FG-E-5.6/1
JULY 1970

USERS' MANUAL

METEOROLOGICAL DATA FOR RADIOLOGICAL DEFENSE

DEPARTMENT OF DEFENSE

OFFICE OF CIVIL DEFENSE

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APPLICATION OF METEOROLOGICAL DATA TO RADIOLOGICAL DEFENSE

SCOPE

This manual provides guidance to assist State and local governments in the use of meteorological data to:

1. Prepare area fallout forecasts and estimates of fallout arrival time for operational use.
2. Prepare hypothetical dose rate and dose contours for use in conjunction with tests and exercises.
3. Determine the most probable direction and extent of fallout distribution in areas of interest as a basis for preattack planning.

FALLOUT FORECASTS

Basic Data

In the preparation of area fallout forecasts and estimates of fallout arrival time, the following basic data are needed:

- Approximate ground zero (GZ) location and time of detonation.
- An assumed yield of the weapon or the dimensions of the nuclear cloud at time of stabilization. (A yield of 3 million tons of TNT—equivalent to 3 megatons (MT)—may be assumed unless there is reason to believe that the nature of the target would make a different yield more likely.)
- Upper air wind information.

Determining Ground Zero Location

Knowledge of the location of likely targets in the general area of the detonation will be helpful in deducing some GZ locations. Analysis of reports of minor blast damage can define the periphery of the blast area, and the center of that area can be taken as GZ. (See FCDG, Part E, Chap. 2, Appen. 3, "Civil Defense Emergency Operations Reporting System," and related handbooks.)

In some instances, the GZ location may be approximated by visual observation of the direction of the flash or of the stem of the subsequent nuclear (mushroom) cloud. However, it must be recognized (1) that anyone making such observations would face the hazards of burns from thermal radiation, destruction of his eyesight, and—if he were within the blast area—injury from flying debris; and (2) that attempts to observe a nuclear blast *would most likely be unsuccessful*. Observation of the nuclear cloud or stem is not possible at night—or during the day, if the sky is overcast. Also, with heavy overcast, diffused light all over the sky might interfere with observing the direction of the flash.

However, if the direction of the flash has been observed, the time interval between the observation of the flash and the detection of the subsequent "bang" will indicate the approximate distance of the GZ location from the observer. The speed of sound at the earth's surface is about 1 mile per 5 seconds, or 12 miles per minute. Thus, if there is a lapse of five minutes between the time the flash is observed and the time the "bang" is heard, the detonation would be about 60 miles away. If, in addition to the direction, the approximate distance of the detonation from the point of observation is known, the GZ location may be determined with sufficient accuracy to prepare an area fallout forecast.

GZ location may be determined in some areas by electronic devices, such as atmospheric overpressure or incident thermal radiation detectors, radar, etc.

Weapon Yield and Dimensions of the Nuclear Cloud

The nuclear cloud from a surface burst will reach stabilization within about 10 minutes after detonation. At this time, when vertical development of the cloud ceases, the dimensions of the cloud (height and diameter) will vary with the size of the weapon and the atmospheric conditions. These variables and the upper air winds are major factors in the spread of fallout. Figure 1 indicates the approximate dimensions of nuclear clouds as a function of total weapon yield.

Upper Air Wind Information (General)

Executive Order 11490 assigns to the Department of Commerce (Weather Bureau) the responsibility for preparing and issuing currently, as well as in an emergency, forecasts and estimates of areas likely to be covered by radiological fallout in the event of nuclear attack, and for making this information available to Federal, State, and local authorities.

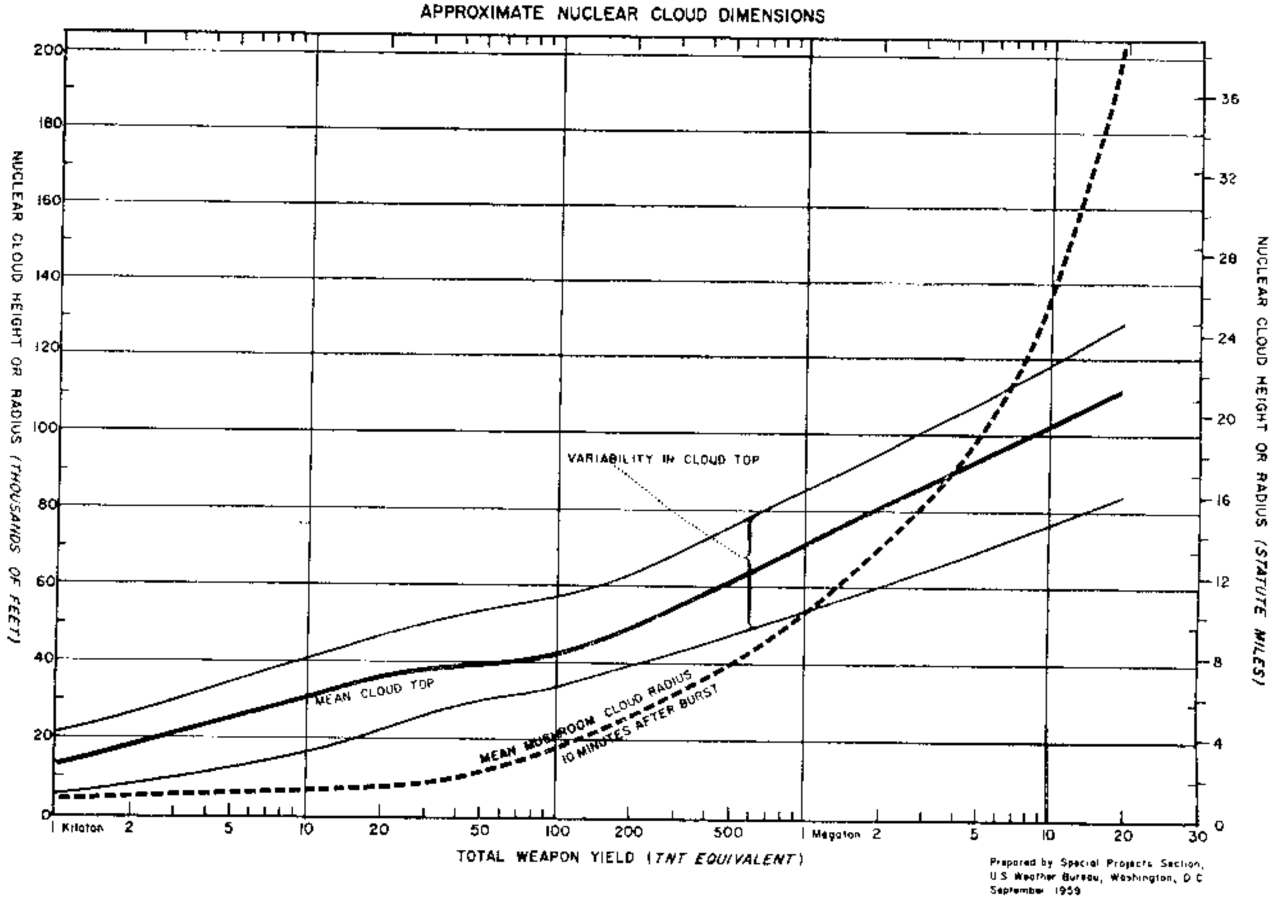


FIGURE 1.—Approximate nuclear cloud dimensions.

TABLE 1.—*Locations of DF data points in the continental United States, Alaska, Hawaii, the Caribbean Area (Puerto Rico), and Canada*

(Data transmitted on FAA Service "C")

Ident. Code	Location	Ident. Code	Location
NERN US	*NORTHEASTERN U. S.*	*SERN*	*SOUTHEASTERN U. S.*
JFK	Brooklyn, NY	RIC	Richmond, VA
BOS	Boston, MA	HAT	Cape Hatteras, NC
AUG	Augusta, ME	RDU	Raleigh, NC
CAR	Caribou, ME	TRI	Bristol, TN
PLB	Plattsburgh, NY	BNA	Nashville, TN
ALB	Albany, NY	JAN	Jackson, MS
BUF	Buffalo, NY	BHM	Birmingham, AL
IPT	Williamsport, PA	ATL	Atlanta, GA
PIT	Pittsburgh, PA	CAE	Columbia, SC
BAL	Baltimore, MD	ILM	Wilmington, NC
CRW	Charleston, WV	JAX	Jacksonville, FL
LOU	Louisville, KY	TLH	Tallahassee, FL

TABLE 1.—*Locations of DF data points in the continental United States, Alaska, Hawaii, the Caribbean Area (Puerto Rico), and Canada*—Continued

(Data transmitted on FAA Service "C")

