Chapter 4

Detailed Fallout Prediction—NBC 3 Report

Overview

The need for a fallout prediction system stems from the large-area radiological hazard that develops from fallout-producing nuclear bursts. Contamination has a large impact on military planning and operations. This hazard produces mass casualties if its presence is not detected and actions taken to minimize the radiological hazards. Commanders at all echelons must understand its effects and take action to minimize those effects.

There are many occasions when a commander will require a fallout prediction. Three examples follow:

- When the commander plans to use a nuclear weapon that lacks 99-percent probability of being fallout safe or whenever a contact backup fuze is used, a prestrike fallout prediction is prepared as part of the target analysis.
- Information may indicate that fallout is occurring or that fallout probably will occur from a nuclear burst (friendly or enemy). In this case, a fallout prediction is required to enable the commander to warn higher, adjacent, and subordinate units.
- When a fallout-producing burst occurs, an evaluating procedure is begun that will answer the commander's questions about the hazard. However, a time lag of several hours to a day or more may occur between the time of burst and the availability of measured data (from radiological monitoring and/or survey). This delays evaluation of the actual hazard. During this time lag, the fallout prediction (area of expected hazard), or at best the fallout prediction supplemented by measured radiation data, may be the only available information for estimating the effects of the radiation hazard on tactical operations or plans. This information is significant in that it will enable the commander to avoid the contamination, if possible.

Significance of Predicted Fallout Zones

In both simplified and detailed prediction, a zone of primary hazard (Zone I) and one of secondary hazard (Zone II) are predicted. Figure 4-1 shows Zones I and II. These zones are defined as areas where exposed, unprotected personnel may receive militarily significant total doses of nuclear radiation within four hours after arrival of fallout. These doses may result in a reduction in combat effectiveness.

Inside the Predicted Area

Zone I delineates the area of primary hazard and it is called the zone of immediate operational concern. In this zone, there will be areas where exposed, unprotected personnel may receive doses of 150 centigray (cGy) (the emergency risk dose), or greater, in a relatively short period of time (less than four hours after arrival of fallout). (See Appendix A for a detailed discussion on emergency risk dose). Major disruptions of unit operations and personnel casualties may occur within portions of this zone. Actual areas of disruption are expected to be smaller than the entire area of Zone I. But, exact locations cannot be predicted.

The exact dose personnel will receive at any location inside Zone I depends on the dose rate at their location, the time of exposure, and available protection. There is, however, a reasonably high assurance that personnel outside the boundary of Zone I will not be exposed to any emergency risk dose in less than four hours. The radiation produced from neutron-induced activity will be closely confined to the area around GZ, which will be well within

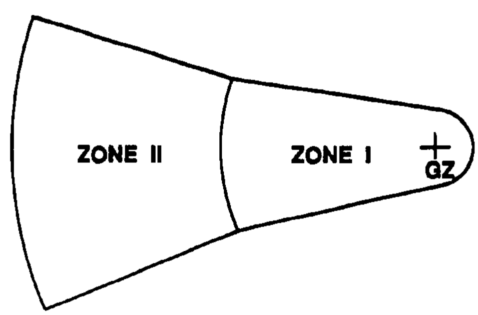

Figure 4-1. Example of predicted Zones I and II.

the limits of Zone I. So induced radiation will have no effect on the extent of Zone I but will cause higher dose rates in the area around GZ. Thus, the dose from induced radiation is not considered in determining the extent of Zone I.

Zone II is called the zone of secondary hazard. In this zone, the total dose received by exposed, unprotected personnel is not expected to reach 150 cGy within four hours after the arrival of fallout; but personnel may receive a total dose of 50 cGy (the negligible risk dose), or greater, within the first 24 hours after the arrival of fallout. But, only a small percentage of personnel in the zone is expected to receive these doses.

The exact dose personnel will receive at any location within Zone II depends upon the dose rate at their location, the time of exposure, and available protection. Personnel located close to the extent of Zone I normally will receive higher doses than those located close to the extent of Zone II. Personnel with no previous radiation exposure maybe permitted to continue critical missions for as long as four hours after the arrival of fallout without incurring the emergency risk dose. If personnel in this zone have previously received significant radiation doses (a cumulative dose of 150 cGy or more), serious disruption of unit mission and casualty-producing doses may be expected.

Outside the Predicted Area

Exposed, unprotected personnel may receive a total dose that does not reach 50 cGy in the first day (24 hours) after actual arrival of fallout. The total dose for an infinite time of stay outside the predicted area should not reach 150 cGy. Therefore, outside the predicted area, no serious disruption of military operations is expected to occur if personnel have not previously been exposed to nuclear radiation. Appreciable previous exposure should be considered. In either case, periodic radiological monitoring coupled with routine radiological defense measures normally will provide adequate protection. These defense measures or protection measures are outlined in FM 3-4.

Reliability

The predicted zones of fallout are larger than the actual area of the ground that will be covered by fallout. These zones represent areas of hazard. Radioactive particles are predicted to fall within these zones. Due to the uncertainty of weather and nuclear burst input data, the precise locations of fallout within the zones cannot be reliably predicted. Reconnaissance, monitoring, and survey will assist in locating contaminated areas after fallout has settled. These procedures are discussed in Chapter 5. The zones, therefore, have been developed so that there is a reasonably high assurance that all militarily significant fallout will occur inside them. This is true in all cases except those that involve rainout or washout. They represent an expected hazard area that can be quickly predicted immediately after receipt of actual or planned nuclear burst information.

Arrival of Fallout

The arrival of fallout is of great interest to commanders. Only by knowing when to expect fallout can plans be made to avoid it. Calculate the estimated time of arrival of fallout using the following procedures—

Step 1. Measure the distance from the given location to GZ.

Step 2. Determine the effective wind speed from the NBC 3 nuclear report or by using the procedures outlined previously for EDMs in the preceding chapter.

Step 3. Divide the distance from GZ by the effective wind speed. The result is the estimated time of arrival :

$$\textit{Time of arrival (TARR)} = \frac{\textit{distance from GZ (km)}}{\textit{effective wind speed (kmph)}}$$

Commanders must remember three basic rules when estimating the time of arrival of fallout

Rule 1. Fallout may arrive as early as one-half of the estimated time of arrival (ETA).

Rule 2. If fallout has not arrived by twice the ETA or H+ 12 (whichever is earliest) fallout is not expected to fall on that location.

Rule 3. Fallout may not cover the entire predicted area. Therefore, units must not move based solely on the fallout prediction.

An estimate may also be made mathematically to determine when fallout will be completed at a particular location on the battlefield:

$$T\ \textit{completion} = 1.25 \times TARR + \frac{\textit{clooud diameter}}{\textit{effective wind speed}}$$

The time (T) in hours stir detonation by which fallout will be completed at any specific point is approximately one and one-quarter the time of arrival (in hours after detonation) of fallout, plus the time in hours required for the nuclear cloud to pass over.

Example: For a particular location, the following data has been determined:

TARR = H + 2 hr

Cloud Diameter = 9 km (this number comes from Figure 4-2, line i, next page). Find the cloud radius for any given yield and multiply by 2.

Effective Wind Speed = 20 kmph

$$T\ \textit{completion} = 1.25 \times 2hr + \frac{18\ km}{20\ kmph}$$

$$T\ \textit{completion} = 2.5 + .9 = H + 3.4\ hrs$$

$$= 3\ hr\ 24\ min\ \textit{after the burst.}$$

The actual time of completion maybe determined by taking a series of dose-rate readings at the same location over a period of time or by looking at an NBC 4 Peak Report. The peak reading indicates that fallout is complete.

