TECHNICAL MANUAL

OPERATOR'S MANUAL

CALCULATOR SET, RADIAC AND

NUCLEAR YIELD: ABC-M28A1

(FSN 6665-130-3616)

HEADQUARTERS, DEPARTMENT OF THE ARMY
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*** This Manual supersedes TB CML 92, 14 Feb 63, including all changes.**

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual contains the operating instructions for the Calculator Set, RADIAC and Nuclear Yield: ABC-M28A1 (FSN 6665-130-3616)*. It includes a description of the calculator set and its use, definitions of terms used, and examples of several types of calculations which can be made with the set.

1-2. Record and Report Forms

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded directly to Commander, Edgewood Arsenal, Attn.: SAREA-DE-ET, Aberdeen Proving Ground, Maryland 21010.

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* Only because the end item is printed with an FSN does this manual use FSN to avoid any confusion. All new procurement will carry an NSN.

Section II. DESCRIPTION

1-3. Description

The ABC-M28A1 calculator set (fig. 1) consists of a RADIAC Calculator, ABC-M1A1 (3) and Calculator, Nuclear Yield, M4A1 (4). The two calculators are packaged in a plastic envelope (1), and are separated by the instruction card (2).

1-4. Use

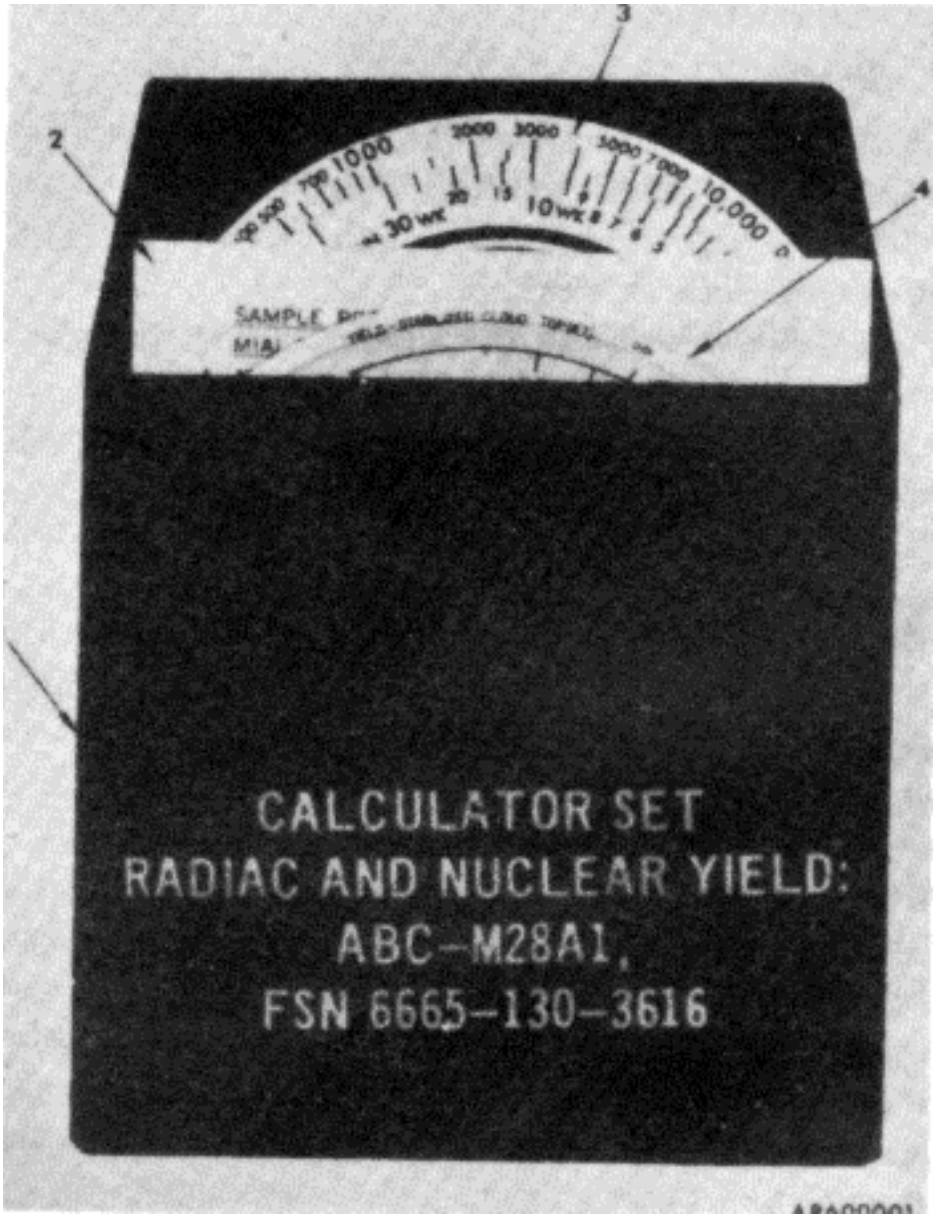
The ABC-M28A1 calculator set provides field units with a tool for predicting radiation fallout hazards.

a. The ABC-M28A1 RADIAC calculator provides a rapid method of calculating radiation hazards from a nuclear burst. The following calculations can be made using data from radiological survey reports and other sources:

(1) Decay of radioactive fallout.
(2) Normalizing survey data.
(3) Dose absorbed by personnel exposed to radioactive fallout.
(4) Dose absorbed by personnel in shelters.
(5) Exit time and length of stay.

NOTE

The ABC-M1A1 RADIAC calculator is not intended for use during buildup of



1 Envelope
2 Instruction card
3 ABC-M1A1 RADIAC calculator
4 M4A1 nuclear yield calculator

Figure 1. ABC-M28A1nuclear calculator set.

radioactivity or for use by Civil Defense personnel in Civil Defense situations.

b. The M4A1 nuclear yield calculator is designed to provide a rapid method of calculating nuclear yield from a nuclear burst when any of the following sets of data is known:

(1) Flash-to-bang time and angle to top or bottom of stabilized nuclear cloud.
(2) Flash-to-bang time and cloud width after bang time.
(3) Fireball illumination time.

1-5. Definitions

For the purposes of this manual, the following definitions apply:

a. ABC-M1A1 RADIAC Calculator

(1) Decay of radioactive fallout. Decay of radioactive fallout is the decrease of radioactivity with the passage of time and is expressed in RADS/ HOUR (rads per hour).
(2) Dose. Dose is the number of rads which an individual will absorb during the time (exit time minus entry time) he is exposed to radioactive fallout.
(3) Rad. A rad is a unit of absorbed dose.
(4) Dose rate. Dose rate is the number of rads per hour to which personnel will be exposed.

(For use with the calculator, roentgens per hour are equivalent to rads per hour.)