Ident. Code	Location
TPA	Tampa, FL
MIA	Miami, FL
MOB	Mobile, AL
MSY	New Orleans, LA
S CNTRL US	*SOUTH CENTRAL U. S.*
HOU	Houston, TX
SAT	San Antonio, TX
CRP	Corpus Christi, TX
BRO	Brownsville, TX
LRD	Laredo, TX
DRT	Del Rio, TX
HOB	Hobbs, NM
AMA	Amarillo, TX
ABI	Abilene, TX
DAL	Dallas, TX
SHV	Shreveport, LA
MEM	Memphis, TN
LIT	Little Rock, AR
OKC	Oklahoma City, OK
ALS	Alamosa, CO
DEN	Denver, CO
GCK	Garden City, KS
HLC	Hill City, KS
ICT	Wichita, KS
MKC	Kansas City, MO
SGF	Springfield, MO
STL	St. Louis, MO
N CNTRL US	*NORTH CENTRAL U. S.*
IND	Indianapolis, IN
ORD	Chicago, IL
CLE	Cleveland, OH
FNT	Flint, MI
SSM	Sault Ste. Marie, MI
GRB	Green Bay, WI
DBQ	Dubuque, IA
DSM	Des Moines, IA
ONL	O'Neill, NB
RAP	Rapid City, SD
ABR	Aberdeen, SD
MSP	Minneapolis, MN
INL	International Falls, MN
NWRN US	*NORTHWESTERN U. S.*
GFK	Grand Forks, ND
DIK	Dickinson, ND
GGW	Glasgow, MT
BIL	Billings, MT
GTF	Great Falls, MT
DLN	Dillon, MT
FCA	Kallispel, MT
GEG	Spokane, WA
SEA	Seattle, WA
PDX	Portland, OR
OTH	North Bend, OR
RBL	Red Bluff, CA
LKV	Lakeview, OR
JDA	John Day, OR
BOI	Boise, ID
CPR	Casper, WY
BFF	Scottsbluff, NB
SWRN US	*SOUTHWESTERN U. S.*
SLC	Salt Lake City, UT
PIH	Pocatello, ID
RKS	Rock Springs, WY
GJT	Grand Junction, CO
FMN	Farmington, NM
ABQ	Albuquerque, NM
BCE	Bryce Canyon, UT
LAS	Las Vegas, NV
ELY	Ely, NV
EKO	Elko, NV
TPH	Tonapah, NV
RNO	Reno, NV
SFO	San Francisco, CA
FAT	Fresno, CA
SBA	Santa Barbara, CA
SAN	San Diego, CA
DAG	Barstow-Daggett, CA
YUM	Yuma, AZ
PRC	Prescott, AZ
TUS	Tucson, AZ
ELP	El Paso, TX
	CANADA
609	St. John
714	Quebec
731	North Bay
749	Ft. William
852	Winnepeg
863	Regina
872	Medicine Hat
882	Revelstoke
892	Vancouver
DFAK	*ALASKA*
BRW	Barrow, AK
BTI	Barter Island, AK
OTZ	Kotzebue, AK
BTT	Bettles, AK
OME	Nome, AK
BET	Bethel, AK
MCG	McGrath, AK
FAI	Fairbanks, AK
ANC	Anchorage, AK
ORT	Northway, AK
SNP	St. Paul, AK
CDB	Cold Bay, AK
AKN	King Salmon, AK
MDO	Middleton Island, AK
NHB	Kodiak, AK
YAK	Yakutat, AK
JNU	Juneau, AK
ANN	Annette Island, AK
SYA	Shemya, AK
ADK	Adak, AK
DFHW	*HAWAII*
ITO	Hilo
LIH	Lihue
DFCA	*CARIBBEAN*
526	San Juan, Puerto Rico

The Weather Bureau maintains a network of "Rawin" observatories which measure, by electronic methods, the direction and speed of the wind from the earth's surface to high altitudes above the surface.

These data are used primarily for routinely analyzing and forecasting the motions of the atmosphere. The data are transmitted to a central location at Suitland, Maryland, where they are processed by a computer system into several forms, for a variety of uses. One form is the fallout vector data for use in preparation of fallout area forecasts. Data are prepared for about 100 locations in the continental United States (except Alaska), and about 30 in Alaska, Hawaii, Puerto Rico, and southern Canada. The locations are shown on the map (Figure 2) and are listed in area groups in Table 1. The boundaries of group areas are indicated by heavy lines on the map. Under the identifying designator "DF" [1] the data are transmitted over the Federal Aviation Administration (FAA) Service "C" Teletypewriter Facility to most Weather Bureau offices, FAA offices, and to other governmental and private subscribers. The data are also relayed to Alaska, Hawaii, and Puerto Rico.

The State and local civil defense offices planning to make their own forecasts should arrange for the receipt of DF messages that might pertain to their areas of jurisdiction. The nearest FAA or Weather Bureau office should be contacted to arrange for appropriate relay of DF messages, unless the data are already available over State emergency circuits.

Wind Data for Fallout Forecasts (Summary Description)

- The data (DF) are based upon U.S. Weather Bureau observations made at 0000 and 1200 Greenwich time (0000Z and 1200Z).
- The observed data are processed by computer at Suitland, Maryland, into forecasts of the integrated effects of the wind layers from the 100 millibar (mb) level (about 53,000 ft.) to the earth's surface, on idealized particles which would fall to the surface from that level *in three hours;* i.e., *three-hour* direction and distance vectors.
- The DF vectors describe the direction to the nearest 10 degrees clockwise from true north, and to the nearest 10-mile distance. A fallout forecast vector for a single location and time is described by four digits: the first two indicate direction of windflow in tens of degrees, and the last two indicate the three-hour distance in tens of miles. For example, the four-digit block "1512" would mean that the direction is 150° clockwise from true north (windflow toward SE), and the distance, 120 miles *in three hours.*

For each data location, data are transmitted to subscribers about six hours after observation times (twice daily) in three forecasts, for 12, 18, and 24 hours after the observation. Each forecast will be used during the six-hour period centered on these times. (See Figure 3.)

The symbolic form of the message is "iii ddss ddss and ddss":

iii—Identifier for location.

dd—True direction toward which particles would fall, in tens of degrees.

ss—Distance in tens of statute miles for three-hour fall from the 100 mb level.

Time indicators: The first ddss group is for use over a 6-hour period centered on observation time plus 12 hours; the second, for observation time plus 18 hours; and the third, for observation time plus 24 hours; i.e., the time for which a forecast is to be used is indicated by the position of the four-digit group. The DF message format is illustrated in Figure 4, in which the first line indicates that the data are DF for the United States, based on observations at 0000Z,[2] on the first day of the month; the second line heads a group of locations in the Northeastern United States; the left-hand column identifies the locations; and the second, third, and fourth columns describe DF vectors for use 12, 18, and 24 hours, respectively, after 010000Z; i.e., at 011200Z, 011800Z, and 02000Z.

Data are provided for about 100 locations in the continental United States (except Alaska), and about 30 in Alaska, Hawaii, Puerto Rico, and Canada. (See Figure 2.)

Data are provided in convenient plotting sequence for each of the six areas of the continental United States (except Alaska), and separately for the other areas.

It is emphasized that the forecast times (observation time plus 12, 18, and 24 hours, with about 6 hours processing and reporting delay) provide for overlap of the forecasts from one observation time to the next. This is intentional, to provide forecasts into the early postattack period, when new meteorological data might not be available. As indicated in Figure 3, the third column data (observation time plus 24 hours) would be used only if new data were not received.

[1] "DFUS" for the continental United States, except Alaska, and for southern Canada; "DFAK" for Alaska; "DFHW" for Hawaii; and "DFCA" for Puerto Rico (Caribbean Area).

[2] Weather Bureau time notation for midnight.