Plot these dose rates against time on log paper. The dose rate will increase, reach a maximum, and then start to decrease with time. Plot a series of readings until the reading falls on the same straight line. This will indicate a constant rate of decay. The time of completion can be determined from the graph by reading the dose rate on the

FALLOUT PREDICTION WORKSHEET-SURFACE BURST

For use of this form, see FM 3-3-1; proponent of this form is TRADOC.

a. Time of burst (date-time group) 270400 DELTA DDtttt (~~Local or~~ ZULU)

b. GZ Coordinates NA170630 FOXTROT yyzzzzzz (~~actual or~~ estimated)

c. FY/TY Ratio (from target analyst for friendly weapons only) 1

d. HOB (from target analyst for friendly weapons only) 0 meters

e. Yield 200 KT ~~or MT~~

f. Cloud-top Height (Fig. 4-3) 16 10^3 meters ~~or feet~~

g. Cloud-bottom Height (Fig. 4-3) 10.4 10^3 meters ~~or feet~~

h. 2/3 Stem Height (Fig. 4-3) 6.8 10^3 meters ~~or feet~~

i. Stabilized Cloud Radius (Fig. 4-3) 9 ZULU rr (km)

j. Time of Fall from Cloud Bottom (Fig. 4-3) 2.8 hours

Fallout Wind Vector Plot (Enter f, g, and h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height)

k. Radial Line Distance from GZ to Cloud-Bottom Height 39.5 km

l. Effective Wind Speed = $\frac{\text{k (GZ to CB dist)}}{\text{j (Time of fall)}} = \frac{39.5}{2.8} \frac{\text{km}}{\text{hr}} =$ 14 ZULU sss (kmph)

m. Downwind Distance of Zone 1 (Enter Fig. 4-7 with i and e) 54 km

n. Adjustment = FY/TY Factor 1 x HOB Factor 1 = 1
(Enter Fig. 4-8 with e and c or use a 1) (Enter Fig. 4-9 or 4-10 with d and e or use a 1)

o. Adjusted Downwind Distance of Zone I (m x n) 54 ZULU xxx (km)

Fallout Wind Vector Plot (Check lateral limits for 40 degrees)

p. Azimuth of Left Radial Line 273 YANKEE dddd (~~mils or~~ degrees)

q. Azimuth of Right Radial Line 354 YANKEE cccc (~~mils or~~ degrees)

r. NBC 3 Nuclear

ALFA AAA	0 0 1	(Strike Serial Number)
DELTA DDtttt	2 7 0 4 0 0	(~~Local or~~ ZULU)
FOXTROT yyzzzzzz	N A 1 7 0 6 3 0	(GZ coordinates—~~actual or~~ estimated)
YANKEE ddddcccc	0 2 7 3 0 3 5 4	(Azimuths or radial lines—~~mils or~~ degrees)
ZULU sssxxxrr	0 1 4 0 5 4 0 9	
	(effective wind speed) (downwind distance) (cloud radius)	

DA FORM 1971-4-R, JAN 94 — Replaces DA Form 1971-4-R, Sep 86, which is obsolete.

Figure 4-2. Completed fallout prediction worksheet.

straight line showing constant decay. This procedure will be discussed later in this chapter.

NBCC Procedures

The NBCC prepares the detailed fallout prediction and disseminates the information to subordinate units as an NBC 3 nuclear report. The NBCC prepares the detailed fallout prediction by determining how high (layer) the fallout particles rise and then uses the wind vector plot to predict where the particles will land. The following steps are used to prepare the detailed fallout predictions:

Step 1. Prepare the fallout wind vector plot as described in Appendix D to this field manual. The fallout wind vector plot is prepared each time new upper air wind data

RADIOACTIVE CLOUD AND STEM PARAMETERS (STABILIZED AT H + 10 MINUTES)

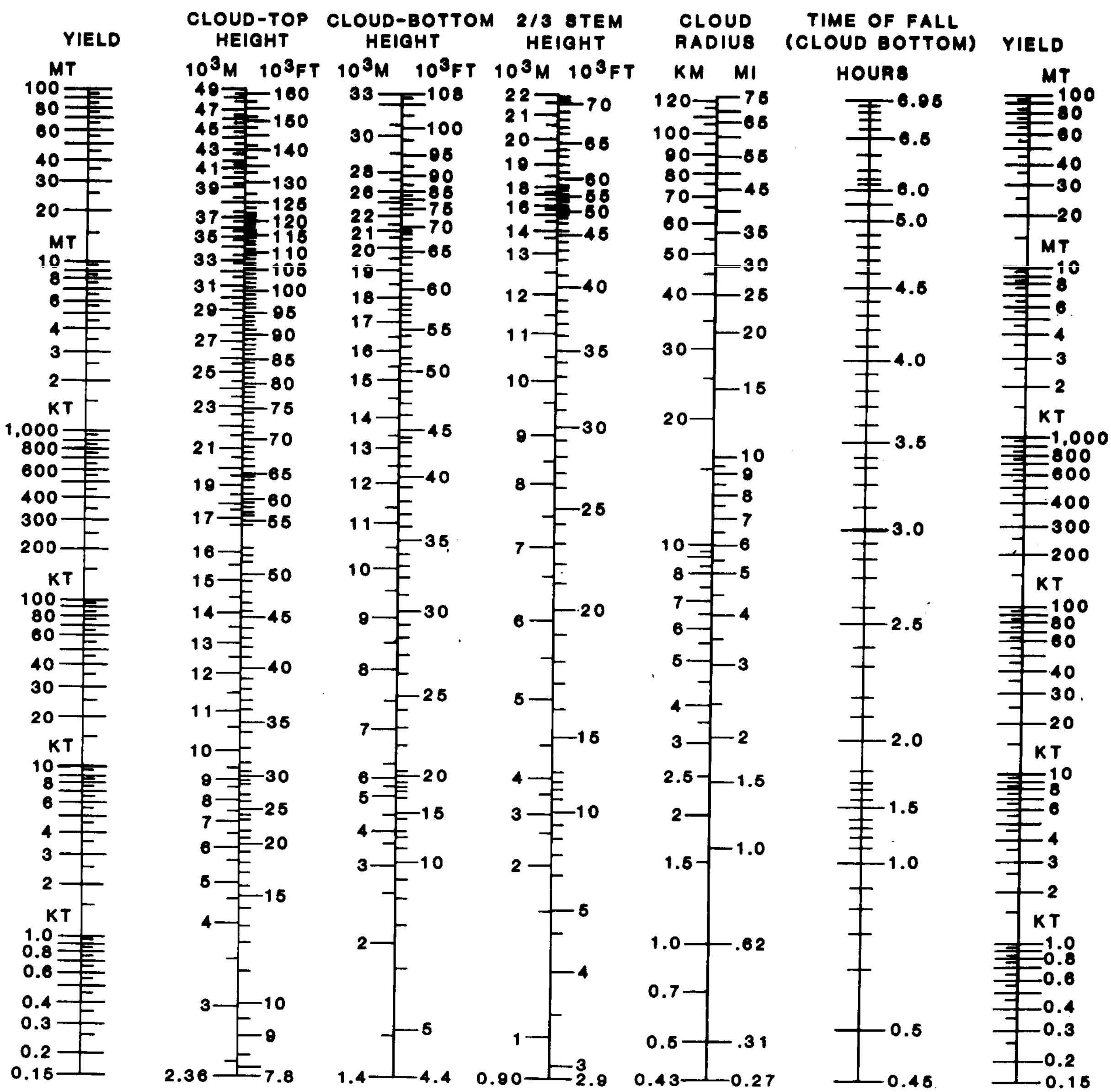

Figure 4-3. Radioactive cloud and stem parameters nomogram.

are received. Every prediction made from the current fallout wind vector plot should be prepared on a separate overlay so that the current fallout wind vector plot can be saved for further use. The fallout wind vector plot may be drawn to any convenient map scale.

Step 2. Determine nuclear burst information. Use DA Form 1971-4-R (Fallout Prediction Worksheet—Surface Burst) for recording data. Nuclear burst information is recorded on lines a through e from the NBC 2 nuclear reports (see Figure 4-2).