(5) Entry time. Entry time is the actual or planned time personnel enter an area of radioactive fallout. It is expressed as the number of hours elapsed from time of burst (H).

(6) Exit time. Exit time is the actual or planned time personnel leave an area of radioactive fallout. It is expressed as a number of hours elapsed from time of burst (H).

(7) Normalization of survey data. Normalization of survey data is the process of converting the dose-rate obtained from a survey at a known time to the dose-rate at 1 hour after a nuclear burst (H+ 1).

(8) Transmission factors. Transmission factors are the fractional amounts of radiation which will be transmitted through various types of shelters. The dose or dose-rate to which unprotected personnel would be exposed is multiplied by the appropriate transmission factor to obtain the dose or dose-rate for personnel protected by a specific shelter.

b. M4A1 Nuclear Yield Calculator (I) Cloud-top or cloud-bottom elevation.

Cloud-top or cloud-bottom elevation is the angle in mils from the observer's position on the ground to the top or bottom of the radioactive cloud

(mushroom cloud) at the time of cloud stabilization.

(2) Cloud width after bang time. Cloud width after bang time is the angle in mils subtended by the radioactive cloud as measured from the observer's position 5 minutes after the detonation is heard.

(3) Fireball illumination time. Fireball illumination time is the time interval in seconds between the blue-white flash of the detonation and the fading of the fireball into a barely luminous cloud.

(4) Flash-to-bang time. Flash-to-bang time is the time interval in seconds between the blue-white flash of a detonation and the arrival of the sound of the detonation at the observer's position.

(5) Yield. Yield is the amount of energy released by the nuclear detonation. It is expressed by comparison to the energy. released by TNT, in units of kilotons of TNT.

CHAPTER 2

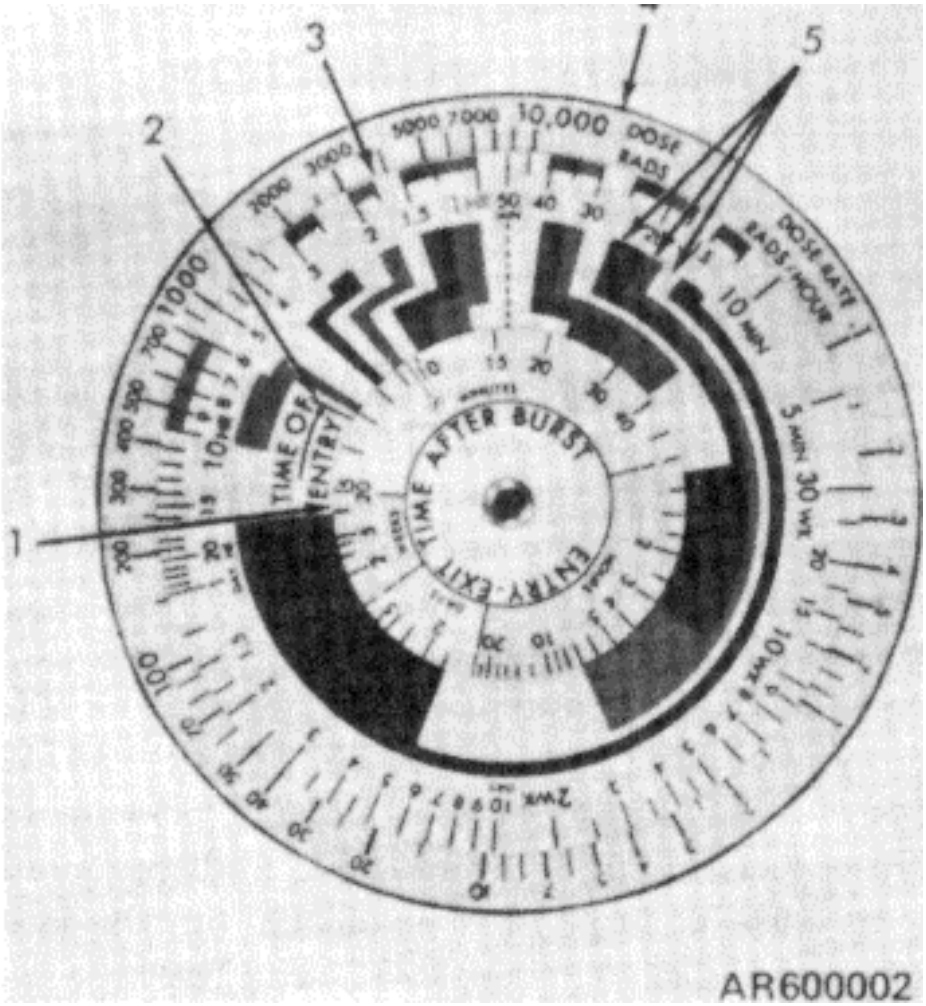
OPERATING INSTRUCTIONS

Section I. THE ABC-M1A1 RADIAC CALCULATOR

2-1. Description

The ABC-M1A1 RADIAC calculator (fig. 2) consists of three opaque white laminated plastic disks.
An inner disk (1), an intermediate disk (3), and an outer disk (4) are mounted concentrically by means of an aluminum rivet.
a. Inner Disk. The inner disk is a 1 15/16 inches in diameter and is used to select Exit Time after burst. An ENTRY-EXIT TIME AFTER BURST logarithmic scale-divided clockwise into minutes (starting at 5), hours, (lays, and weeks (ending at 20)-is imprinted in black on the outer edge of the disk. The HOURS and WEEKS portions of the scale are imprinted on a yellow background. The time longer than 20 weeks overlaps the MINUTES portion of the scale to halfway between the 9 and 10 MINUTES position where the symbol for infinity (cot) marks the end of the scale.

b. Intermediate Disk. The intermediate disk (3) 3 7/8 inches in diameter and is used to select Entry Time after burst. A logarithmic scale-divided counterclockwise into minutes (starting at 5), hours,



1 Inner disk
2 Index line
3 Intermediate disk
4 Outer disk
5 Black, red, and white guide bands

Figure 2. ABC-M1A1 RADIAC calculator.

days, and weeks (ending at 30)-is imprinted in black on the outer edge of the disk. The 1 HR position (H+1) is imprinted in red. A TIME OF

ENTRY index line (2) is imprinted on the intermediate disk. The index line is used for aligning the inner disk with reference to the intermediate disk. Red and black bands on the intermediate disk form a set of black, red, and white guide bands (5) from the scale on the inner disk to the scale on the intermediate disk.

c. Outer Disk. The outer disk is 41/2 inches in diameter. A logarithmic scale divided clockwise from .1 to 10,000 is imprinted in black on the outer edge of the disk. The scale serves to indicate both a dose (DOSE RADS) and a dose rate (DOSE RATE RADS/HOUR).

d. Instructions. Condensed instructions for use of the calculator to obtain dose rate and total dose and a table of transmission factors for several types of shelters are printed on the back of the calculator (fig. 3),

2-2. Operating Procedures

The types of problems that can be solved with the ABC-M1A1 RADIAC calculator are explained and illustrated below:

a. Decay of Radioactive Fallout (fig. 4).

