	42.7	1.4
42.8	46.3	1.5
46.4	49.8	1.6
49.9	53.4	1.7
53.5	56.1	1.8

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FORMAT OF TABLES FOR ILLUMINATING PROJECTILES

The tables for illuminating projectiles, which are described in this annex, are in a section of the tabular firing tables titled Part 2. Following is an explanation of the contents of each column of these tables.

Column 1 – Range to Illumination

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to the vertical projection of the illumination point on the weapon level surface. Shading can be used to indicate that the illuminating canister is ejected on the ascending branch of the trajectory.

Column 2 – Quadrant Elevation

The angle of the weapon in the vertical plane that, used in conjunction with the fuze setting given in column 3 and in standard conditions, produces an air burst such that the ignition of the illuminant occurs at a predefined altitude above the level point at the range given in column 1. Shading can be used to indicate that the illuminating canister is ejected on the ascending branch of the trajectory.

Column 3 – Fuze Setting

A number to be set on the fuze that, used in conjunction with the quadrant elevation given in column 2, produces an air burst such that the ignition of the illuminant occurs at a predefined altitude above the level point at the range given in column 1.

Column 4/5 – Change in Elevation/Fuze Setting for 50 M Increase in Height-of-Burst

Changes in quadrant elevation and fuze setting for an increase of 50 meters in height of burst. The changes in columns 4 and 5 must be applied simultaneously to increase the height of burst without changing the range.

Column 6 – Range to Fuze Function

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to the vertical projection of the point at which the fuze functions on the weapon level surface.

Column 7 – Range to Impact (No Fuze Function)

The distance measured on the surface of a sphere concentric with the earth, from the muzzle to the impact point on the weapon level surface of a non-functioning projectile.

FIRING TABLE FOR ILLUMINATING PROJECTILE

PROJ, ILLUMINATING | **CHARGE 5**
FUZE, TIME, M111 | **V_0 = 330.0 M/S**

1	2	3	4	5	6	7
RANGE TO ILLUMINA-TION	QUADRANT ELEVATION FOR STANDARD CONDITIONS	FUZE SETTING	CHANGE IN ELEVATION FOR 50 M INCREASE IN HEIGHT OF BURST	CHANGE IN FUZE SETTING FOR 50 M INCREASE IN HEIGHT OF BURST	RANGE TO FUZE FUNCTION	RANGE TO IMPACT (NO FUZE FUNCTION)
(X)	(A_{QE})	(FS)	(ΔA_{QE}/50m Y_b)	(ΔFS/ 50m Y_b)	(X_{FUZE})	($X_{NO-FUZE}$)
M	MIL		MIL		M	M
1000	711.5	4.4	32.1	0.13	907	6701
1100	671.5	4.7	31.2	0.12	1002	6642
1200	637.0	5.0	30.3	0.12	1087	6563
1300	607.1	5.3	29.2	0.11	1173	6474
1400	581.2	5.6	28.2	0.11	1291	6381
1500	558.8	6.0	27.2	0.11	1384	6289
1600	539.3	6.3	26.2	0.10	1469	6200
1700	522.5	6.7	25.2	0.10	1577	6117
1800	507.9	7.1	24.3	0.10	1668	6039
1900	495.4	7.4	23.4	0.10	1745	5969
2000	484.6	7.8	22.6	0.10	1831	5906
2100	475.4	8.2	21.9	0.10	1928	5849
2200	467.5	8.6	21.2	0.10	2011	5800
2300	461.0	9.0	20.5	0.10	2103	5758
2400	455.5	9.4	19.9	0.10	2197	5722
2500	451.1	9.8	19.3	0.10	2286	5693
2600	447.7	10.2	18.7	0.10	2371	5669
2700	445.1	10.6	18.2	0.10	2463	5652
2800	443.2	11.0	17.7	0.10	2558	5639
2900	442.1	11.5	17.2	0.10	2642	5631
3000	441.8	11.9	16.8	0.10	2734	5629
3100	442.0	12.4	16.4	0.10	2821	5630
3200	442.9	12.8	16.0	0.10	2917	5636

FORMAT OF TABLES FOR CARGO PROJECTILES – ALTERNATIVE 1

1. The tables for cargo projectiles, which are described in this annex, are in a section of the tabular firing tables titled Part 2, or in a separate addendum.

2. The tables below are used to produce corrections to the quadrant elevation and fuze setting for a cargo projectile trajectory that will achieve submunition expulsion from the carrier projectile at the height, above and possibly short of the point of graze, which will give optimum target coverage. The height is variable and quadrant elevation dependent. The solutions are calculated as a correction to the quadrant elevation obtained for the reference projectile using the Part 1 tables. The tables do not include possible fuze function at a specified self-destruct time.