Step 3. Determine cloud parameters. Once yield is determined (Step 2), use Figure 4-3 to determine cloud parameters. Place a straightedge so that the values on the left yield index scale and on the right yield index scale are

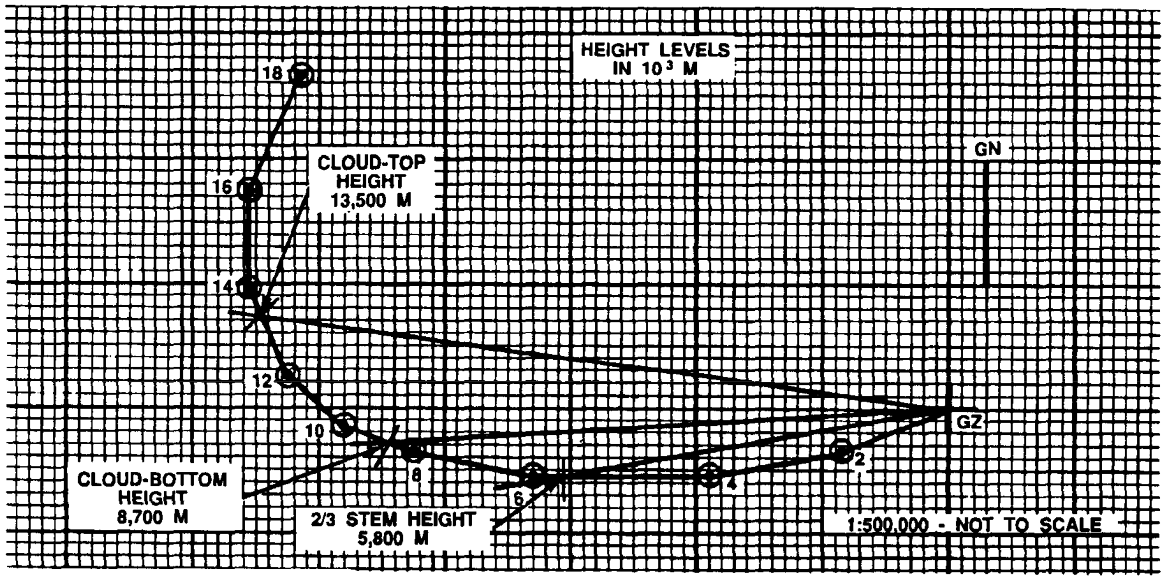

Figure 4-4. Initial determination of radial lines.

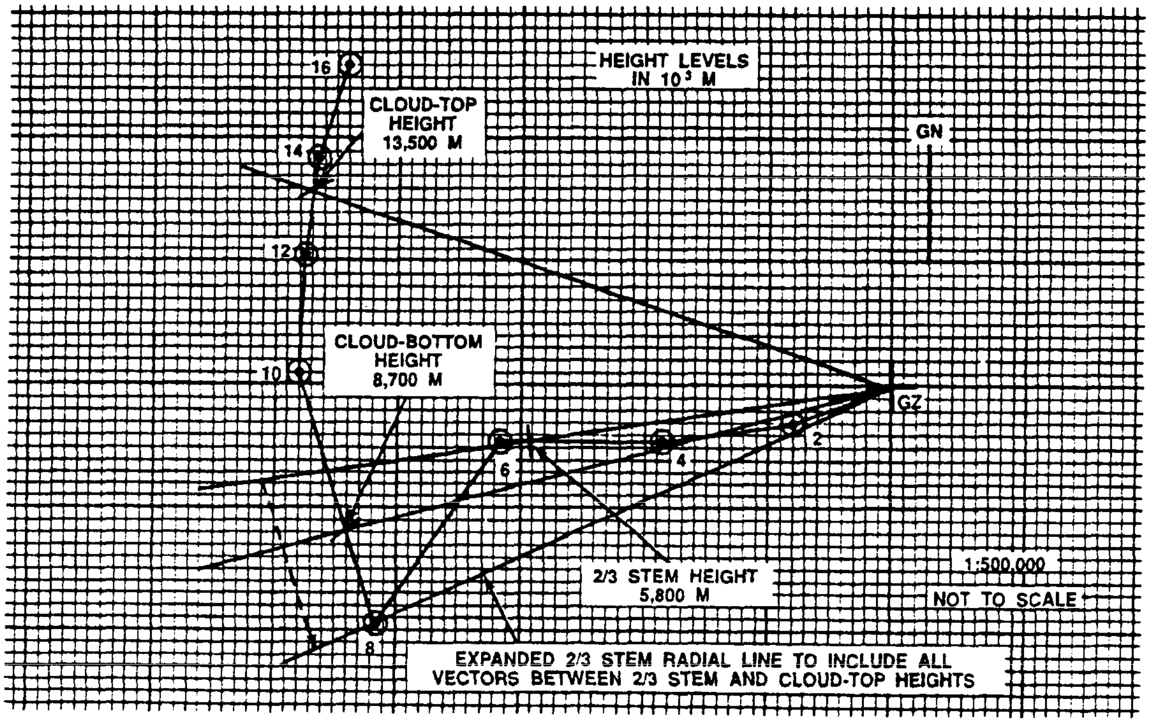

Figure 4-5. Expansion of radial lines.

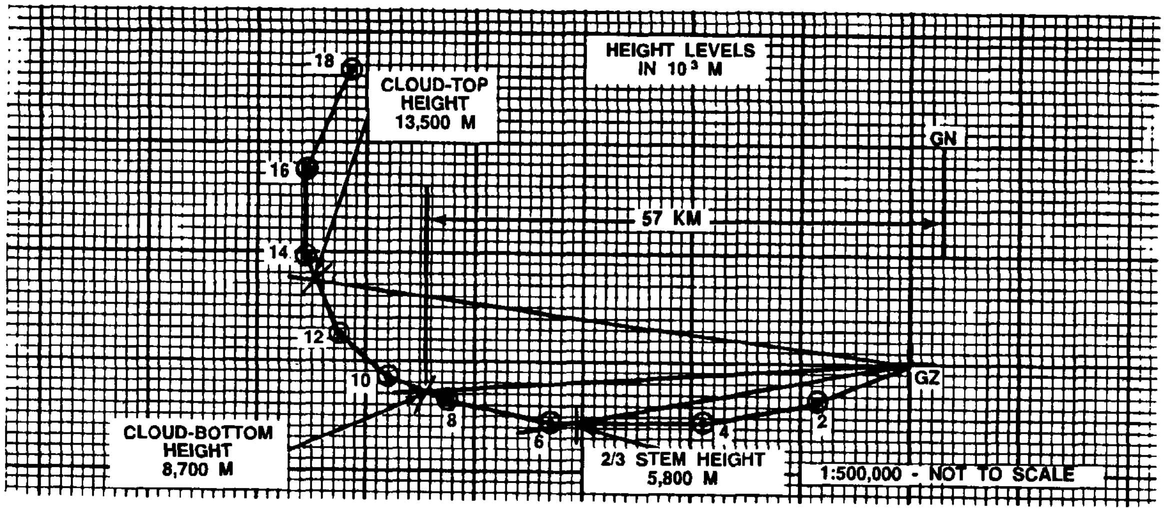

Figure 4-6. Determination of effective wind speed.

the same. Read all parameters under the straightedge. Record cloud parameter values on lines f through j of the worksheet.

Step 4. Determine lateral limits of the fallout prediction. Mark points representing the cloud-top height, cloud-bottom height, and two-thirds stem height on the fallout wind vector plot. Draw radial lines from the GZ point through these height points (Figure 4-4). (Interpolate linearly between the wind vector if necessary.) Disregard all wind vectors below the two-thirds stem height point and above the cloud-top height point when preparing the prediction. If wind vectors between the two-thirds stem height point and the cloud-top height point fall outside the radial lines drawn from GZ through these points, expand the angle formed by these two radial lines to include these outside wind vectors. An example of this is shown in Figure 4-5

Step 5. Determine the effective wind speed. Measure the length of the radial line, in kilometers, from GZ to the cloud-bottom height point (Figure 4-6). Record this value on line k of the work sheet. Read the time of fall from the cloud bottom (determined in step 3) from the work sheet (item j). Compute the effective wind speed as shown in the formula below, and record on line Lima of the work sheet:

$$\textit{Effective wind speed} = \frac{\textit{radial line distance from GZ to cloud-bottom height (km)}}{\textit{time of fall from cloud bottom (hr)}}$$

Note: If the effective wind speed is less than 8 kmph, it is a special case. When the wind speed is less than 8 kmph, always use an 8 kmph wind speed in step 6.

Step 6. Determine the downwind distances of Zones I and II.