(1) Problem. The dose rate reported by a survey team at 21/2 hours after burst (H+21/2 hours) was 50 rad/hr.

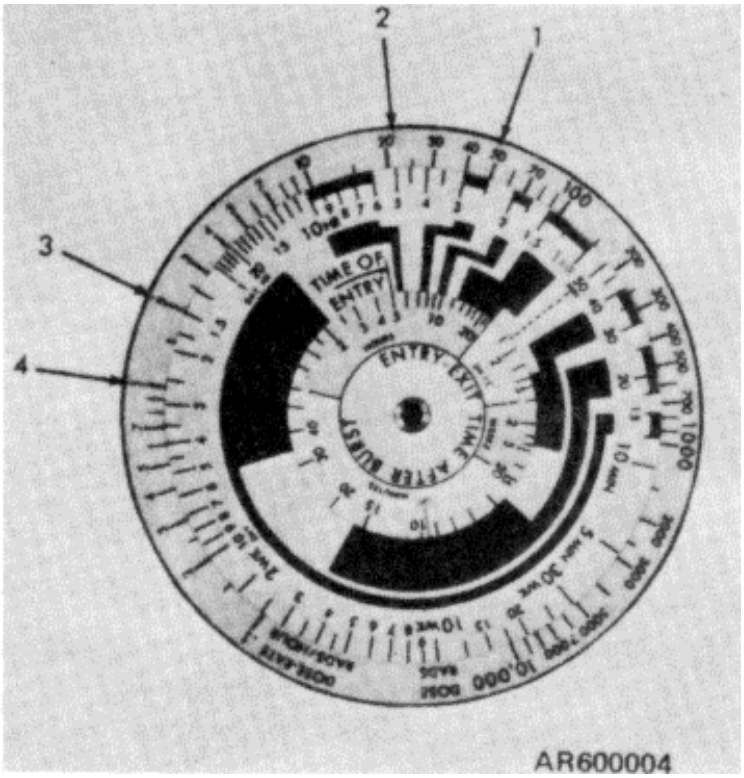
Figure 3. Back of ABC-M1A1 RADIAC calculator.

(a) What will the dose rate be at H+5 hours?

(b) When will the dose rate be 2 rads/hrs?

(c) When will the dose rate be 1 rad/hr?

(2) Solution. Aline 50 rad/hr on the DOSE-RATE RADS/HOUR scale with 2.5 hours on the



1 50 rad/hr aligns with 2.5 hours
2 22 rad/hr indicated at H + 5 hours
3 1.5 days indicated at 2 rad/hr
4 2.75 days indicated at 1 rad, hr

Figure 4. Decay of radioactive fallout.

time scale on the edge of the intermediate disk
(1): Hold this setting.
(a) Read the dose rate on the DOSE-RATE

RADS/HOUR scale that aligns with 5 hours (5 HR) on the time stale on the edge of the intermediate disk. The correct answer is 22 rad/hr at H+5 hours (2).

(b) Read the time on the scale on the edge of the intermediate disk that aligns with 2 R.AD/ HR on the DOSE-RATE RADS/HOUR scale. The correct value is H+1.5 days (3) for a dose rate of 2 rad/hr.

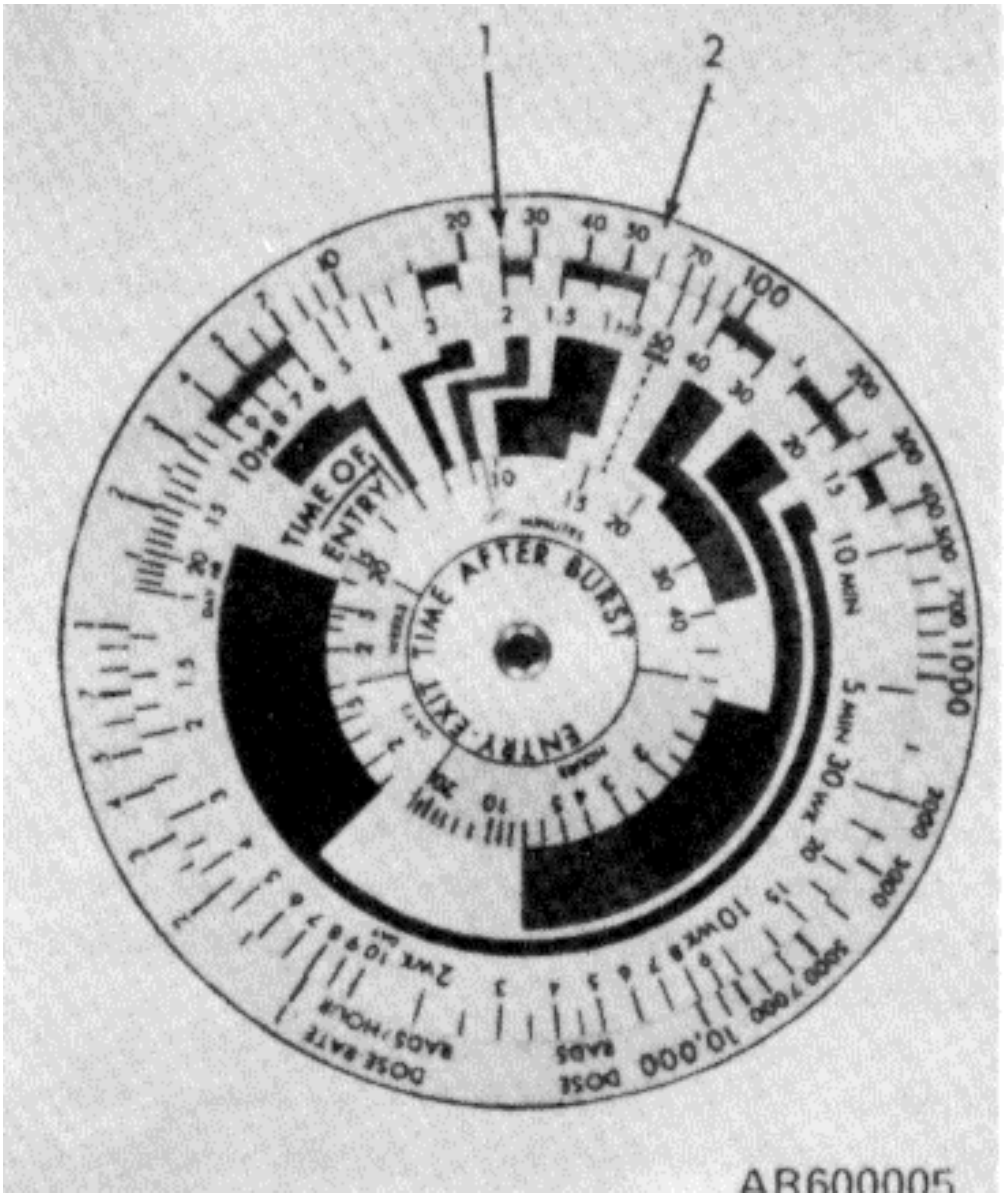
(c) Read the time on the stale on the edge of the intermediate disk that aligns with I RAD/ HR on the DOSE/RATE RADS/HOUR scale. The correct value is H+2.75 days (-1) for a dose of 1 rad /hr.

b. Normalizing Survey Data (fig. 5).