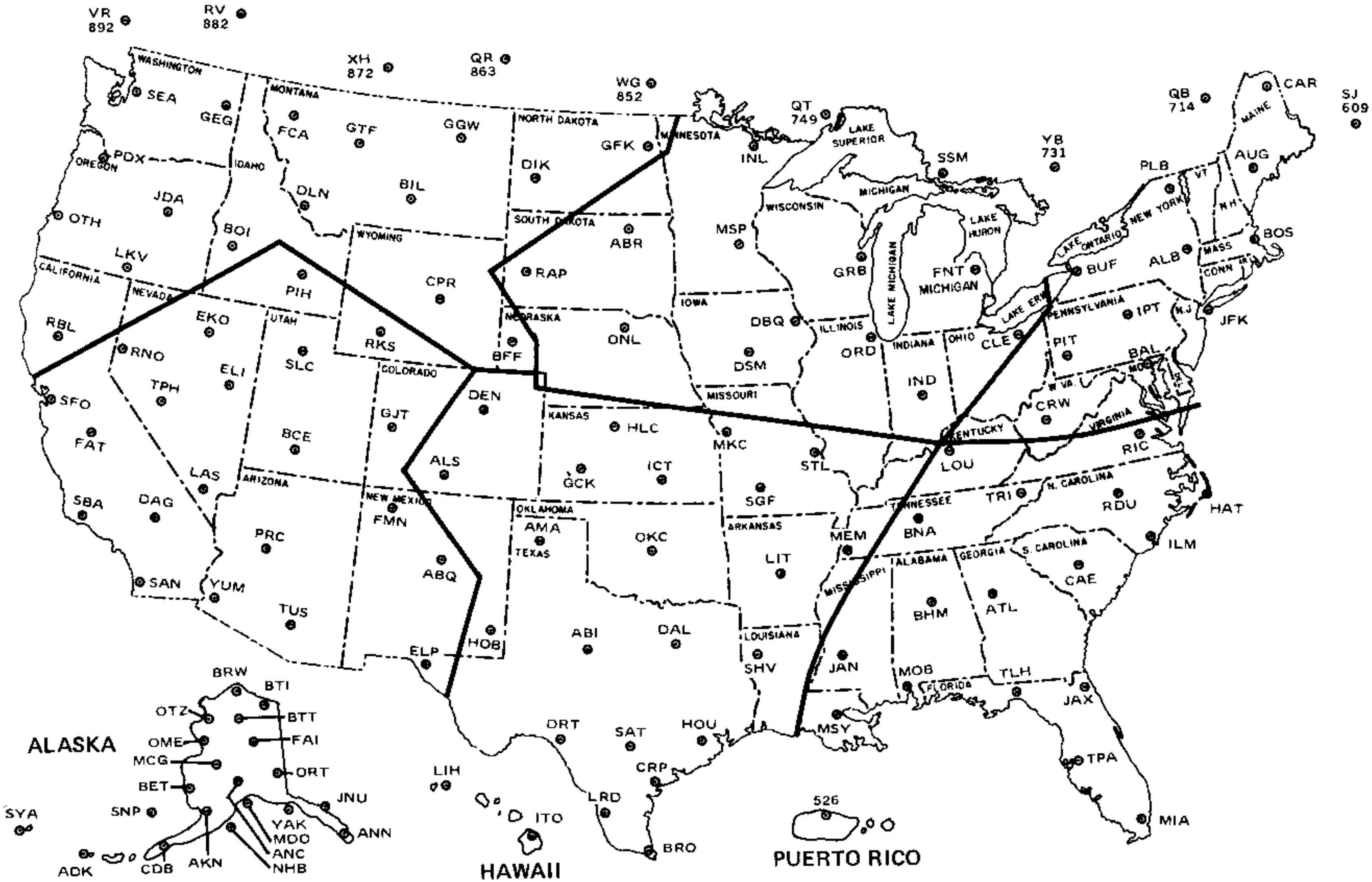
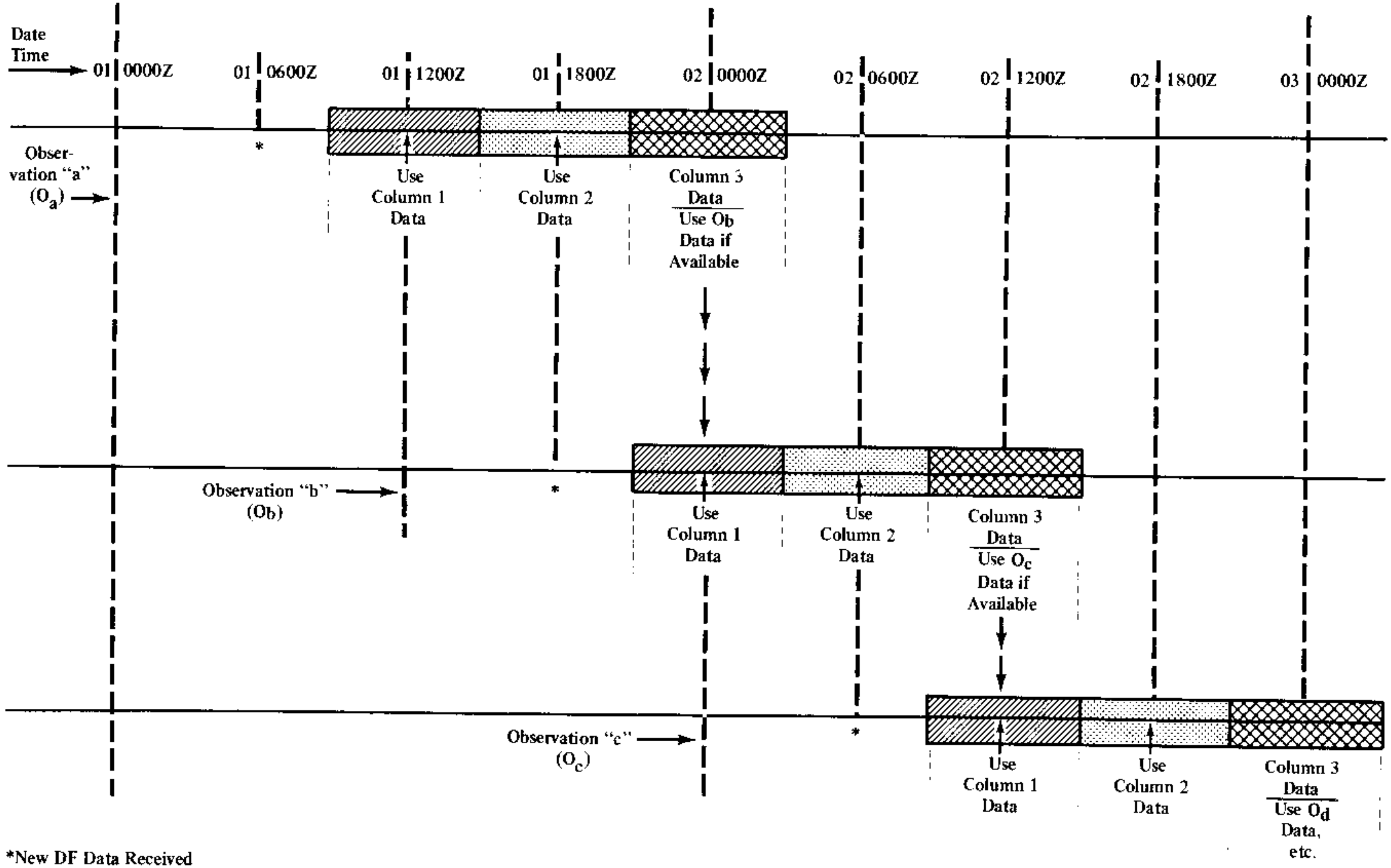


FIGURE 2.—DF data points.



*New DF Data Received
Column 1, Column 2, and Column 3 Refer to Data Columns in the DF Data Report.