Using Figure 4-7, align a straightedge from the yield on the right-hand scale to the value of the effective wind speed on the left-hand scale. Where the straightedge intersects with the center scale, read the downwind distance of Zone I. Record this value on line M of the work sheet.

Obtain the fission yield/total yield (FY/TY) ratio from the nuclear target analyst. FY/TY can also be found in FM 101-31-2 (S). The FY/TY ratio is expressed as a percentage. It states the percent of the weapon's explosive ability that is contributed by the fission process. The remainder of the weapon's yield is derived from fusion. This is significant in fallout prediction. The fusion portion of the weapon does not create residual contamination. Thus, a weapon with a FY/TY ratio of 0.6 means that 60 percent is fission and 40 percent is fusion. A crude comparison could be that this weapon will make 40 percent less fallout than a weapon with the same size yield which is 100 percent fission. If the FY/TY ratio is known, obtain the FY/TY adjustment factor from Figure 4-8, page 4-7, or by using the FY/TY table in Appendix E.

Lay a straightedge from the total yield on the left-hand scale to the value of the FY/TY ratio on the right-hand scale. Where the straightedge intersects with the center scale, read the FY/TY adjustment factor. If the FY/TY ratio is not known, assume the yield to be 100-percent fission and use an FY/TY adjustment factor of 1. Record the FY/TY adjustment factor on line N of the work sheet,

HOB is known (as in the case of a prestrike friendly burst), obtain the height-of-burst adjustment factor from Figure 4-9 or 4-10, pages 4-8 or 4-9. Figure 4-9 is for yields equal to or less than 100 KT. Figure 4-10 is for yields greater than 100 KT. Lay a straightedge from the yield on the left-hand scale to the value of the Height-of-Burst on the center scale. At the intersection of the straightedge with the right-hand scale, read the height-of-burst adjustment factor. If height-f-burst is not known, assume a zero height-of-burst and use a height-f-burst adjustment factor of 1. Record on line n of the work sheet.

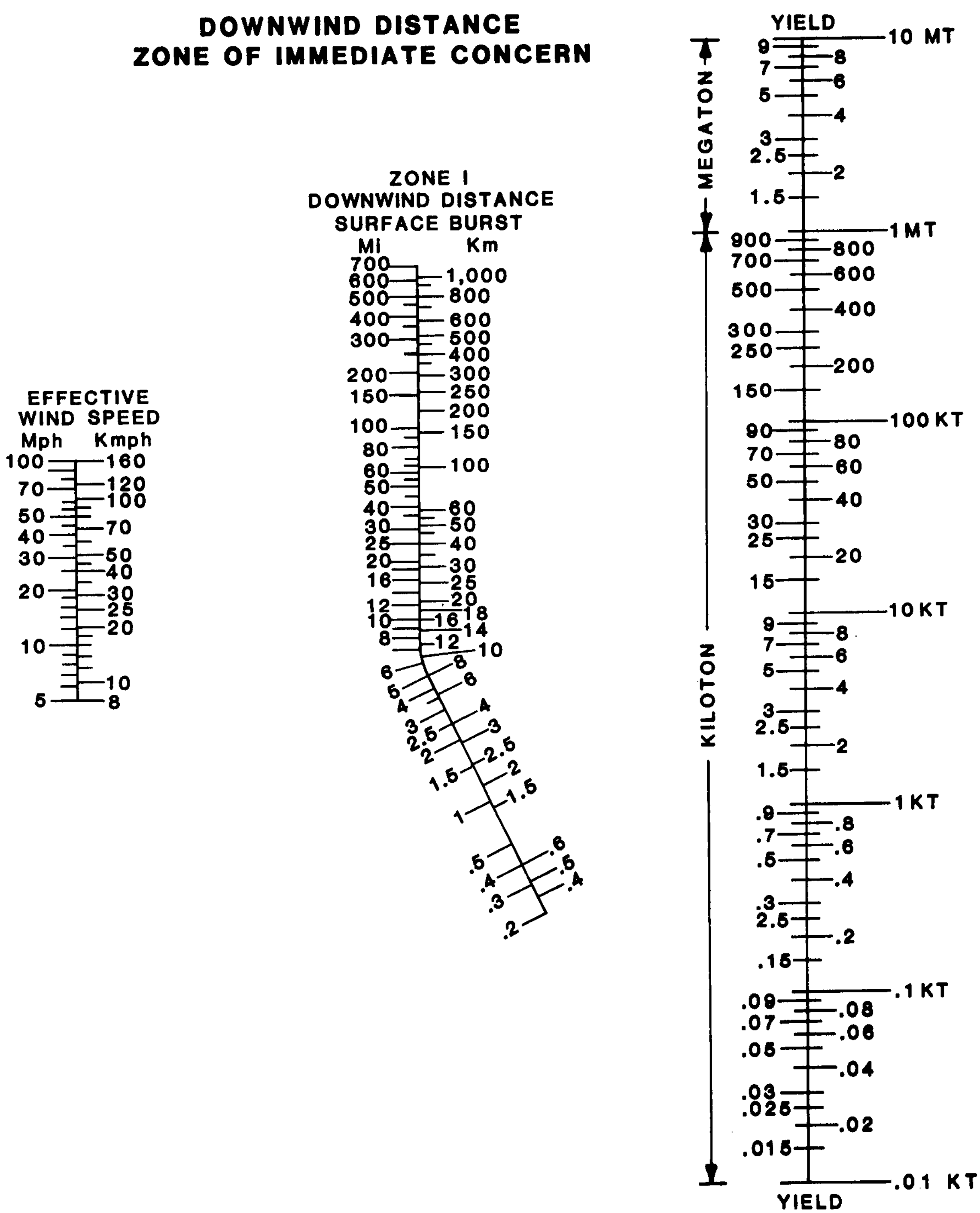

Figure 4-7. Nomogram for determining Zone I.