(1) Problem. The following survey readings were reported from units in a fallout area. Normalize the readings to 1 hour after burst (H+1).

Unit	*Time*	*Reported Dose Rate*
Co. A	H+2	25 rad/hr
Co. B	H+3	10 rad/hr
Co. C	H+4	15 rad/hr

(2) Solution. To normalize Co. A's reported dose rate, aline 2 HR on the time scale on the edge of the intermediate disk with 25 RAD/HR on the DOSE-RATE RADS/HOUR scale (1). Hold this setting. Read the dose rate on the DOSE-



1 2 HR aligned with 25 RAD/HR 2 58 RAD/HR.

Figure 5. Normalizing survey data.

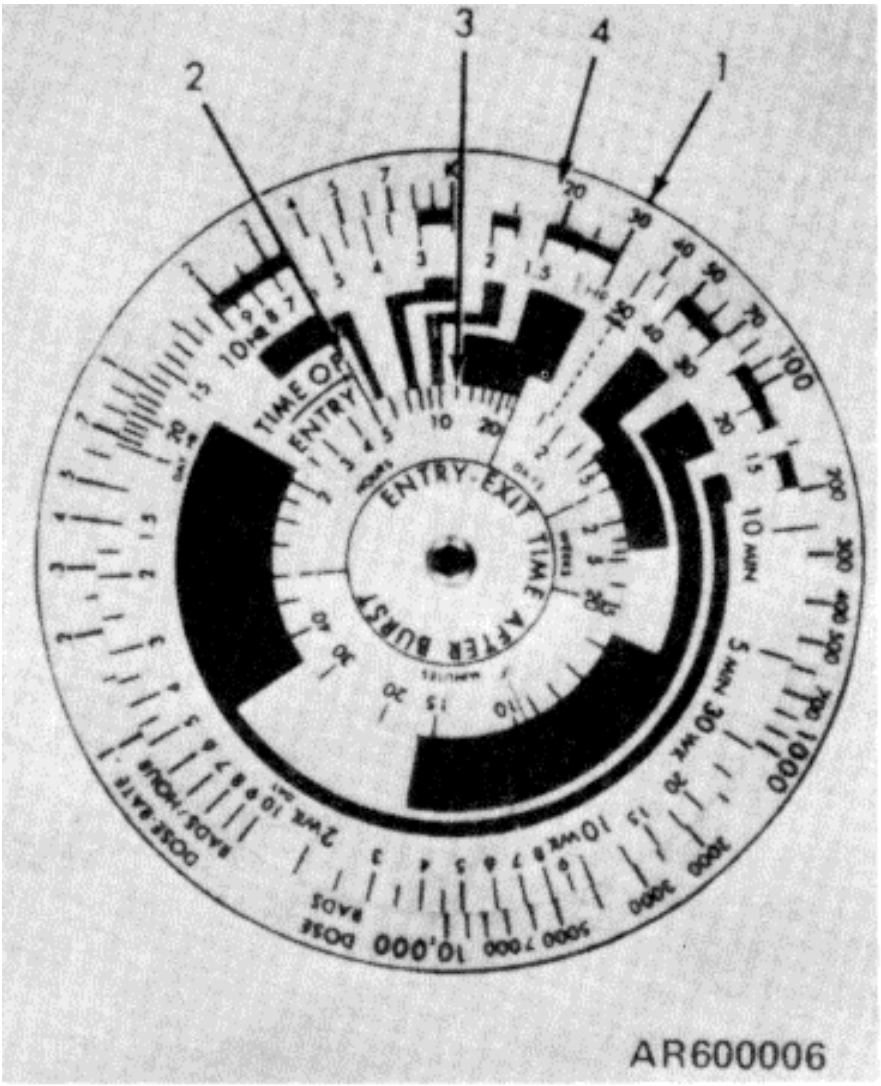
RATE RADS/HOUR scale that aligns with 1 HR on the time scale on the edge of the intermediate disk. The correct value is 58 rad/hour (2). Follow the same procedure with the other reported dose rates. Correct normalized dose rates are tabulated below:

Unit	*Time*	*Reported Dose Rate*	*H+1 Dose Rate*
Co. A	H+2	25 rad/hr	58 rad, hr
Co. B	H+3	10 rad/hr	39 rad, hr
Co. C	H+4	15 rad/hr	80 rad, hr

c. Dose Absorbed by Personnel Exposed to Radioactive Fallout (fig. 6). The following problem assumes no shielding for personnel exposed to fallout.

(1) Problem. The mission of a unit requires that personnel enter a fallout area 5 hours after an atomic burst and remain in the area for 7 hours. A dose rate of 30 rad/hr was present in the area at H+ hour. What is the dose these personnel would receive?

(2) Solution. Aline 30 RAD/HR on the DOSE-RATE RADS/HOUR scale with 1 HR on the time scale on the edge of the intermediate disk (1). Hold this setting. Aline 5 HOURS on the ENTRY-EXIT TIME AFTER BURST scale on the inner disk with the TIME OF ENTRY index line on the intermediate disk (2). Hold this set-



1 30 rad/hr aligned with 1 hour
2 5 HOURS aligned with TIME OF ENTRY index
3 12 hours
4 18 rads

Figure 6. Dose absorbed by personnel.

ting. Locate 12 HOURS (3) on the ENTRY-EXIT TIME AFTER BURST scale. (This value represents H+5 hours plus the 7 hours that personnel must remain in the fallout area.) Note the position of the 12-HOUR line in relation to the white guide band on the intermediate disk. Follow the white guide band outward to the outer disk and read the dose on DOSE RADS scale on the outer disk. The correct value is 18 rads (4) which is in the same relative position on the intermediate disk with respect to the white guide band as the 12 HOUR line on the inner disk.

d. Dose absorbed by Personnel in Shelters.

(1) Problem. If personnel in the unit (c above) enter the fallout area in an armored personnel carrier (APC), what is the dose that the personnel will receive?

(2) Solution. The transmission factor for APC's is .30 (fig. 3). The dose received by unshielded personnel (c above) was 18 rads. Total dose inside the APC, therefore, would be .30 times 18 or 5.4 rads.

e. Exit Time and Length of Stay (fig. 6). By reversing the order of the procedure used in c. above, exit time and length of stay in fallout area can be calculated from survey data when a permissible dose is known.