3. The table columns for the quadrant elevation corrections are described below:

Column 1 – Quadrant Elevation

The elevation obtained through use of the Part 1 tables for the required range.

Column 2 – Correction to Quadrant Elevation for Cargo Projectile

The correction, for the specified projectile, to the quadrant elevation in column 1.

Column 3 – Correction to Quadrant Elevation for an Increase of 50M in Height of Burst

The change in quadrant elevation required to adjust the height of burst of the projectile up 50 M.

Column 4 – Correction to Quadrant Elevation for an Increase of 100M in Range

The change in quadrant elevation required to obtain an increase in range of 100 M.

Column 5 – Correction for Low Level Wind of One Knot

The deflection of the cargo projectile's submunitions for each one knot of low-level wind.

Column 6 – Travel Time

The travel time, for the specified conditions, from launch to the impact of the submunitions on the ground.

Column 7 – Range to Impact

The distance, measured on the surface of a sphere concentric with the earth, from the muzzle to a point at the same altitude, at which a projectile, whose fuze has not functioned (and, therefore, not ejected its submunitions) will impact.

Column 8 – Correction to Deflection

The correction for the deflection obtained through use of the Part 1 tables for the required range.

4. The table columns for the fuze setting corrections are described below:

Column 1 – Fuze Setting

The fuze setting obtained through use of the Part 1 tables for the required range.

Column 2 – Correction to Fuze Setting for Cargo Projectile

The correction, for the specified projectile, to the fuze setting in column 1.

Column 3 – Correction to Fuze Setting for an Increase of 50M in Height

The change in fuze setting required to adjust the height of burst of the projectile up 50M.

Column 4 – Correction to Fuze Setting for an Increase of 100M in Range

The change in fuze setting required to obtain an increase in range of 100 M.

FIRING TABLE FOR CARGO PROJECTILE
(Quadrant Elevation)

PROJ, CARGO, M777 **CHARGE 5**
FUZE, Time, M888 **V_0 = 400.0 M/S**

1	2	3	4	5	6	7	8
QUADRANT ELEVATION FOR PROJ M666	CORRECTION TO QUADRANT ELEVATION FOR PROJ M777	CORRECTIONS TO QUADRANT ELEVATION FOR AN INC OF		CORR FOR LOW LEVEL WIND OF 1 KNOT	TRAVEL TIME	RANGE TO IMPACT (NO FUZE FUNCTION)	CORR TO DEFL FOR PROJ M777
		50M IN HEIGHT	100 M IN RANGE				
(A_{QE})	($\Delta_C A_{QE}$)	($\Delta_C A_{QE}$/ 50m Y)	($\Delta_C A_{QE}$/ 100m X)	(Δ_C DEF/ 1 KT W_s)	(TT)	($X_{NO-FUZE}$)	(Δ_CDEF)
MIL	MIL	MIL	MIL	M	S	M	MIL
50	28	14.3	0.9	3.2	12.6	5107	R0.1
55	26	13.2	1.1	3.1	13.1	5250	R0.1
60	24	12.3	1.3	3.1	13.7	5409	R0.1
65	33	11.5	1.4	3.0	14.2	5578	R0.1
70	22	10.8	1.5	3.0	14.7	5755	R0.1
75	21	10.3	1.6	2.9	15.2	5935	R0.1
80	20	9.8	1.7	2.9	15.7	6117	R0.1
85	19	9.3	1.8	2.8	16.2	6299	R0.2
90	19	9.0	1.9	2.8	16.7	6481	R0.2
95	18	8.6	2.0	2.7	17.2	6662	R0.2
100	18	8.3	2.1	2.7	17.7	6841	R0.2
105	17	8.0	2.2	2.6	18.2	7017	R0.2
110	17	7.8	2.3	2.5	18.7	7192	R0.2
115	16	7.5	2.4	2.5	19.2	7363	R0.2
120	16	7.3	2.5	2.4	19.6	7532	R0.2
125	16	7.1	2.6	2.3	20.1	7698	R0.2
130	16	7.0	2.6	2.3	20.6	7862	R0.2
135	15	6.8	2.7	2.2	21.0	8022	R0.3
140	15	6.6	2.8	2.2	21.5	8179	R0.3
145	15	6.5	2.9	2.2	21.9	8334	R0.3
150	15	6.4	3.0	2.1	22.4	8486	R0.3
155	15	6.2	3.0	2.1	22.8	8635	R0.3
160	15	6.1	3.1	2.0	23.2	8782	R0.3
165	15	5.9	3.2	2.0	23.7	8927	R0.3
170	14	5.8	3.3	1.9	24.1	9069	R0.3
175	14	5.7	3.3	1.9	24.5	9209	R0.3