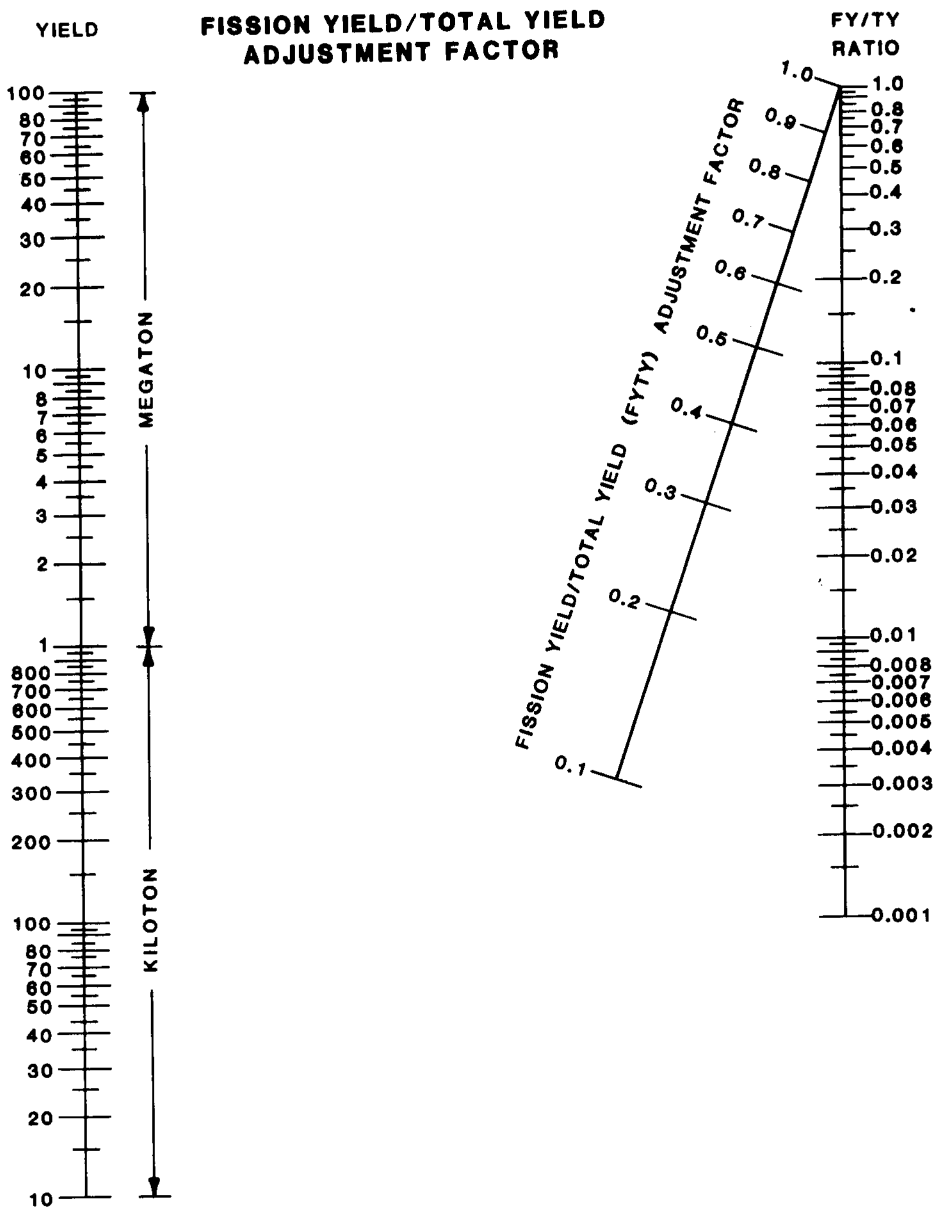

Figure 4-8. Nomogram for determining fission yield and/or total yield adjustment factor.

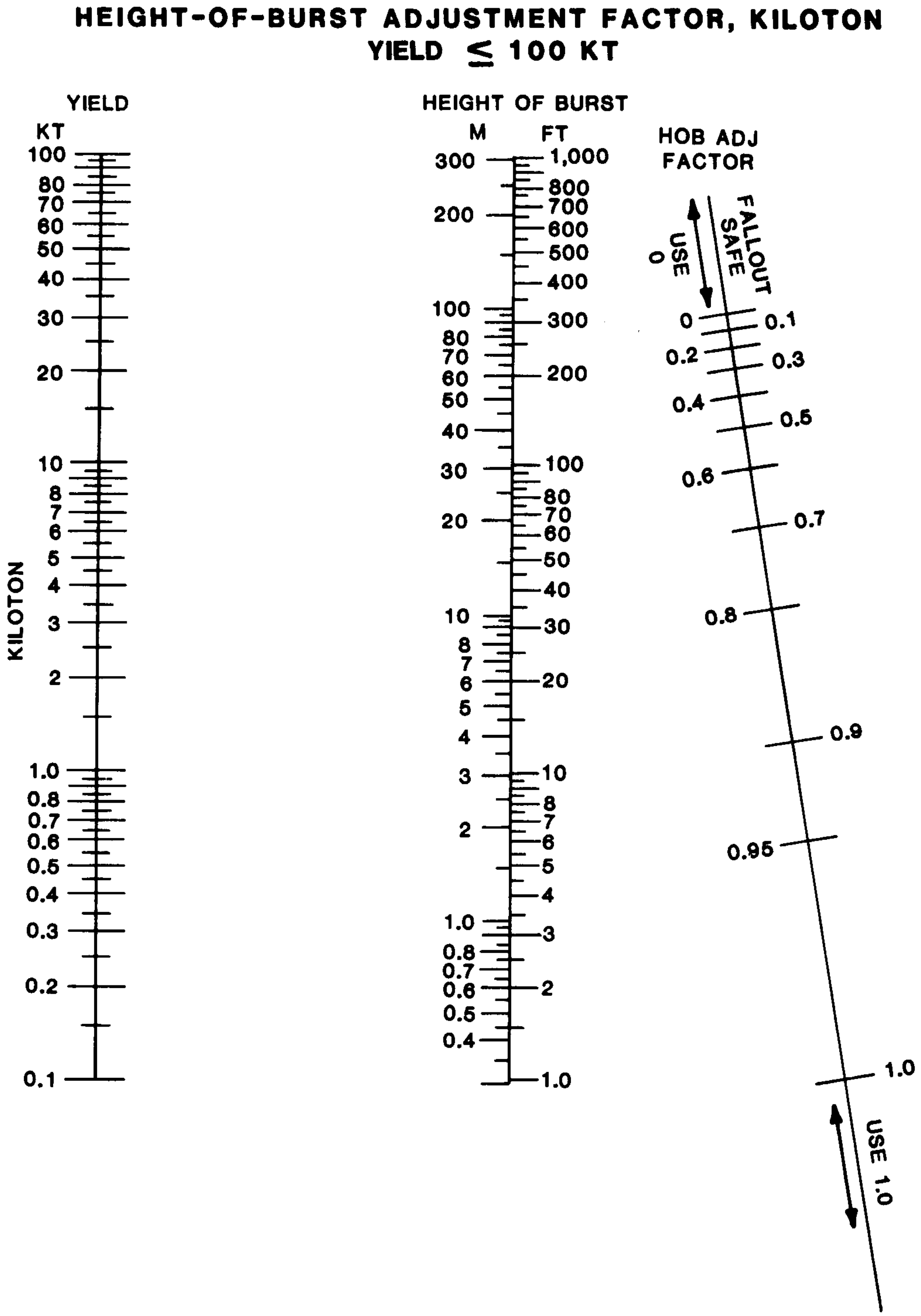

Figure 4-9. Nomogram for determining height-of-burst adjustment factor.