FIGURE 3.— Time periods for use of DF data.

```
ZCZC

DFUS KWBC Ø1ØØØØ 1/

NERN US
JFK  1Ø11  111Ø  12Ø9  BOS  Ø914  1Ø12  1112  AUG  1Ø17  1Ø15  1111
CAR  1Ø18  1Ø17  1117  PLB  1115  1215  1215  ALB  1113  1112  1212
BUF  1211  1212  1311  IPT  111Ø  121Ø  131Ø  PIT  12Ø9  131Ø  1211
BAL  1ØØ9  12Ø9  131Ø  CRW  12Ø9  1211  1212  LOU  1211  1213  1112

SERN US
----- etc.
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1/ Greenwich Mean Time (ZULU)

FIGURE 4.—DF message format.

Use and Limitations of Fallout Forecasts

Errors are to be expected in forecasts of fallout deposit. There are not good wind data, available on a current basis, for fallout particles carried to altitudes above the 100 mb level. As they fall back to the 50- or 60-thousand-foot level, particles carried to levels higher than that are acted upon by wind layers that are not well defined. Variations in wind direction and speed from level to level and vertical air movement, i.e., turbulance, tend to spread or diffuse fallout from the nuclear cloud.

The location of a nuclear detonation (GZ) may not be well defined. Weapon yields affect the height of the cloud stabilization, which in turn determines which wind layers act on the fallout. The weapon yield and height of the tropopause affect the diameter of the nuclear cloud at stabilization (maximum height), and the diameter of the cloud, in turn, affects the width of the fallout pattern.

The area forecasts, prepared from the DF wind vectors, do not indicate the relative degrees of hazard, and should be used primarily to determine the likelihood of fallout occurrence and its approximate arrival time. This information might be of value to industry in more effectively planning and scheduling its shutdown procedures. Also, it may be of value to a community in implementing plans for movement of its people to fallout shelter; to individuals in the improvisation of fallout shelter; and to farmers in getting livestock under cover. However, after fallout has arrived at a location, survival and recovery operations will be based upon dose rate reports from Weapons Effects Reporting Stations (see FG E-2 3/4) and other radiological monitors.

Preparing Fallout Forecasts Using DF Data

Fallout wind vector data will be used in two ways: to assist in analysis of attack effects over broad areas, such as a large State, an OCD Region, or the Nation; and to forecast at State-Area level, those areas likely to receive fallout, and the exepcted time of arrival.

Forecasts for Large Areas (Several States).—As an aid for attack analysis, a streamline analysis is prepared. For the area of concern, DF vector *indicators* are plotted at each DF data point. An arrow about an inch long with its head pointed in the direction of the wind flow is centered on the data point, and the code for the three-hour wind distance is noted at the arrowhead. This avoids plotting long, unwieldy vectors. A series of smoothed lines is then drawn to show the curvature of the wind streams that are moving across the area. The streamlines do *not* pass through the data points except by chance. Figure 5 is an example of such a DF data plot and streamline analysis.

The U.S. Weather Bureau issues—and periodically updates—a defense operations manual for the use of its personnel in support of emergency operations. In most States and many localities, it should be feasible to arrange for professional meteorologists to provide general weather service support for civil defense operations, including fallout streamline analyses, during an emergency.

For States and State-Areas.—The DF data are used for preparation of initial fallout forecasts for States and State-Areas and for some local jurisdictions. The responsibility for forecasting fallout, and warning jurisdictions likely to be affected, is usually assigned to the State or State-Area EOC. Any jurisdictions expecting to prepare their own forecasts should arrange for

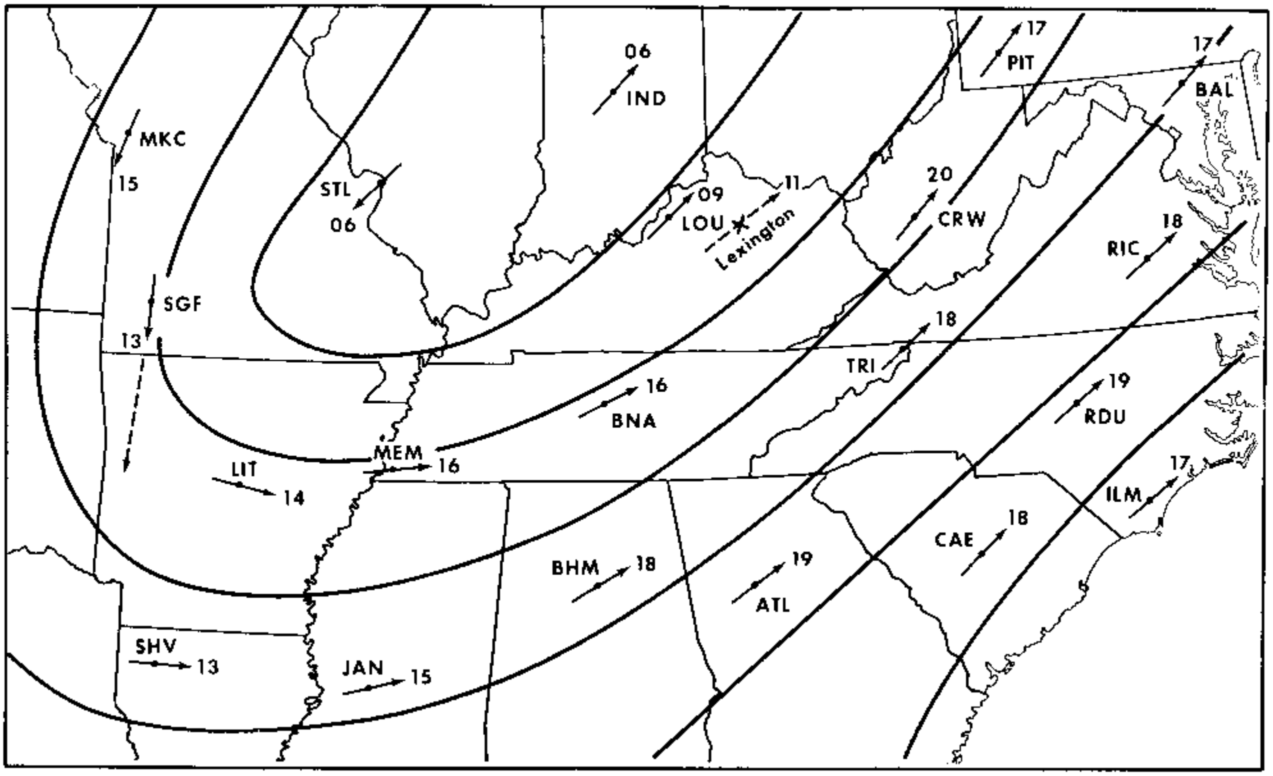

FIGURE 5.—Example streamline analysis.

receipt of U.S. Weather Bureau DF reports on a routine basis, and should practice the procedures frequently. Arrangements must also be made to receive reports of NUDET locations.

A map, provided with overlays, and of a scale to permit plotting the progress of fallout as reports are received from monitoring stations should be used. The map should cover areas surrounding NUDET locations to a distance of about 500 miles. A scale of 1:1,000,000 (16 miles per inch) is suitable, but map scale is not critical.

Figure 6 illustrates a fallout forecast template which may be used to simplify the task of plotting areas likely to be affected by fallout. The scale is such that the circle around the point of detonation (GZ) is about the size of the nuclear cloud from a 3 MT weapon at the time of stabilization—about 10 minutes after the detonation. Its radius represents 15 miles on the scale of the map with which it is used in this example. The scale of the center line "KL" is also the same as the scale of the map. The sides of the template (AE and FJ) make 20° angles with the direction of line KL. The broken lines and marked angles need not appear on the finished template. They are included for assistance in constructing it. The scales are marked on typewriter correction tape applied along the edges and mid-line of the template.

Figure 7 illustrates the use of a template constructed of transparent plastic.

Initial Fallout Forecast Plotting Procedures (steps 1–8):