(1) Problem. How long can a unit remain in

a fallout area and not exceed a dose of 18 rads if the dose rate was 30 rad/hour at H+1 and the unit is scheduled to enter the area at H+5 hours?

(2) Solution. Aline 30 RADS)/HOUR on the DOSE-RATE RADS/HOUR scale with 1 HR on the time scale on the intermediate disk. Hold this setting and aline 5 HOURS on the ENTRY-EXIT TIME AFTER BURST scale with the TIME OF ENTRY index line on the intermediate disk. Hold this setting. Locate 18 rads on the DOSE RADS scale on the outer disk. Note the position of 18 rads in relation to the white guide band on the intermediate disk. Follow the white guide band inward and read the time on the ENTRY-EXIT TIME AFTER BURST scale which corresponds to the same position on the white guide band as the 18 rads line on the DOSE RADS scale. The reading on the ENTRY-EXIT TIME AFTER BURST scale is 12 HOURS. At this time, H+12 hours, the unit must leave the area. Since the unit entered the area at H+5 and left the area at H+ 12, the allowable length of stay is 7 hours.

f. Earliest Allowable Entry Time.

(1) Problem. If a reading of 1000 rad/hr is observed at H+15 minutes, when can unprotected personnel enter the area and remain for a period of 3 days and not exceed an absorbed dose of 200 rads?

(2) Solution. Aline 1000 rads on the DOSERATE RADS/HOUR scale with 15 minutes on the time scale on the intermediate disk. Hold this setting. Manipulate the ENTRY-EXIT TIME AFTER BURST scale until 200 rads on this scale, as indicated by the guide band, aligns with a time in excess of 3 days. Note the time on the ENTRYTIME AFTER BURST scale which is now aligned with the TIME OF ENTRY index line on the intermediate disk. By careful manipulation of the ENTRY-EXIT TIME AFTER BURST scale, it can be determined that troops can enter the area at H+ 11 hours and leave 3 days thereafter and not exceed an absorbed dose of 200 rads.

Section II.

THE M4A1 NUCLEAR YIELD CALCULATOR

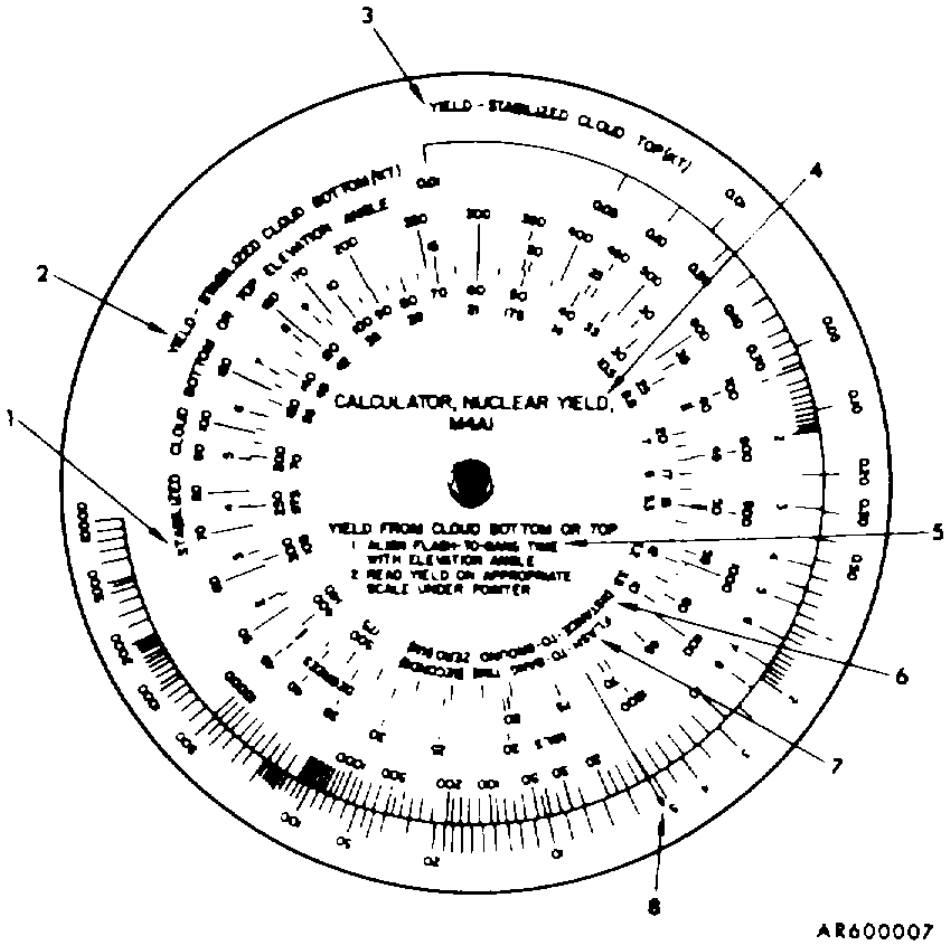
2-3. Description

The M4A1 nuclear yield calculator consists of three plastic disks mounted concentrically by means of a metal rivet. The front disk and the back disk are 41/4 inches in diameter. The middle disk is 41/2 inches in diameter. The front disk and the back disk are opaque white plastic at the center and transparent plastic at the outer edge. The middle disk is opaque white laminated plastic.

The front disk and the back disk are imprinted with logarithmic scales, condensed instructions for use, and an indexing pointer. The middle disk is imprinted with logarithmic scales on both the front and back faces of the disk.

a. Front of the Calculator (fig. 7). A YIELD-STABILIZED CLOUD BOTTOM scale (2), A YIELD-STABILIZED CLOUD TOP scale (3), and a STABILIZED CLOUD BOTTOM OR TOP ELEVATION ANGLE (MILS) scale (1) are imprinted on the front face of the middle disk. A FLASH-TO-BANG TIME (SECONDS) scale (7), nomenclature (4), and condensed instructions (5) are imprinted on the opaque surface of the front disk. An indexing pointer (8) is imprinted on the transparent portion of the front disk.

b. Back of the Calculator (fig. 8). An OBSERVED CLOUD WIDTH AT 5 MINUTES AFTER BANG TIME (MILS) scale (1), a YIELD scale (3), and a FIREBALL ILLUMINATION TIME (SECONDS) scale (2) are imprinted on the back face of the middle disk. A combined FLASH-TO-BANG TIME (SECONDS) scale (5), a DISTANCE-TO-GROUND ZERO (KM) scale (6), and condensed instructions (7) are imprinted on the opaque surface of the back disk. An indexing pointer (6) is imprinted on the transparent portion of the back disk.