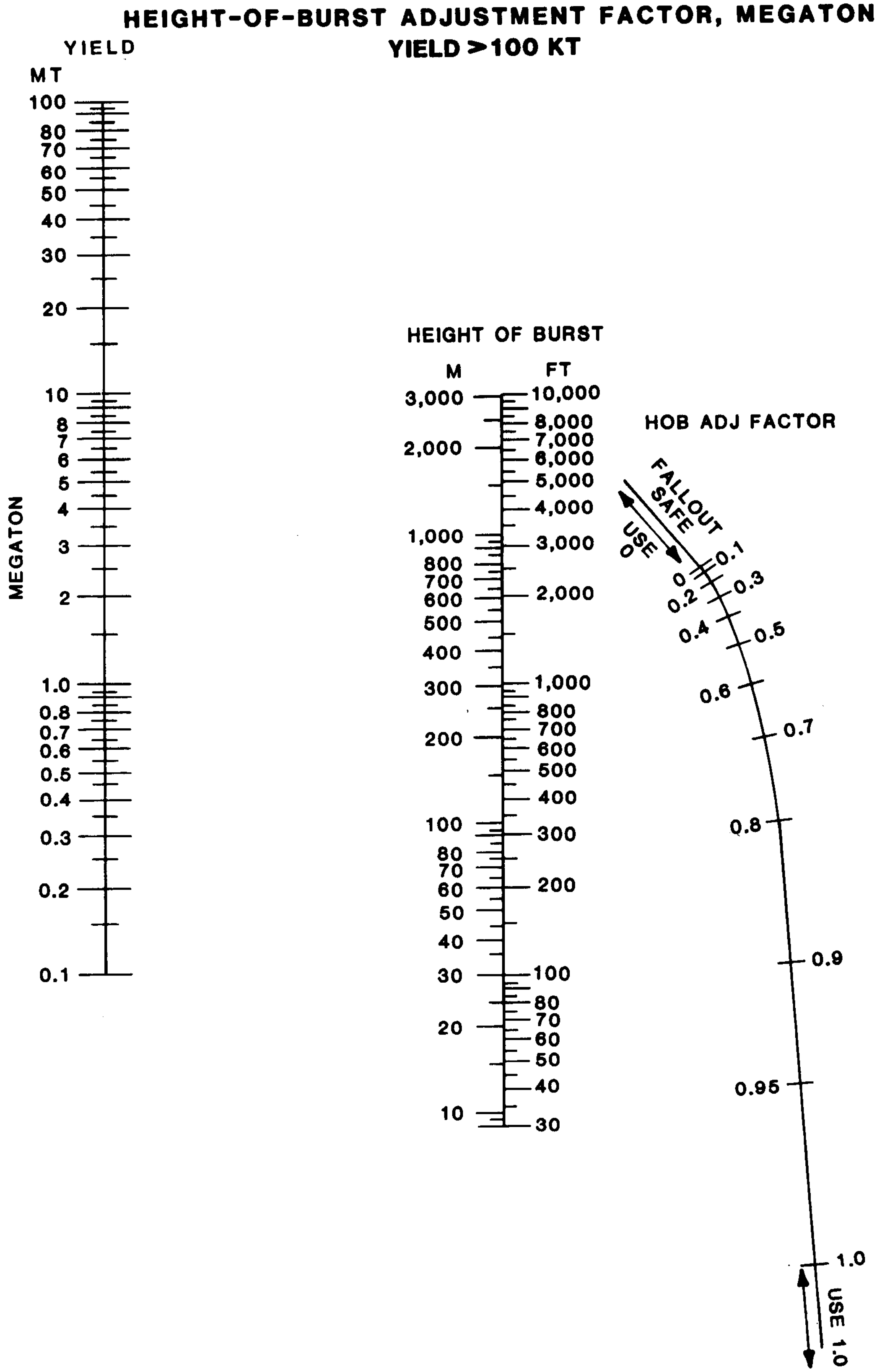

Figure 4-10. Nomogram for determining height-of-burst adjustment factor, megaton.

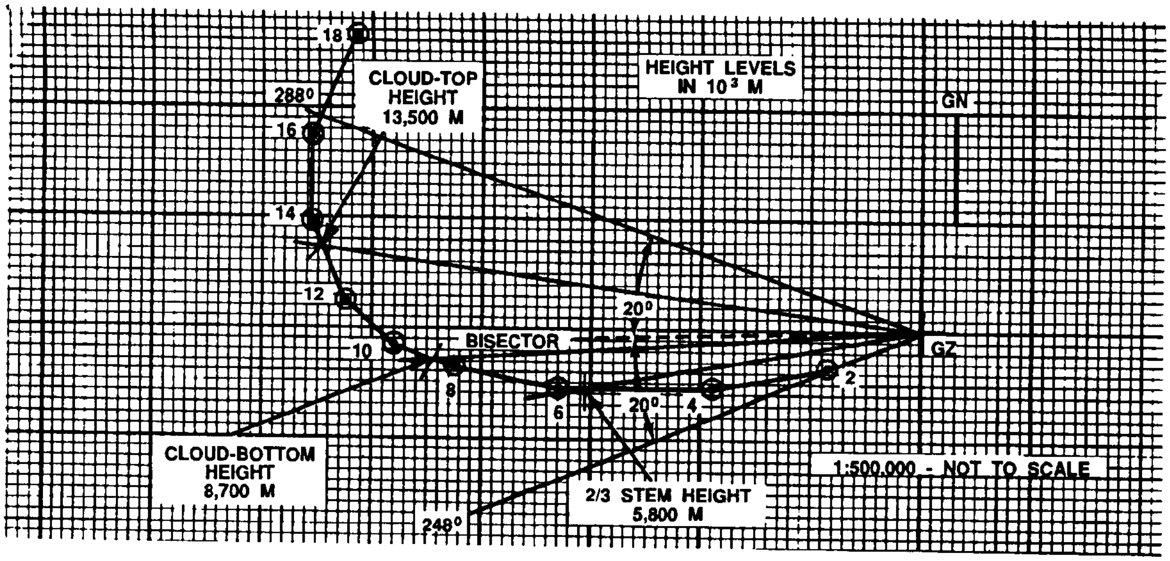

Figure 4-11. Constructing radial lines.

HOB adjustment factor may also be obtained by using the HOB adjustment table in Appendix E.

Multiply the Zone I downwind distance for a surface burst (determined in “a” above) by both the height-of-burst and the FY/TY adjustment factor to obtain the adjusted downwind distance of Zone I for the given conditions. Record this value on line o of the work sheet.

Double the Zone I distance recorded on line o to obtain the adjusted downwind distance of Zone II.

Note: If the effective wind speed is less than 8 kmph, the detailed prediction is now complete. Prepare the NBC 3 nuclear report (line r on the work sheet) as described in Step 9. If the wind speed is not less than 8 kmph, go to Step 7.

Step 7. Construct left and right radial lines.

Measure the angle formed by the radial lines drawn from GZ to the cloud-top height and two-thirds stem height points on the fallout wind vector plot (or the radial lines which have been expanded to include vectors between the two-thirds stem height and the cloud-top height). If the angle formed is 40 degrees or greater, measure the azimuths (in roils or degrees from GN) of the final left and right lines and record on lines p and q of the work sheet. If the angle formed is less than 40 degrees, bisect the angle and expand the angle formed by the two radial lines to 40 degrees (20 degrees on each side of the bisector) (Figure 4-11, above).

Step 8. Complete the fallout prediction.

Start with GZ on an overlay at the selected map scale, and extend the radial lines at their proper azimuths to any convenient distance. Mark GN on this overlay. (The fallout wind vector plot was originally drawn to a convenient map scale; for example, 1:500,000. If it is more convenient, a different map scale can now be used to complete the fallout prediction.)

Between the two radial lines drawn from GZ, and using GZ as center, draw two arcs with radii equal to the Zone I and Zone II downwind distances found in step 6 (Figure 4-12, next page, Part 1).

Using GZ as center, draw a circle around GZ with a radius equal to the cloud radius at the selected map scale (Figure 4-12, Part 2).

Draw two tangents extending from the GZ circle to the points of intersection of the two radial lines with the Zone I arc (Figure 4-12, Part 3).

Using GZ as center, indicate the estimated times of arrival of fallout by drawing dashed arcs downwind at distances representing effective wind speed for each hour of interest (Figure 4-12, Part 4).

Step 9. Prepare the NBC 3 nuclear report. Complete line r of the work sheet. The report will always include the following line items:

Alfa—This line is the strike serial number. The strike serial number is assigned by the NBCC at the operations center responsible for the area in which the strike occurs.

Delta DDtttt—This line is the date-time group of the burst, with DD (the day) and tttt (H-hour) in local or Zulu time (GMT) (state which).

Foxtrot yyzzzzzz—llis line is the actual or estimated (state which) coordinates of GZ. The two letters yy represent the appropriate 100, OQO-meter grid square and the letters zzzzzz coordinates of GZ within this grid square. This line item will be encoded if sent over an unsecure communications net. This is to deny tactical information on the effectiveness and accuracy of enemy weapons.