1. For an assumed or actual NUDET time, select the DF data valid for that time.
2. Plot the DF vectors (distance to map scale in the indicated direction) at the DF points in the area of interest. (NOTE: Detailed plotting procedures are presented in OCD courses of instruction for radiological defense personnel.
3. Plot the location of the assumed or actual NUDET on the map.
4. If the NUDET location is a DF data point, the plotted Weather Bureau DF vector is used directly. If not, a new vector is constructed at the NUDET location. In length and direction it should fit into the wind pattern indicated by nearby DF vectors. This is illustrated in an example streamline analysis based on DF data for Lexington, Kentucky, in Figure 5. For nearby locations the directions of

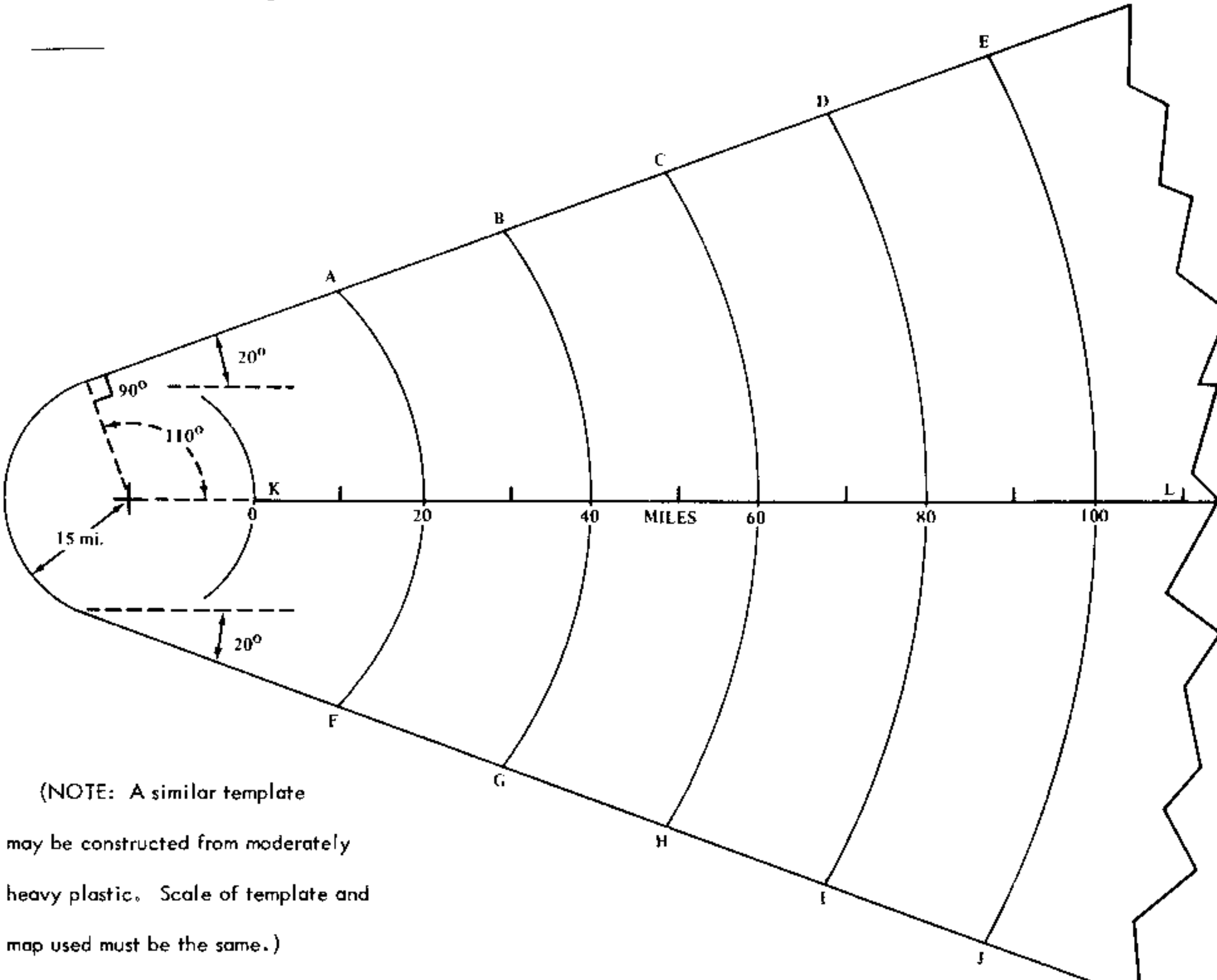

FIGURE 6.—Fallout forecast template.

the DF vectors are nearly the same, but note that speeds increase with distance to the southeast from data location "LOU." The speed at Lexington is estimated to be "11" (110 mi. in three hours). For a location in north-central Arkansas, the *direction* of DF vectors at nearby Springfield (SGF), Little Rock (LIT), and Memphis (MEM) varies more than the speed, and adjustment would be needed, as indicated in step 8, below.

5. Apply the template to the map with the center of the cloud stabilization circle at GZ, and the center scale along the DF vector. Locate the DF three-hour distance on the center scale and mark corresponding points at the sides of the template. Starting at one of these points, draw a line along the edge of the template, around the rounded end, to the other point marked. Note the point on the map under the DF distance on the center scale, lift the template, mark the point, and draw in the three-hour "isochrone" (same time for fallout arrival).

The above procedure is illustrated in Figure 7. It was assumed, from DF data, that the fallout wind vector for Roanoke was 80° from true north, and the three-hour distance, 90 miles. The fallout vector was drawn from Roanoke (GZ), and the template positioned as shown. Note that the "90" mark on the template scale lies 90 miles beyond the *leading edge* of the stabilized nuclear cloud, and extends beyond the fallout vector which is measured from GZ.

Distances corresponding to the 90-mile scale location were laid off at the two sides of the template, and a line drawn from one point to the other around the rounded end. The point on the map under scale point 90 was noted and marked and the three-hour "iso-

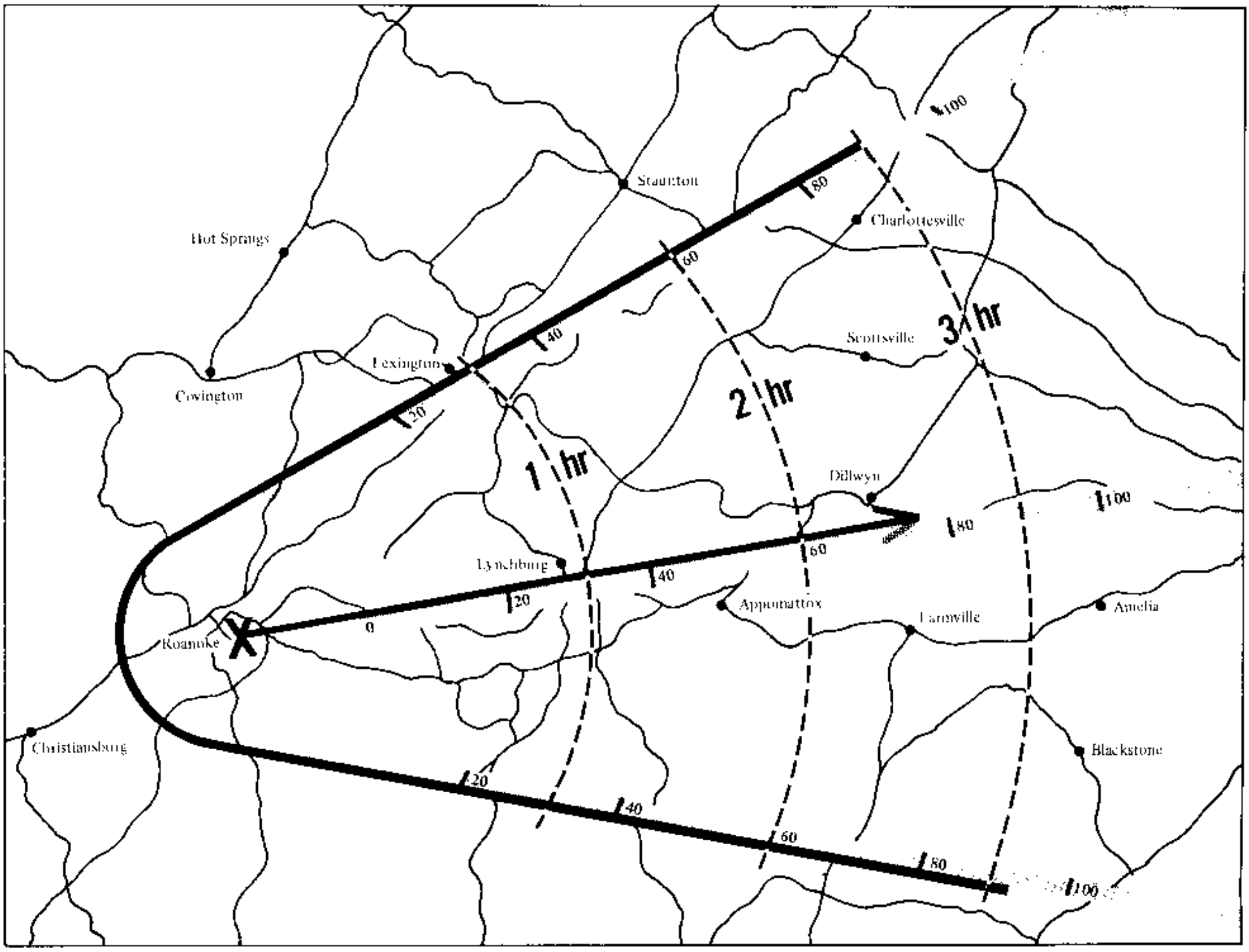

FIGURE 7.—Using a fallout forecast template.

chrone" drawn. In one hour the spread of fallout would be one-third of 90, or 30 miles, and the spread in two hours, 60 miles. The one- and two-hour isochrones were drawn by the same method used for the three-hour line.

6. Fallout arrival time for a given location is estimated from the map, with the use of the plotting template, centered on GZ. The expected speed of progress of fallout is determined by dividing the DF vector by three, as illustrated in 5 above. In the example (Figure 7), fallout would be expected at Lynchburg in about one hour; at Appomattox in a little over one and one-half hours; at Scottsville, Dillwyn, and Farmville in about two and one-half hours, and at Charlottesville in a little less than three hours.
7. The format for Initial Fallout Warnings and Update Fallout Warnings is provided in the Federal Civil Defense Guide, Part E, Chapter 2, Appendix 3.
8. Where DF vectors at nearby data points indicate a material change in direction of the windstream, the fallout area forecast should be modified to fit a streamline plot. For example; in Figure 5, the path of fallout from a detonation at Springfield, Missouri, would be expected to swing to the east rather than continue to move south, as indicated by the broken-line 3-hour vector plot from SGF.

Update Fallout Warnings

These updated forecasts and associated warnings are based on radiological monitoring reports and are not as dependent upon the less reliable input data available for making the initial forecast. The procedures for preparing update forecasts and warnings follow. The plotting template (Figure 6) will be of value in carrying out the procedures.

As the fallout cloud develops and travels downwind, the incoming fallout reports from Weapons Effects Reporting Stations provide a basis for modifying and amplifying the Initial Fallout Warning. If there are no reports of significant fallout radiation in the expected area within one hour of a detonation, it must have been an air burst, and the initial warning should be cancelled. If the Initial Fallout Warning did not accurately forecast the direction of fallout movement, a cancellation of the initial warning is issued to those local governments no longer considered in the path of fallout, and other local governments are warned as appropriate.

Similarly, if the forecast of time of fallout arrival was significantly in error, a revised set of forecast arrival times is developed. In addition, estimates of the probable severity of fallout radiation; i.e., whether or not meter readings in excess of 50 R/hr can be expected, is included in the Update Fallout Warning message. If the Update Fallout Warning includes localities outside the State-Area developing the message, the Update Fallout Warning is also transmitted to the State EOC for relay to potentially affected downwind State-Areas and States as a basis for the warning of local governments within their jurisdictions.