1 STABILIZED CLOUD BOTTOM OR TOP ELEVATION ANGLE (MILS) scale
2 YIELD-STABILIZED CLOUD BOTTOM (KT) scale
3 YIELD-STABILIZED CLOUD TOP (KT) scale
4 Nomenclature
5 Instructions
6 DISTANCE-TO-GROUND ZERO (KM) scale
7 FLASH-TO-BANG TIME (SECONDS) scale
8 Indexing pointer

Figure 7. Front of the M4A1 nuclear yield calculator.

2-4. Operating Procedures

The types of problems that can be solved with the M4A1 nuclear yield calculator are explained and illustrated below. The calculations are dependent upon measurements which may be obtained by using instruments such as field glasses, or by estimation. Accuracy in estimating angular measurements in mils can be gained by "calibrating" the fingers (explained in FM 6-40).

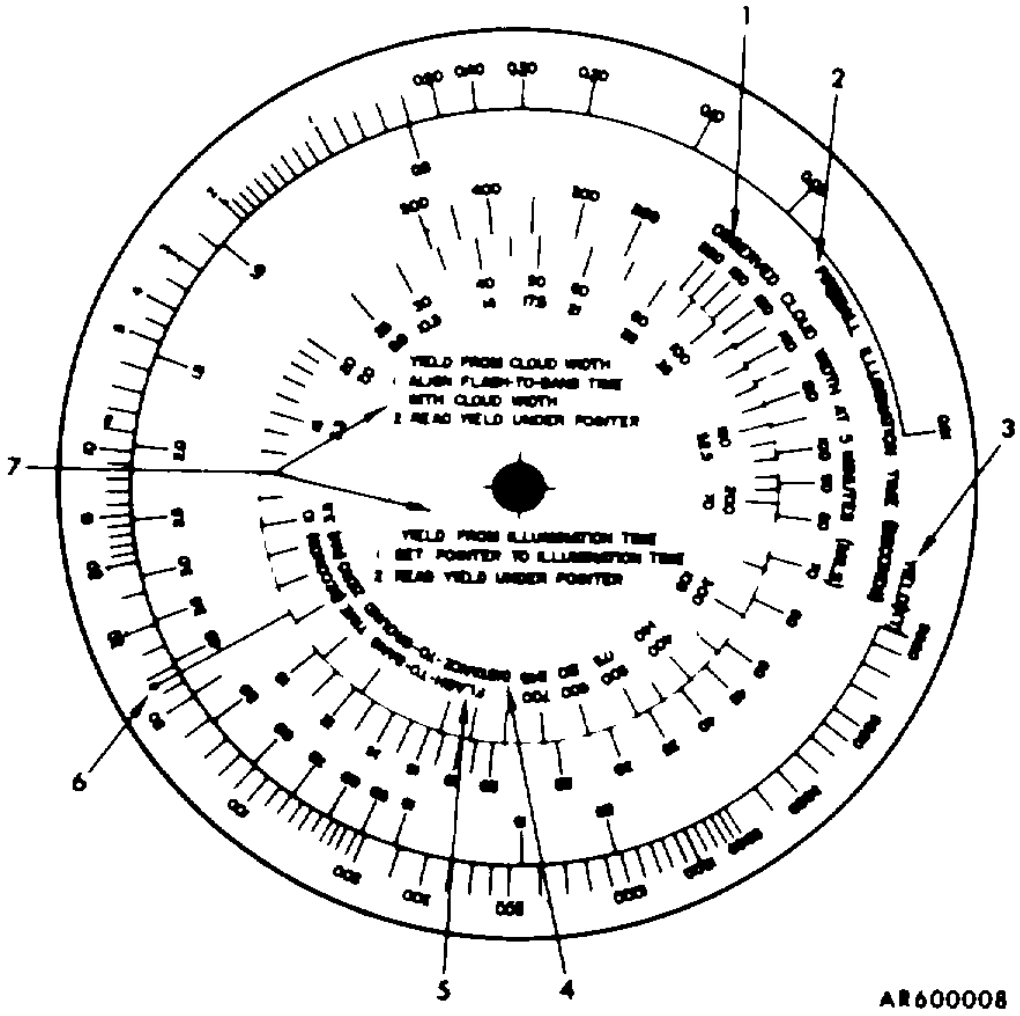
a. Yield from Flash-to-Bang Time and Angle to Cloud Top (fig. 9).

(1) Example: An observer reports a flash-to bang time of 100 seconds and the elevation of the cloud top to be 300 mils at stabilization time. Using the calculator, determine the yield from the burst.

(2) Solution. Aline 100 seconds (1) on the FL.ASH-TO-BANG TINME scale with 300 mils (2) on the STABILIZED CLOUD BOTTOM OR TOP ELEVATION ANGLE scale. Read the yield on the YIELD-STABILIZED CLOUD TOP scale that falls under the indexing pointer. The yield of the observed weapon is 20 KT (3).

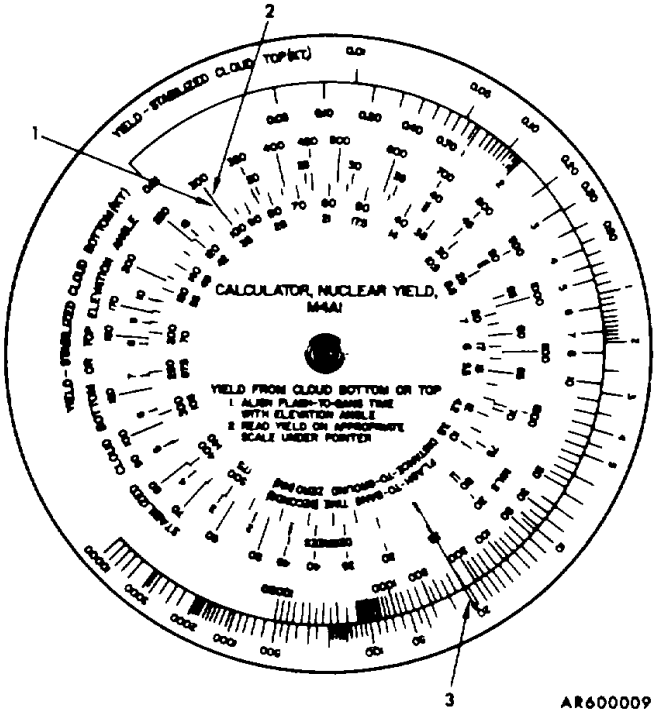
b. Yield from Flash-To-Bang Time and Angle to Closed Bottom (fig. 10).

(1) Example: An observer reports a FLASH-TO-BANG TIMIE of 100 seconds and the elevation



1 OBSERVED CLOUD WIDTH AT 5 MINUTES scale
2 FIREBALL ILLUMINATION TIME (SECONDS) scale
3 YIELD scale
4 DISTANCE-TO-GROUND ZERO (KM) scale
5 FLASH-TO-BANG TIME (SECONDS) scale
6 Indexing pointer
7 Instructions

Figure 8. Back of the M4A1 nuclear yield calculator.