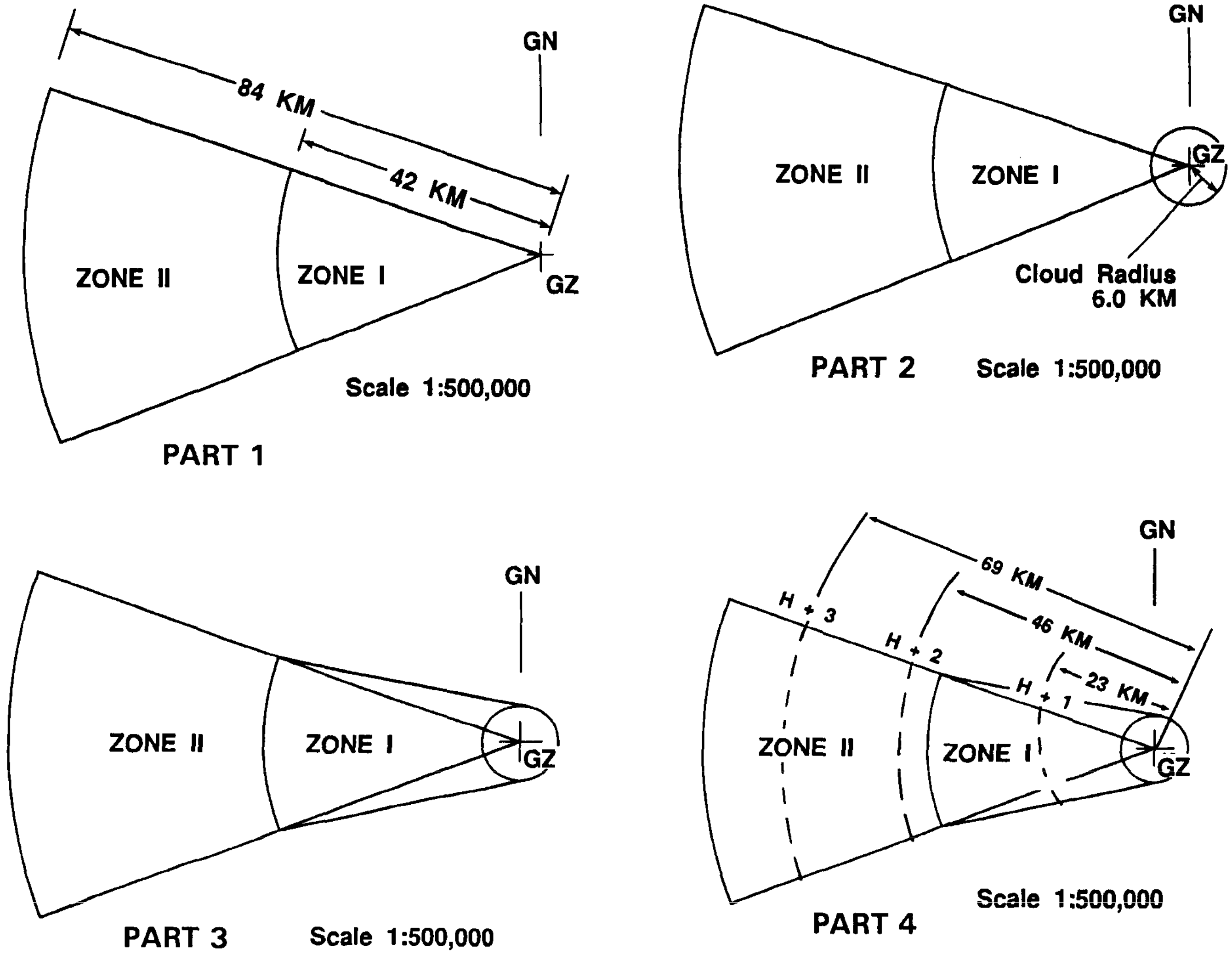

Figure 4-12. Four parts of completing a fallout prediction.

Yankee ddddcccc—This line is the azimuths of the two radial lines to the nearest mil or degree from GN. The letters dddd represent the azimuth of the left radial line and the letters cccc represent the azimuth of the right radial line. Left and right in this case are the angles as they would appear to an observer located at GZ looking downwind. The unit of measurement (roils or degrees) of the azimuths must be indicated. Omit this line when the special case of low winds (less than 8 kmph) exists.

Zulu sssxxxrr—This line is the prediction dimensions. The letters sss represent the effective wind speed (to the nearest kilometer per hour), xxx represent the downwind distance of Zone I (to the nearest kilometer), and rr represent the radius of the stabilized cloud (GZ circle) to the next higher kilometer if the value is not a whole number. (This line contains only three digits when the special case of low winds applies.) Figure 4-13, next page, shows sample NBC reports.

Unit Procedures

Upon receipt of an NBC 3 nuclear report, the unit inspects the report. Several items are looked at. First, has the report been received or previously plotted? Second, is the GZ location within the unit's area of interest or zone of operations? If the report is new and/or may impact on unit operations, it must be plotted. Two different plotting procedures exist. Each procedure is discussed in the following paragraphs. See figures 4-14 and 4-15, next page.

Example 1—(Winds less than 8 kmph)

Standard Format	USMTF Program
NBC 3 Nuclear	MSGID/NBC3/NUC//
A N016	ALFA/N016//
D 221100Z	DELTA/221100Z//
F BV754082 Estimated	FOXTROT/E/32UBV754082//
Z 017	ZULU/17//

Note that line item Yankee is omitted for wind speeds of less than 8 kmph.

Example 2

Standard Format	USMTF Program
NBC 3 Nuclear	MSGID/NBC3/NUC//
A N004	ALFA/N004//
D 211100Z	DELTA/211100Z//
F MN556705 Estimated	FOXTROT/E/32UMN556705//
Y 01500050	YANKEE/015DEG/0050DEG//
Z 01501002	ZULU/015/010/02//

Figure 4-13. Sample NBC 3 nuclear reports.

If the NBC 3 nuclear report contains line item Yankee, follow these steps:

Step 1. Identify map scale to be used. Obtain a sheet of overlay paper or other transparent material. Mark a GZ location and GN.

Step 2. Examine line item Yankee. Starting at the GZ location, draw the left radial line and then the right radial line measured from GN.

Step 3. From line item Zulu, determine the downwind distance of Zone I. Starting from GZ, draw an arc between the radial lines with a radius equal to the distance of Zone I. Label this area Zone I. Draw a second arc between the radial lines at twice the radius as the downwind distance of Zone II. Label this area Zone II.

Step 4. From line item Zulu, determine the size of the cloud radius. Using GZ as the center, draw a circle with a radius equal to the stabilized cloud radius.

Step 5. Draw tangent lines from the outer edge of the cloud radius to the points of intersection of the radial lines with the Zone I arc.

Step 6. From line item Zulu, determine the effective wind speed. Beginning at GZ, draw as many dashed time-of-arrival arcs between the radial and tangent lines as will fit inside the prediction. Label the dashed arcs as hours after the burst: H + 1, H + 2, and so on. H + 1 is the closest arc to GZ. If a time-of-arrival arc coincides with a Zone I or Zone II arc, extend the zone boundary with a dashed line.

Step 7. Add marginal information to the plot. This should be all known information about the attack.

Step 8. Orient the prediction to the map and evaluate the hazard.

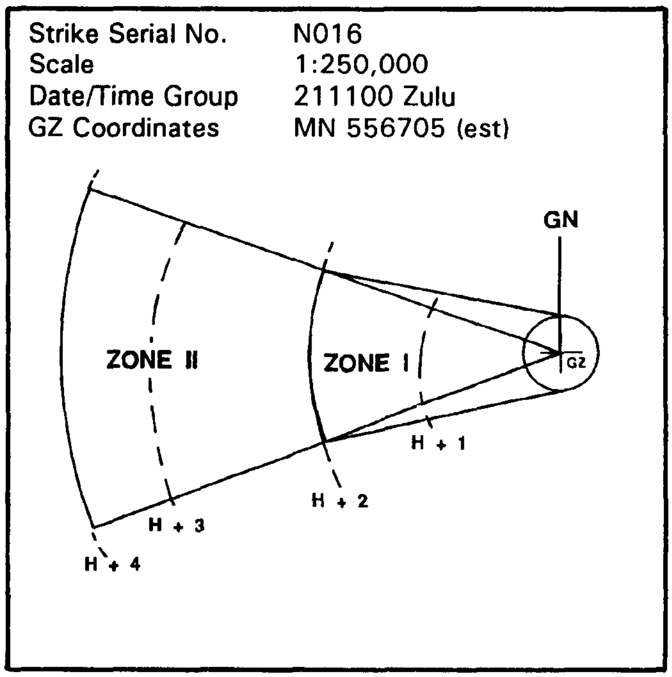

Figure 4-14. Fallout prediction from NBC 3 nuclear report.

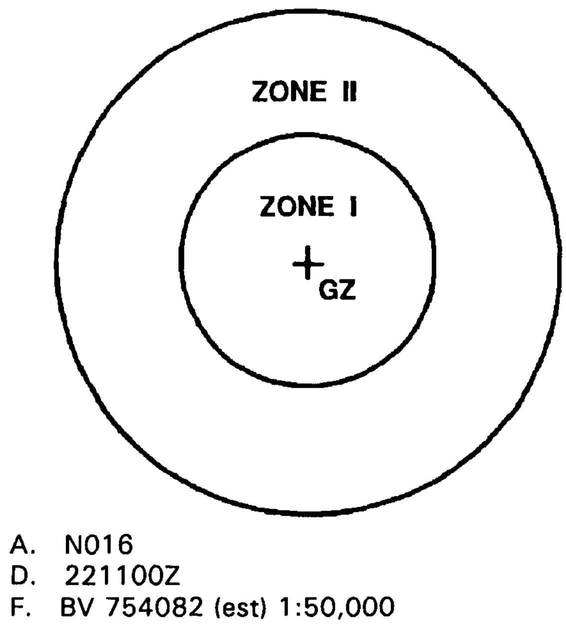

Figure 4-15. Fallout prediction from NBC 3 nuclear report (special case).