FIRING TABLE FOR CARGO PROJECTILE
(Fuze Setting)

PROJ, CARGO, M777
FUZE, Time, M888

CHARGE 5
V_0 = 400.0 M/S

1	2	3	4
FUZE SETTING FOR PROJ, M666 (FS)	CORRECTION TO FUZE SETTING FOR PROJ M777 (Δ_c FS)	CORRECTIONS TO FUZE SETTING FOR AN INCREASE OF 50 METERS IN HEIGHT (Δ_c FS /50m Y)	100 METERS IN RANGE (Δ_c FS /100m X)
22.3-28.0	*-0.1*	0.0	0.4
28.1-31.6	0.0	0.0	0.4
31.7-34.5	0.1	0.0	0.4
34.6-37.1	0.2	0.0	0.4
37.2-39.9	0.3	0.0	0.5
40.0-42.4	0.4	0.0	0.5
42.5-44.4	0.5	0.0	0.5
44.5-46.2	0.6	0.1	0.5
46.3-47.6	0.7	0.1	0.6
47.7-48.8	0.8	0.1	0.6
48.9-49.8	0.9	0.1	0.6
49.9-50.7	1.0	0.1	0.7
50.8-51.4	1.1	0.1	0.7
51.5-52.1	1.2	0.1	0.7
52.2-52.8	1.3	0.1	0.7
52.9-53.4	1.4	0.1	0.8
53.5-53.9	1.5	0.1	0.8
54.0-54.4	1.6	0.1	0.9
54.5-54.8	1.7	0.2	0.9
54.9-55.2	1.8	0.2	0.9
55.3-55.5	1.9	0.2	1.0
55.6-55.9	2.0	0.2	1.0
56.0-56.2	2.1	0.2	1.1
56.3-56.4	2.2	0.2	1.1
56.5-56.7	2.3	0.2	1.2
56.8-56.9	2.4	0.2	1.2
57.0-57.1	2.5	0.3	1.3
57.2-57.3	2.6	0.3	1.3
57.4-57.5	2.7	0.3	1.4
57.6-57.7	2.8	0.3	1.4

FORMAT OF TABLES FOR CARGO PROJECTILES – ALTERNATIVE 2

1. This format table is employed to obtain a fire-control solution for the specified range-to-burst. Table F(ii) in Part 1 must be employed to obtain the corrections to non-standard conditions.

2. The table columns are described below:

Column 1 – Range to Mean Submunition Impact

The distance, measured on the surface of a sphere concentric with the earth, from the muzzle to the point of impact. Shading can be used to indicate that the submunitions are ejected from the carrier on the ascending branch of the trajectory.

Column 2 – Quadrant Elevation

The elevation required to reach the range tabulated in column 1. The maximum elevation shown represents the highest angle at which predictable projectile flight is possible under standard conditions of meteorology and material. This number varies with non-standard conditions of meteorology and material and is particularly sensitive to changes in range wind. Shading can be used to indicate that the submunitions are ejected from the carrier on the ascending branch of the trajectory.

Column 3 – Fuze Setting

The fuze setting required to cause the fuze to function in such a way that the submunitions will be dispensed from the carrier at the required height of burst above and possibly short of the point of submunition impact to produce optimum dispersion and target coverage.

Column 4 – Correction to Elevation for an Increase of 50M in Height of Burst

The change in elevation required to adjust the height of burst of the projectile or the altitude of the target up 50M.

Column 5 – Correction to Fuze Setting for an Increase of 50M in Height of Burst

The change in fuze setting required to adjust the height of burst of the projectile up 50M. Note that the corrections can be positive or negative depending upon range and charge.

Column 6 – Range to Fuze Function

The distance, measured on the surface of a sphere concentric with the earth, from the muzzle to a point, vertically above which the fuze will function. Note that this will be a shorter range than Range to Submunition Impact, depending upon the remaining velocity of the projectile and the angle of descent.

Column 7 – Range to Impact

The distance, measured on the surface of a sphere concentric with the earth, from the muzzle to a point at the same altitude, at which a projectile, whose fuze has not functioned (and, therefore, not ejected its submunitions) will impact.

Column 8 – Height of Burst

The height of burst at fuze functioning of the carrier projectile above and possibly short of the point of graze.