1 100 seconds 2 300 MILS 3 20 KT

Figure 9. Yield from flash-to-bang time and elevation of cloud top.

of the cloud bottom to be 200 mils at stabilization time. Using the calculator, determine the yield from the burst.

(2) Solution. Aline 100 seconds on the FLASH-TO-BANG TIME scale with 200 mils (1)

on the STABILIZED CLOUD BOTTOM OR TOP ELEVATION ANGLE scale. Read the yield on the YIELD-STABILIZED CLOUD BOTTOM SCALE that falls under the indexing pointer. The yield of the observed weapon is 20 KT (2).

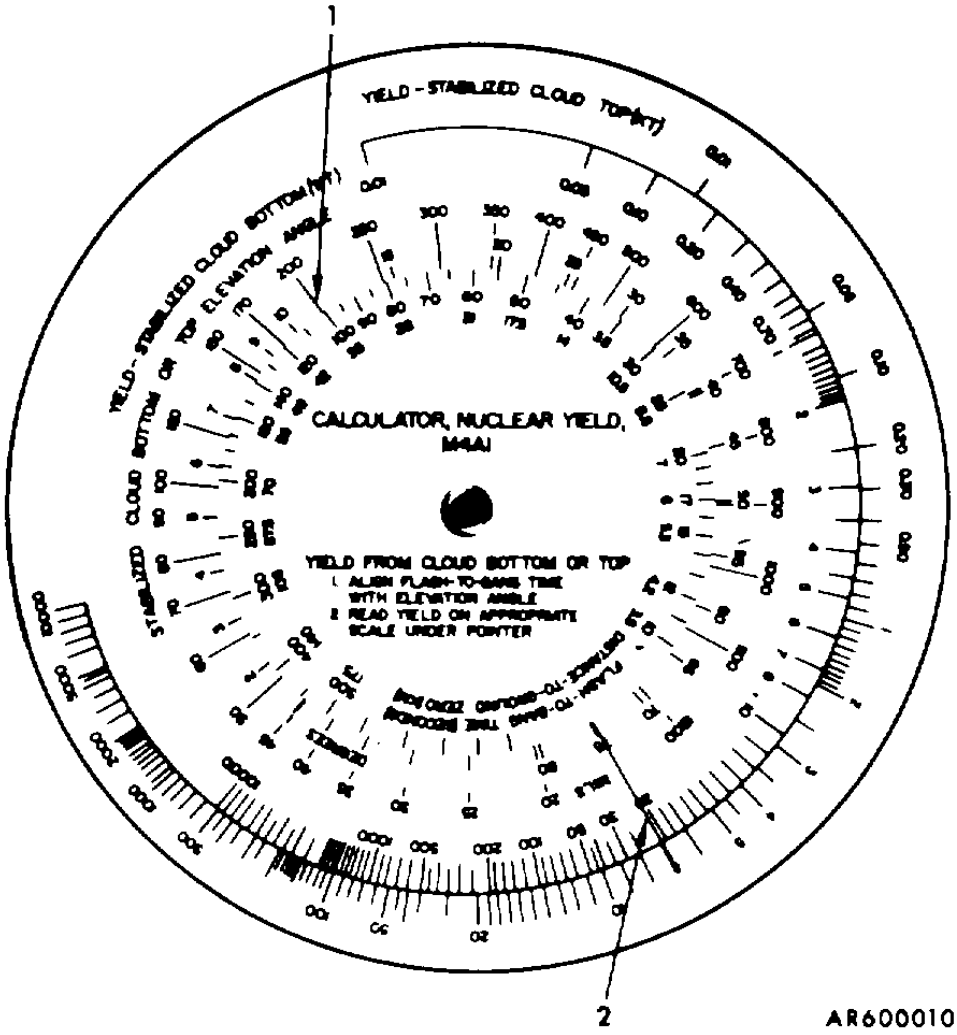
c. Yield from Flash-to-Bang Time and Cloud Width at 5 minutes (fig. 11).

(1) Example: An observer reports that FLASH-TO-BANG TIME from a burst was 100 seconds and the cloud width at 5 minutes was 180 mils. Using the calculator, determine the yield from the burst and the distance of the observer from the burst.
(2) Solution. Aline 100 seconds on the FLASH-TO-BANG TIME scale (I) with 180 mils (1) on the OBSERVED CLOUD WIDTH AT 5 MINUTES (MILS) scale. Read the yield 50 KT (3) at the point where the indexing pointer aligns with the YIELD

scale. Read 35 KM (2) on the DISTANCE-TO-GROUND ZERO scale which aligns with 100 seconds on the FLASH-TO-BANG TIME scale. Yield is 50 KT; distance is 35 KM.

d. Yield from Illumination Time (fig. 12).
(1) Example: An observer reports that the fireball illumination at his position was 3 seconds. Using the calculator determine the yield from the burst.

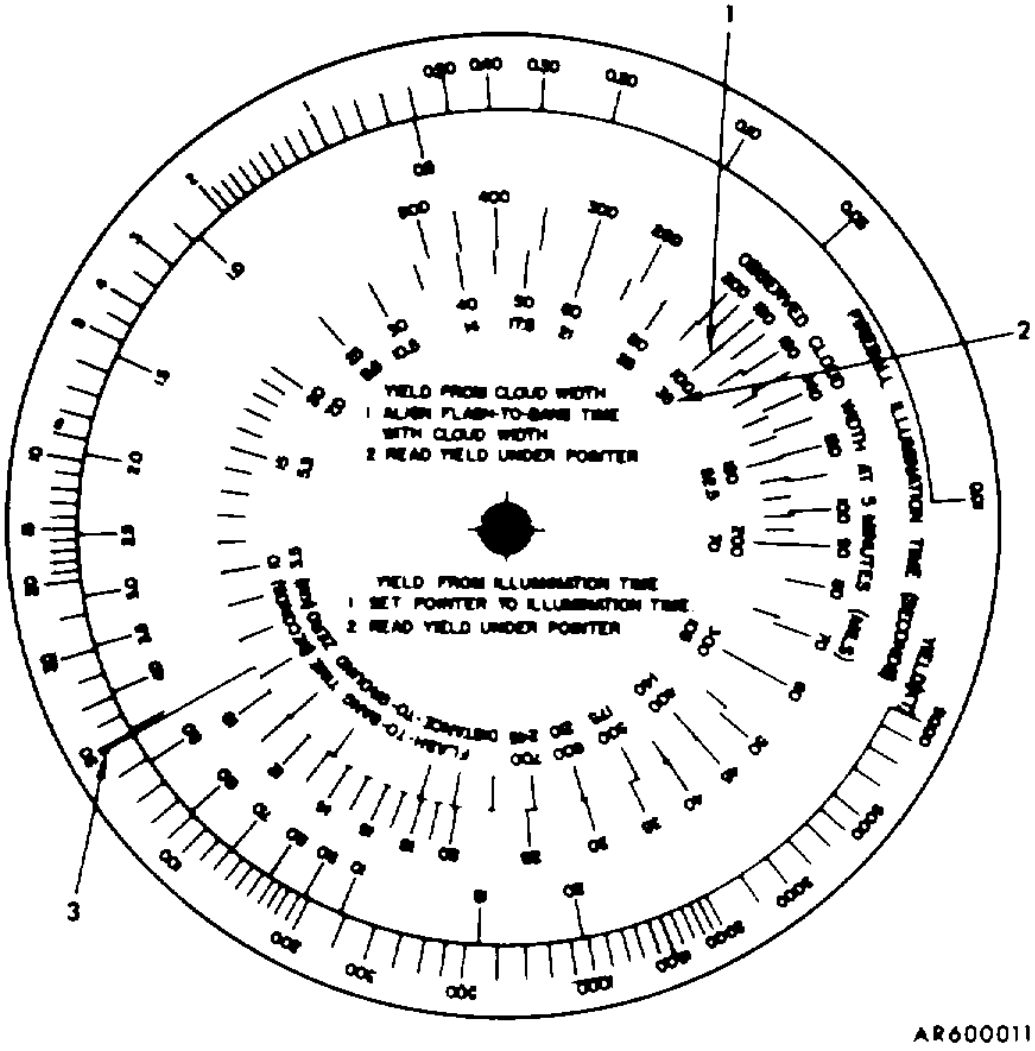
(2) Solution. Aline the indexing pointer with