The plotting of (1) locations and times of "50 R/hr and Rising" reports and (2) Peak Dose Rate (above 50 R/hr) reports provide a basis for forecasting more precisely where there is likely to be severe fallout radiation. The plotted points of fallout arrival will indicate the rate of speed and lateral spread of the fallout cloud, while the plotted locations of severe fallout permit the projection of the area of heavy fallout yet to occur.

Procedures for Preparing Update Fallout Warnings:

1. Continue to plot and log reports of (1) fallout arrival (0.5 R/hr), (2) dose rate increase above 50 R/hr, and (3) peak dose rates (above 50 R/hr) in R/hr.
2. Observe and analyze the progress and dispersion of the fallout cloud as reflected in the plotted fallout reports from the Weapons Effects Reporting Stations, as follows:
   a. Near the mid-line of the developing fallout area, determine the elapsed time between fallout arrival at two selected locations by subtracting the first arrival time from the second; measure the distance between the selected locations; and divide that distance by the time (in hours) to determine approximate effective wind speed. Compare the results with the initial estimate of effective wind speed as determined in Steps (5) and (6) of the Initial Fallout Warning procedures, and adjust the original forecast as necessary.
   b. Observe the location of stations reporting fallout arrival at points along the lateral edges of the fallout pattern. Ask other nearby stations, as necessary, to define clearly the lateral edges of the fallout pattern. Compare the results with the initial estimate of the lateral edges as developed in Step (5) of the procedure for Initial Fallout Warning, above, and modify the initial forecast of direction and lateral dispersion as appropriate.
   c. Observe the direction of the apparent hot line (center of heavy fallout area) and the width of the area with reported radiation intensities above 50 R/hr. From Table 2, determine the probable limit of the downwind distance at which dose rates of 50 R/hr or greater can be expected.
   d. From Table 3 determine the probable limit of the distance downwind at which dose rates of 0.5 R/hr can be expected.
3. Based on the effective wind speed and geographical limits of dose rates of 0.5 R/hr and 50 R/hr developed above, compose and dispatch the Update Fallout Warning to local governments in your area (and to the State EOC for local governments outside your area) where fallout can be expected, indicating to each whether or not dose rates over 50 R/hr are to be expected. Also notify any local gov-

TABLE 2.—*Maximum downwind extent of 50 R/hr intensity*

(In statute miles)

Wind speed \ Weapon yield	1 MT	3 MT	10 MT	30 MT
Miles per hour	Distance (miles)	Distance (miles)	Distance (miles)	Distance (miles)
10	50	70	110	140
20	90	130	200	275
30	130	185	275	400

TABLE 3.—*Maximum downwind extent of .05 R/hr intensity*

(In statute miles)

Wind speed \ Weapon yield	1 MT	3 MT	10 MT	30 MT
Miles per hour	Distance (miles)	Distance (miles)	Distance (miles)	Distance (miles)
10	120	165	230	300
20	225	310	430	575
30	325	430	625	830

ernments that were given the Initial Fallout Warning, but that now appear to be outside the probable fallout pattern, of this fact.

4. File a copy of the Update Fallout Warning message.
5. Repeat this procedure periodically as additional fallout reports are received and, if appropriate, prepare and dispatch further revisions of the Update Fallout Warning.

CLIMATOLOGICAL FACTORS TO BE CONSIDERED IN DETERMINING FALLOUT PROBABILITY

Because of the prevailing westerly winds in temperate latitudes, fallout from surface burst nuclear weapons in the North Temperate Zone would spread from a westerly toward an easterly direction most of the time. Because of the prevailing easterly winds in tropical latitudes, fallout from surface burst nuclear weapons in tropical latitudes would spread from an easterly direction toward a westerly direction most of the time. Therefore, in the temperate and tropical latitudes, upper wind climatological data may be of value in planning countermeasures for defense against fallout. The following sections pertain to the annual and seasonal variation of the mean wind field from the earth's surface to an 80,000-foot altitude as it would affect the spread of fallout across the United States.

Basis of the Data

The data in this section are based upon daily upper air wind observations taken during the period March 1, 1951, through February 29, 1956, at rawinsonde observatories located across the fifty States, the Panama Canal Zone, southern Canada, and Puerto Rico. For the winter season (December, January, February), there were 452 sets of observations; for the spring and summer seasons, 460 sets; and for the fall, 455. The annual data were derived by vectorial addition and averaging of the seasonal data.

Seasonal and Annual Tabulation