If the NBC 3 nuclear report does not contain line item Yankee, follow these steps:

Step 1. Identify map scale to be used. Obtain a sheet of overlay paper or other transparent material. Mark a GZ. A GN line is not necessary.

Step 2. The three digits shown are the radius of a circle for Zone I. Using the GZ as the center, draw a circle with a radius equal to Zone I distance. Label this area Zone I. Draw a second circle at twice this radius for Zone II. Label this arc Zone II.

Step 3. Add marginal information to the plot. This should be all known information about the attack.

Step 4. Orient the prediction to the map and evaluate the hazard.

Fallout Plotting from NAV NBC 3 Nuclear Report

In the case of a fallout producing nuclear detonation, the NBC collection/sub-collection center will prepare a fallout prediction, using the detailed procedure, as described previously.

The prediction will be passed to naval forces/ships in the format of a NAV NBC 3 nuclear report. An example follows:

NAV NBC 3 Nuclear

A. 24 (Strike serial number)
D. 2014052 (Date-time of burst)
F. 56º00ºN-11º15'E (Location of burst)
N. 10KT (Weapon yield)
Y. 01470187 DEGREES (Direction measured clockwise from GN to left and right radial lines)
z. 01000802 (Effective downwind speed (knots) 3 digits, downwind distance of Zone I (nautical miles) 3 digits, and cloud radius (nautical miles) 2 digits).

The NBC information contained in the NAV NBC 3 nuclear report can easily and rapidly be transferred to the ships fallout template (see Figure 3-35, in Chapter 3).

From letter "Y" it is seen that the angle between the GN line and the left radial line is 147 degrees, and the angle between the GN line and the right radial line is 187 degrees.

The effective downwind direction will then be the bisector of the angle formed by the two radial lines:

$$\frac{147\ degrees + 187\ degrees}{2} = 167 degrees$$

From GZ, draw the GN line through 167 degrees on the compass rose, and label GN.

From letter "Z," find the downwind distance of Zone I to be 8 nautical miles. Then the downwind distance of Zone II will be 8 x 2 = 16 nautical miles. Using the appropriate map scale, with GZ as center and the two distances as radii, draw two arcs between the radial lines.

From letter "Z," the last two digits are the cloud radius, in this example 02 nautical miles. Using GZ as center and 2 nautical miles radius, draw the cloud radius semi-circle upwind of GZ to scale.

From the intersections of the Zone I arc with the radial lines, draw lines to connect with the ends of the semicircle.

From Figure 3-36, in Chapter 3, find the safety distance for the yield, in this example for a 10 KT weapon. Safety distance for 10 KT yield is 2.5 nautical miles.

Determine the area where deposition of fallout is estimated to take place at a specific time after the detonation. The effective downwind speed is given in letter "Z," the first three digits. In the example, the wind speed is 10 knots. Multiply the effective downwind speed by the time (hours after detonation, that is, 1.25 hours after detonation, or H + 1.25 hours):

10 knots x 1.25 hours = 12.5 nautical miles.

Add and subtract the safety distance (from e above) to and from 12.5 nautical miles.

12.5 + 2.5 = 15 nautical miles, and
12.5 -2.5 = 10 nautical miles.

Using these two distances as radii and GZ as center draw two arcs across the fallout pattern. The area confined by the two arcs and the cross wind boundaries of the fallout area defines the approximate area of deposition at H + 1.25 hours.

Complete the fallout plot by indicating the following on the fallout template:

(1) NAV NBC 3 nuclear report used
(2) Yield and date-time of burst
(3) GZ
(4) Geographic chart number (scaling).

Note: When the effective downwind speed is less than 5 knots, the predicted fallout area will be circular. Then, the NAV NBC 3 nuclear report contains no letter "Y," and letter "Z" contains only three digits, indicating the Zone I downwind distance in nautical miles. The fallout prediction plot is prepared by drawing two concentric circles with GZ as center and Zone I and Zone II downwind distances as radii-the Zone II radius being twice the Zone I radius.

There may occur cases in which meteorological information normally used for fallout prediction is not available, for example the basic wind data message and the NAV EDM.

It may, however, be possible for ships to obtain the necessary wind data for fallout prediction from other sources and to compute the effective downwind direction and speed by using standard pressure level winds.

This method of computation is described in Appendix D to this field manual.

Actual Fallout Direction

The actual direction fallout takes can be determined in several ways. First, data submitted by radar operators on line item Papa Bravo of the NBC 1 nuclear report reflects the direction fallout is actually traveling. This can indicate fallout prediction reliability. Direction may be determined even before the fallout prediction is created. When actual direction varies with predicted direction, the prediction is revised in favor of the actual direction.

A second method of determining actual fallout direction is to plot NBC 4 nuclear reports, since these reports should originate from within the predicted area. If the reports come from areas not predicted to receive fallout, the prediction may require revision. Note that the prediction's shape is not an absolute boundary. Fallout will occur outside the area. However, militarily significant fallout as defined by Zone I and Zone II should be inside the predicted area.

When a unit is in an area predicted to receive fallout, it must take action to reduce the potential threat. These actions must be listed in the unit SOP. Some examples of these actions are—

- Alert all personnel.
- Construct shelters with overhead cover or improve existing shelters.
- Calculate when fallout will arrive (H + . hours after burst). Plan on having only half of this time to be sure.
- Upload and prepare to move out of the contaminated area.
- Request permission to move depends on a combination of several factors (previous radiation absorbed dose; location within the prediction, especially Zone I; importance of mission in the area; physical capability; and optimum time to exit).
- Move only when told to (depending on prearranged plans).
- Fasten clothing, roll down sleeves, and put on and wear helmet and gloves.
- Calculate Optimum Time of Exit (Topt) and advise higher headquarters (discussed in detail in Chapter 6).
- Feed all personnel if time permits.
- Fill canteens; cover food and water in airtight containers.
- Cover as much equipment as possible with NBC Protective Cover (NBC-PC) to reduce the decon burden.
- Use expendable field expedient covers such as plastic, foliage, mud (washed off later to remove fallout), and tarpaulins.
- Improve shielding ability of evacuation vehicles by adding clean earth before fallout arrives.
- Strike and store all tentage if unit intends on moving. If not, cover tentage with NBC-PC.
- Implement continuous radiological monitoring.
- Shutoff all ventilation systems not provided with dust filtration capability.
- Protect items that will be difficult or impossible to decontaminate later (such as rope).
- Do not allow personnel to leave shelters while fallout is arriving.
- Request air evacuation.

Once the unit receives an NBC 3 nuclear report, the report must be plotted on the operations map. This is best accomplished by an overlay on clear plastic or other transparent material.

The preceding paragraphs outlined actions that should be part of a unit SOP. Once the chemical staff places the NBC 3 nuclear report on the situation map, he or she must be prepared to answer these two basic questions from the commander:

1. Where did it go off?
2. Are we or any of our troops in danger?

The first question is easy, but one should be prepared to discuss the exact location and whether or not there is a crater. If any friendly units were in the immediate area of ground zero, obtain a battle damage assessment or post-strike analysis. Either one may be obtained from either the unit itself, if it is an organic element, the affected units higher headquarters, or through intelligence channels.

The other question is more difficult to answer. The commander must understand that the NBC 3 nuclear report is only a prediction of potential fallout. The plot is safesided to incorporate all areas that may be affected. The plot, by no means, indicates that fallout will cover everything within the radial lines. Calculate, for the commander, the time of arrival fallout as discussed earlier. This will provide necessary information to the commander and the unit as a whole as to when the fallout may arrive.

Armed with this information the affected unit may adjust plans accordingly and know how long they have to prepare before the arrival of fallout.

If a unit lies within the predicted fallout area, the commander will be interested in how soon that unit can depart the area, if required. This is calculated as the optimum time of exit .