1 200 MILS 2 20 KT

Figure 10. Yield from flash-to-bang time and elevation of cloud bottom.

3 seconds (1) on the FIREBALL ILLUMINATION TIME scale and read the yield (2) on the YIELD scale that falls under the indexing pointer. Yield is approximately 22 KT.

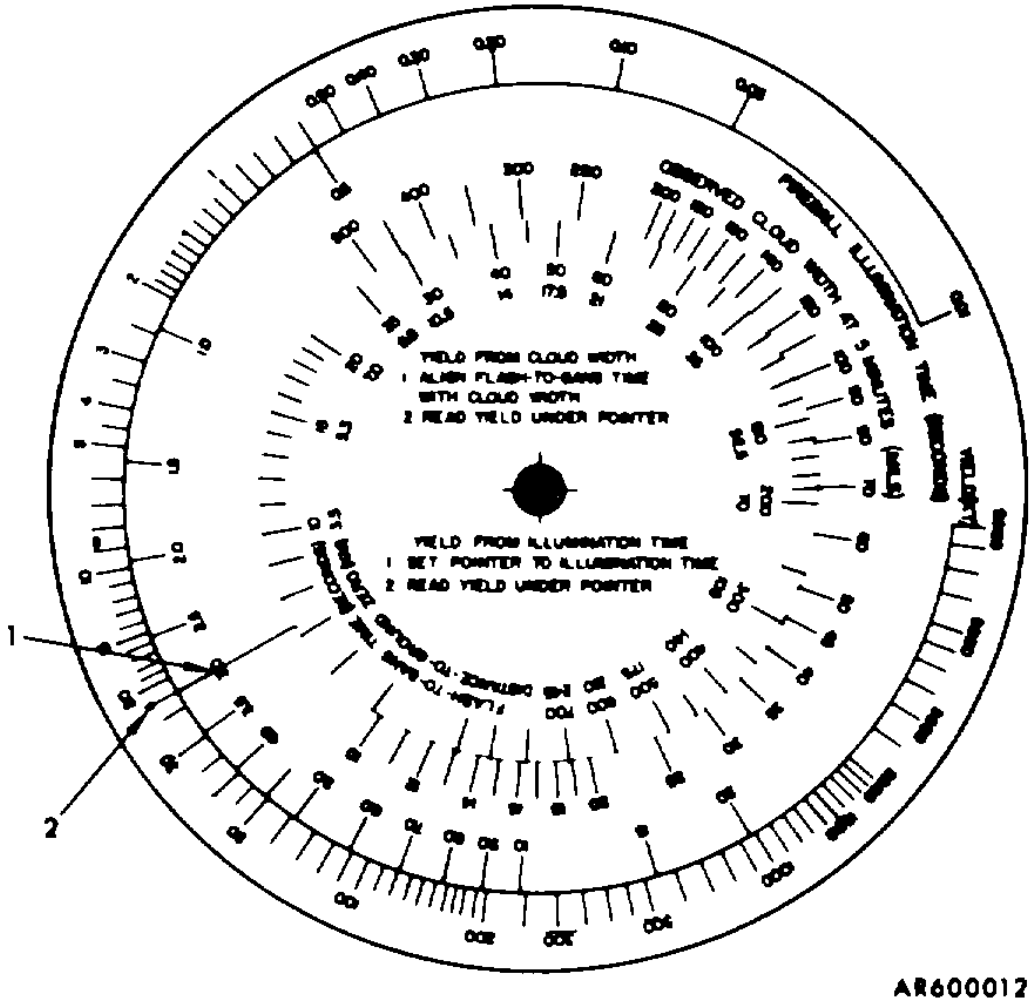


1 100 seconds aligned with 180 MILS

2 50 KT

3 35 KM

Figure 11. Yield from flash-to-bang time and cloud width at 5 minutes.



1 Indexing pointer aligned with 3 seconds 2 22 KT yield

Figure 12. Yield from illumination time.

By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

Official

VERNE L. BOWERS
Major General, United States Army
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THE METRIC SYSTEM AND EQUIVALENTS

NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

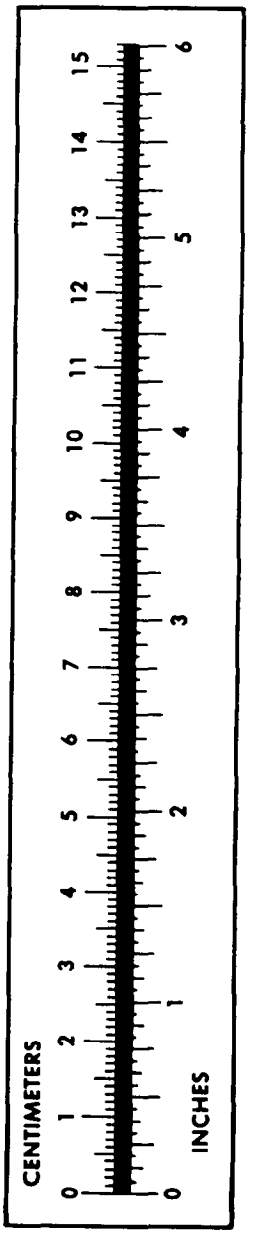
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621



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