Table 4 indicates the seasonal and annual climatological, mean wind direction and average speed in the atmospheric layer from an 80,000-foot altitude to the surface of the earth for each of 52 rawin locations. For radiological defense planning purposes it represents, by seasons, the mean direction and speed of spread of fallout along the surface of the earth for multimegaton surface detonations. The first column of Table 4 lists alphabetically the locations where the upper air wind observations were taken. Under each column labeled spring, summer, fall and winter, ther are three subcolumns, labeled *D*, *S* and *V*. *D* is the cl matological mean wind direction in full degrees fro true north. *S* is the average speed in knots and *V* i the vector standard deviation. The *D* values on Tabl 4 represent the mean direction toward which the win is blowing and thus, the mean direction toward whic fallout would spread. For example, at Buffalo i springtime, the mean direction is 096 degree (slightly south of east), and the average speed is 26. knots. The vector standard deviation, 23.1 miles, ind cates the degree of scatter or distribution of the obse vations about the mean. As a further example, a Washington, D.C. in winter, the mean direction is 08 degrees (almost straight east), and the average spee is 44.7 knots.

Streamline and Isotach Analysis

Figures 8 through 12 portray the data from Table 4 in map form. The solid black lines, and streamline with arrows, indicate the mean direction of spread and the broken lines, isotachs, indicate the averag wind speed in knots. Figures 8 through 11 are for th fall, winter, spring, and summer seasons respectively and Figure 12 portrays the annual data. During th fall, winter and spring seasons the mean direction o flow is generally west to east. Average speeds ar greatest in winter and least in summer. However, a indicated on Figure 11, during the summer seaso there is a pronounced directional shift across the Gul of Mexico and the southern States, with the mean flow generally from the east toward the west.

Daily Variability

It should be noted that the data in Table 4 and Figures 8 through 12 represent mean or averaged data, based upon five years of upper air observations. On any one day, the actual direction and speed may vary considerably from the seasonal or annual mean.

Table 5 shows the ratios of the vector standard deviations to the average wind speeds for winter and summer and the range of the mean seasonal direction in degrees for each of the 52 rawin locations. The former tabulations indicate the ratio of the scatter to the scaler magnitude of the vector and thus, are a measure of the reliability of the mean as a prediction. The mean data in Table 4 are more representative of the winds on any particular day where the ratio of V/S has a low value. For example, the mean data for Washington in winter (089 degrees, 45 knots) has a V/S value of .55, whereas the summer mean data (112 degrees, 10 knots) has a V/S value

Table 4.—*Climatological mean wind direction (D) and average speed (S) in knots in the layer from 80,000 ft. altitude to surface of the earth and vector standard deviation (V)*

Location	Spring			Summer			Fall			Winter			Annual	
	D	*S*	*V*	*D*	*S*	*V*	*D*	*S*	*V*	*D*	*S*	*V*	*D*	*S*
Albrook	276	02. 5	08. 3	277	14. 7	07. 3	275	08. 8	07. 6	044	02. 2	09. 3	279	6
Albuquerque	082	24. 9	19. 4	035	03. 6	13. 2	095	17. 1	19. 5	092	28. 9	22. 3	087	18
Anchorage	056	05. 8	19. 4	049	03. 7	17. 0	053	14. 3	20. 4	080	17. 7	28. 0	064	10
Annette	077	12. 9	22. 4	098	05. 0	18. 9	076	22. 0	21. 7	090	24. 0	23. 5	084	16
Big Spring	078	30. 7	18. 7	284	05. 3	13. 8	093	15. 5	20. 0	084	35. 6	21. 2	084	19
Bismark	097	17. 1	20. 0	085	16. 8	15. 1	087	23. 9	20. 5	109	27. 8	20. 5	095	21
Boise	096	16. 6	20. 0	062	15. 7	14. 8	097	19. 4	20. 7	102	25. 9	22. 9	092	19
Brownsville	078	24. 4	15. 4	275	12. 8	10. 7	088	08. 2	17. 7	077	29. 5	16. 5	075	13
Buffalo	096	26. 3	23. 1	107	16. 6	16. 5	083	28. 8	22. 6	089	37. 4	23. 7	092	27
Burrwood	087	28. 1	18. 7	261	09. 5	11. 8	088	14. 0	19. 4	083	37. 0	17. 8	086	18
Caribou	089	19. 0	22. 7	093	16. 4	18. 7	080	29. 9	23. 3	081	29. 7	24. 1	084	23
Charleston	092	29. 8	22. 3	229	03. 6	13. 6	079	19. 0	21. 6	088	42. 4	19. 4	089	22
Columbia	087	28. 2	22. 6	099	08. 4	13. 4	096	23. 8	21. 3	091	38. 5	25. 3	092	24
Dayton	092	28. 7	23. 5	115	11. 5	14. 9	089	24. 9	20. 9	090	41. 5	26. 0	092	26
Denver	090	20. 7	20. 2	073	10. 0	13. 5	103	18. 6	19. 7	104	26. 0	22. 0	097	18
Dodge City	083	25. 7	20. 4	072	06. 7	13. 1	096	20. 8	20. 7	093	32. 2	23. 2	090	20
Edmonton	099	12. 8	17. 8	076	09. 5	15. 3	102	23. 0	18. 5	109	27. 1	18. 2	100	17
Ely	095	17. 7	20. 0	052	12. 9	13. 0	092	16. 9	19. 0	102	24. 0	23. 0	089	17
Fairbanks	067	06. 8	18. 2	060	04. 6	14. 8	061	15. 3	18. 4	085	18. 7	25. 5	072	11
Fort Worth	082	31. 5	20. 4	282	03. 7	13. 2	095	16. 5	20. 7	085	37. 8	22. 3	087	20
Great Falls	095	18. 8	19. 4	069	16. 8	15. 3	102	24. 1	20. 3	106	30. 0	21. 8	098	22
Green Bay	096	21. 7	21. 5	105	17. 3	16. 1	097	26. 2	22. 1	098	32. 4	23. 0	099	24
Greensboro	092	30. 2	22. 8	137	05. 0	14. 5	081	22. 3	21. 5	087	43. 4	21. 2	090	25
Hempstead	094	29. 0	24. 4	104	13. 6	16. 7	081	29. 0	24. 2	089	42. 7	25. 3	090	29
Internat'l Falls	099	16. 3	20. 2	098	17. 8	16. 5	106	24. 0	21. 4	107	27. 9	21. 2	104	21
Jacksonville	094	27. 7	20. 8	253	06. 5	12. 0	083	16. 5	20. 7	088	39. 0	18. 2	090	20
Lake Charles	083	29. 6	19. 0	263	08. 2	12. 1	094	15. 3	19. 8	082	38. 8	19. 3	085	19
Lihue	093	15. 8	15. 0	289	04. 5	09. 8	123	01. 0	12. 0	106	15. 1	16. 8	100	07
Little Rock	085	31. 1	21. 8	212	01. 9	13. 2	096	19. 7	20. 8	085	40. 5	23. 2	089	22
Long Beach	093	20. 7	20. 4	029	07. 6	13. 2	082	12. 7	17. 1	101	22. 2	23. 3	098	14
Maniwaki	097	20. 5	22. 7	108	16. 2	17. 0	085	27. 3	23. 0	089	30. 8	22. 2	092	23
Medford	100	18. 8	21. 2	064	12. 0	16. 0	092	17. 0	22. 2	099	26. 3	24. 3	092	18
Miami	097	21. 8	17. 2	267	12. 4	10. 7	080	06. 5	18. 4	088	29. 5	17. 2	092	11
Montgomery	092	30. 7	22. 5	246	05. 4	13. 4	087	18. 5	21. 5	086	42. 2	21. 4	091	21
Mt. Clemens	089	26. 2	24. 0	109	16. 2	16. 4	088	26. 9	22. 3	090	37. 0	24. 7	003	26