FIRING TABLE FOR CARGO PROJECTILE

PROJ, CARGO, M777 | **CHARGE 5**
FUZE, Time, M888 | **V_0 = 400.0 M/S**

1	2	3	4	5	6	7	8
RANGE TO MEAN SUB-MUNITION IMPACT	QUADRANT ELEVATION	FS	CHANGE IN ELEVATION FOR 50 M INCREASE IN HEIGHT	CHANGE IN FS FOR 50 M INCREASE IN HEIGHT	RANGE TO FUZE FUNCTION	RANGE TO IMPACT (NO FUZE FUNCTION)	HEIGHT OF BURST
(X)	(A_{QE})	(FS)	(ΔA_{QE}/ 50m Y)	(ΔFS/ 50m Y)	(X_{FUZE})	($X_{NO-FUZE}$)	(Y_b)
M	MIL		MIL		M	M	M
400	1123.2	2.9	26.5	0.16	365	5247	600
500	1028.5	3.1	29.9	0.16	457	5928	600
600	945.7	3.3	32.0	0.15	542	6346	600
700	873.7	3.6	32.9	0.14	639	6583	600
800	811.5	3.8	33.1	0.14	724	6696	600
900	757.8	4.1	32.7	0.13	816	6726	600
1000	711.5	4.4	32.1	0.13	907	6701	600
1100	671.5	4.7	31.2	0.12	1002	6642	600
1200	637.0	5.0	30.3	0.12	1087	6563	600
1300	607.1	5.3	29.2	0.11	1173	6474	600
1400	581.2	5.6	28.2	0.11	1291	6381	600
1500	558.8	6.0	27.2	0.11	1384	6289	600
1600	539.3	6.3	26.2	0.10	1469	6200	600
1700	522.5	6.7	25.2	0.10	1577	6117	600
1800	507.9	7.1	24.3	0.10	1668	6039	600
1900	495.4	7.4	23.4	0.10	1745	5969	600
2000	484.6	7.8	22.6	0.10	1831	5906	600
2100	475.4	8.2	21.9	0.10	1928	5849	600
2200	467.5	8.6	21.2	0.10	2011	5800	600
2300	461.0	9.0	20.5	0.10	2103	5758	600
2400	455.5	9.4	19.9	0.10	2197	5722	600
2500	451.1	9.8	19.3	0.10	2286	5693	600

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FORMAT FOR ABRIDGED FIRING TABLE

The role and use of the abridged format table is described in paragraph 9 of the agreement. The data are obtained from Tables F(i) and G.

ABRIDGED TABLE
BASIC DATA

CART, HE, M111 — **CHARGE 5**
FUZE, PD, M222 — **V_0 = 317.2 M/S**

1	2	3	4	5	6	7	8	9	10
RANGE	QUADRANT ELEVATION FOR STANDARD CONDITIONS	TIME OF FLIGHT	DRIFT (CORRECTION TO LEFT)	PROBABLE ERRORS		ANGLE OF DESCENT	REMAINING VELOCITY	VERTEX HEIGHT	RANGE FOR NO MOTOR FUNCTION
				RANGE	DEFL				
(X)	(A_{QE})	(TOF)	(A_d)	(E_X)	(E_Z)	(A_ω)	(V_ω)	(Y_S)	($X_{NO\text{-}MOT}$)
M	MIL	S	MIL	M	M	MIL	M/S	M	M
0	0.0	0.0	0.0	0	0	0	317	0	0
100	5.1	0.3	0.1	0	0	5	315	0	90
200	10.0	0.7	0.2	1	0	10	314	0	185
300	15.0	1.1	0.3	1	1	15	312	1	275
400	20.1	1.3	0.2	2	1	20	310	2	350
500	25.2	1.6	0.3	2	1	26	309	3	445
600	30.4	1.9	0.3	3	1	31	307	4	540
700	35.6	2.3	0.4	3	1	36	306	6	635
800	40.9	2.6	0.4	4	1	42	304	8	735
900	46.1	2.9	0.5	4	2	48	303	10	830
1000	51.5	3.3	0.5	5	2	53	301	13	925
1100	56.8	3.6	0.6	5	2	59	300	15	1020
1200	62.2	3.9	0.7	6	2	65	298	19	1115
1300	67.7	4.3	0.7	6	2	71	297	22	1200
1400	73.2	4.6	0.8	7	2	77	295	26	1280
1500	78.8	5.0	0.8	7	2	83	294	30	1385
1600	84.3	5.3	0.9	8	2	89	293	34	1475
1700	90.0	5.6	1.0	8	3	95	292	39	1560
1800	95.7	6.0	1.1	9	3	101	290	44	1645
1900	101.4	6.3	1.1	9	3	108	289	49	1720
2000	107.2	6.7	1.2	10	3	114	288	54	1800

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