Nantucket	090	29. 3	24. 3	091	14. 6	17. 7	077	30. 3	23. 6	085	42. 6	26. 2	085	29
Nashville	088	31. 2	22. 7	146	03. 7	13. 3	089	22. 0	21. 2	086	42. 7	22. 8	089	24
Nome	042	05. 7	18. 8	040	03. 2	17. 0	066	11. 1	19. 5	081	17. 4	25. 7	066	09
Norfolk	095	31. 0	23. 0	124	06. 8	15. 7	079	23. 9	22. 9	089	44. 9	22. 3	089	26
Oakland	104	19. 5	21. 5	060	11. 2	15. 1	093	14. 0	20. 7	105	25. 1	25. 6	096	17
Omaha	089	24. 2	22. 0	089	11. 8	13. 9	100	24. 2	21. 2	098	32. 3	22. 9	097	23
Pittsburgh	093	29. 5	23. 7	110	13. 1	15. 8	083	27. 3	22. 2	089	43. 0	23. 6	092	29
Rantoul	092	28. 2	23. 5	110	11. 9	14. 8	095	25. 3	21. 4	091	39. 0	24. 9	096	27
Rome	094	26. 8	24. 2	104	17. 0	18. 1	081	29. 2	23. 7	088	37. 5	24. 4	090	27
San Juan	105	10. 5	12. 7	276	13. 4	09. 0	250	05. 7	13. 1	114	11. 8	13. 6	172	02
Seattle	093	16. 8	21. 8	076	11. 0	18. 0	091	21. 4	21. 8	097	25. 7	24. 0	092	18
Sault Ste. Marie	098	19. 9	22. 0	110	17. 7	17. 0	095	25. 3	22. 9	098	30. 4	23. 5	100	21
St. Cloud	095	18. 9	21. 0	095	17. 7	16. 8	103	25. 2	21. 3	103	29. 1	22. 0	101	23
Tucson	081	26. 7	20. 3	349	05. 1	14. 4	085	14. 4	18. 6	088	27. 4	22. 7	078	16
Washington	094	30. 5	24. 1	112	10. 5	16. 5	080	26. 7	22. 9	089	44. 7	24. 2	089	27
Whitehorse	060	08. 7	19. 7	071	02. 9	15. 1	066	17. 8	19. 5	087	21. 3	23. 9	073	12

of 1.57. Therefore, the mean winter data for Washington are more representative of the winds on any one day during the winter than the mean summer data are representative of the winds on any one summer day. Further, at Ft. Worth in summer when V/S equals 3.56, the mean summer data (282 degrees, 4 knots) would not be a very reliable prediction for the winds on any one summer day.

In Table 5, the tabulations D_1–D_2 indicate the seasonal variation of the mean wind directions. As such they give a measure of the reliability of the annual data in Table 4 when this is used as a planning guide for selecting stockpiling sites or strategic locations. The lower the value of D_1–D_2, the more reliable are the annual mean data. For example, Green Bay shows a mean directional range of only 009 degrees during the four seasons. Therefore, the annual data in this region should be very valuable as a criterion for civil defense planning purposes in locating areas of low fallout probability. On the other hand, Ft. Worth and Big Spring have mean directional ranges of 200 degrees and 206 degrees, respectively, during the four seasons. The annual data would be of limited value in these regions and for civil defense planning, the seasonal data should be used.

The values for D_1–D_2 have been plotted and analyzed in Figure 13. The analysis shows that the seasonal variation of the mean wind direction is very low across New England and the Upper Mississippi Valley. Actually, it is less than 50 degrees for most sections north of the 36th parallel of latitude. Civil defense organizations north of the 36th parallel should be able to apply the annual fallout probabilities quite successfully in their survival planning. However, in the southern States where the range of the seasonal mean direction exceeds 80 degrees, it becomes increasingly difficult to apply the fallout probabilities to survival planning.

Probabilities in Windrose Form

The climatological data referred to above have also been processed in windrose format indicating the percentage of the time that fallout would spread in the direction of each ten-degree sector of the compass and the probabilities of the speed of spread being within each of the categories 1–25, 26–50, 51–75, and 76–100 miles per hour. This degree of detail is not generally required by civil defense offices in their survival planning. However, in instances where this degree of detail is required for an engineering survey, copies of the windrose may be obtained upon request to the Office of Civil Defense.

TABLE 5.—*Ratio of vector standard deviations to average wind speeds (V/S) and the range of the annual mean wind direction in degrees (D_1–D_2)*

	V/S Summer	V/S Winter	D_1–D_2
Albrook	0. 5	4. 22	129
Albuquerque	3. 7	0. 77	060
Anchorage	4. 6	1. 58	031
Annette	3. 8	0. 98	022
Big Spring	2. 52	0. 60	206
Bismark	. 90	0. 74	024
Boise	. 94	0. 89	040
Brownsville	. 84	0. 56	108
Buffalo	. 99	0. 63	024
Burrwood	1. 24	0. 48	178
Caribou	1. 14	0. 81	013
Charleston	3. 78	0. 46	150
Columbia	1. 60	0. 66	012
Dayton	1. 30	0. 63	026
Denver	1. 35	0. 85	030
Dodge City	1. 96	0. 72	024
Edmonton	1. 61	0. 70	033
Ely	1. 00	0. 96	050
Fairbanks	3. 22	1. 36	025
Fort Worth	3. 56	0. 59	200
Great Falls	. 91	0. 78	037
Green Bay	. 93	0. 71	009
Greensboro	2. 9	0. 49	056
Hempstead	1. 23	0. 59	023
Internat'l Falls	. 93	0. 76	009
Jacksonville	1. 85	0. 47	170
Lake Charles	1. 48	0. 50	181
Lihue	2. 18	1. 11	196
Little Rock	7. 94	0. 57	127
Long Beach	1. 74	1. 05	047
Maniwaki	. 95	0. 72	023
Medford	1. 33	0. 92	036
Miami	. 86	0. 58	187
Montgomery	2. 48	0. 51	160
Mt. Clemens	1. 01	0. 67	021
Nantucket	1. 21	0. 61	014
Nashville	3. 59	0. 53	060
Nome	5. 31	1. 48	041
Norfolk	2. 31	0. 50	045
Oakland	1. 35	1. 02	045
Omaha	1. 18	0. 71	011
Pittsburgh	1. 21	0. 55	027
Rantoul	1. 24	0. 64	019
Rome	1. 06	0. 65	023
San Juan	. 67	1. 15	171
Seattle	1. 64	0. 93	021
Sault Ste. Marie	. 96	0. 77	015
St. Cloud	. 95	0. 76	008
Tucson	2. 82	0. 83	090
Washington	1. 57	0. 55	032
Whitehorse	5. 2	1. 12	027

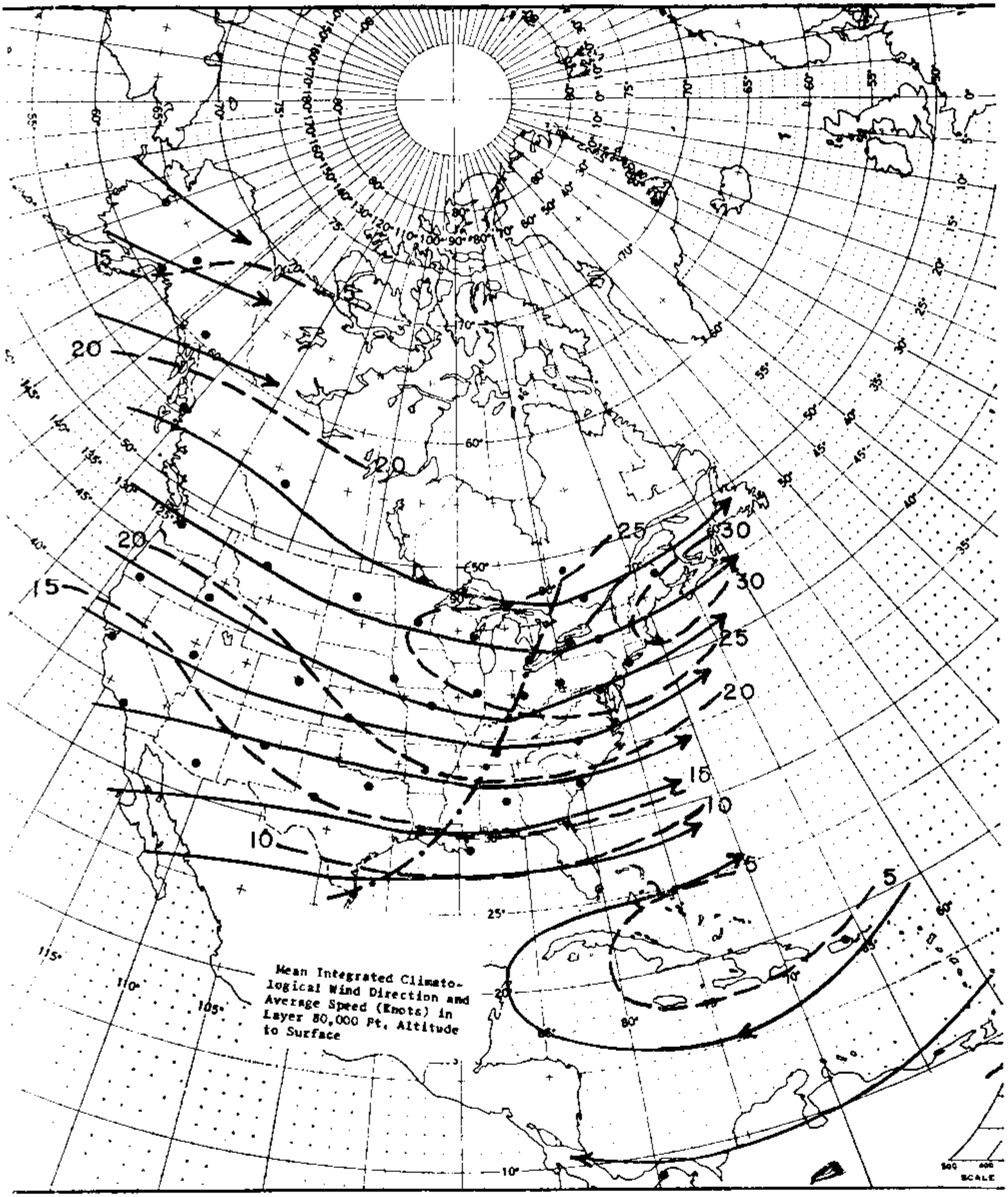

FIGURE 8.—Fall climatological wind direction and average speed.

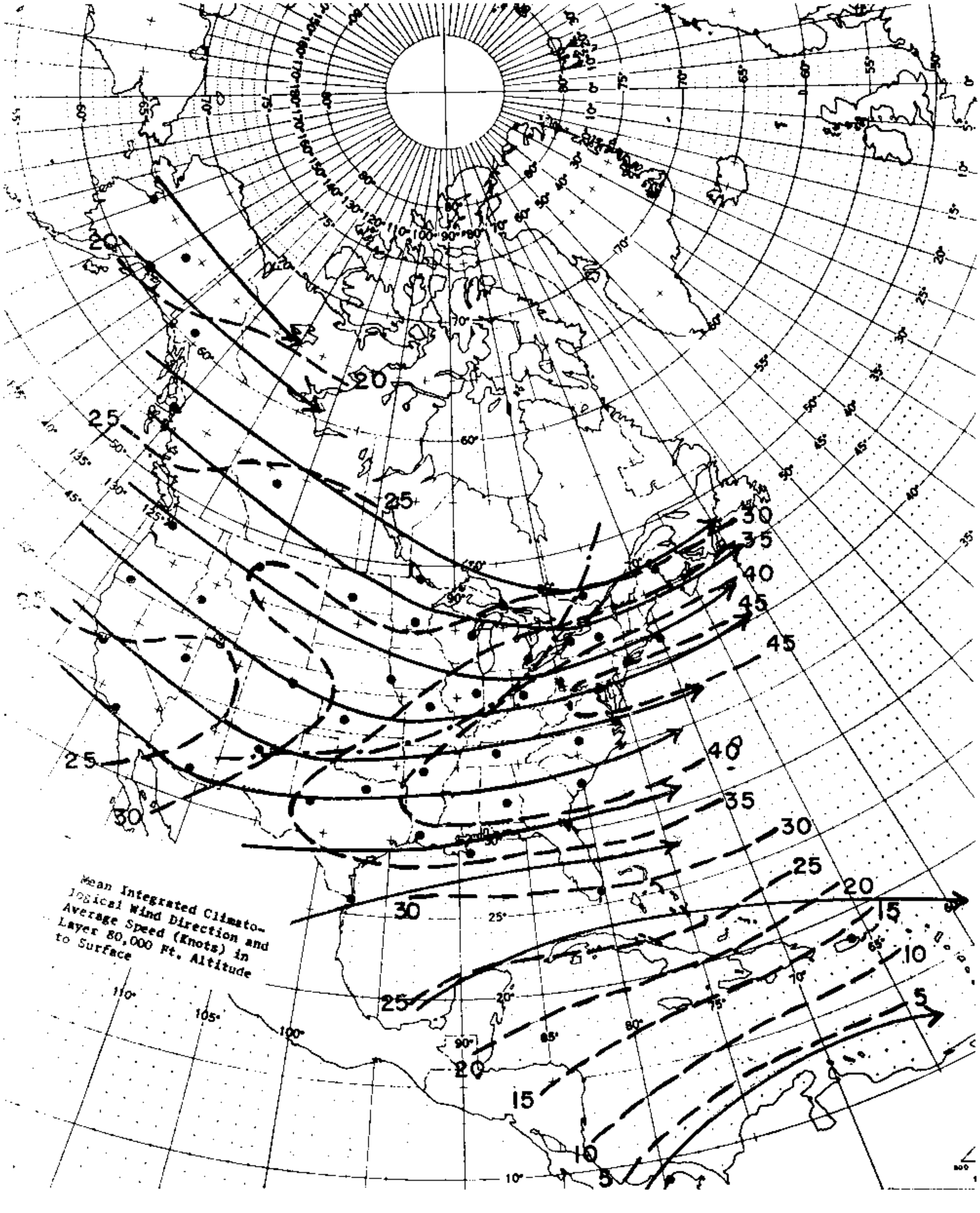

FIGURE 9.—Winter climatological wind direction and average speed.

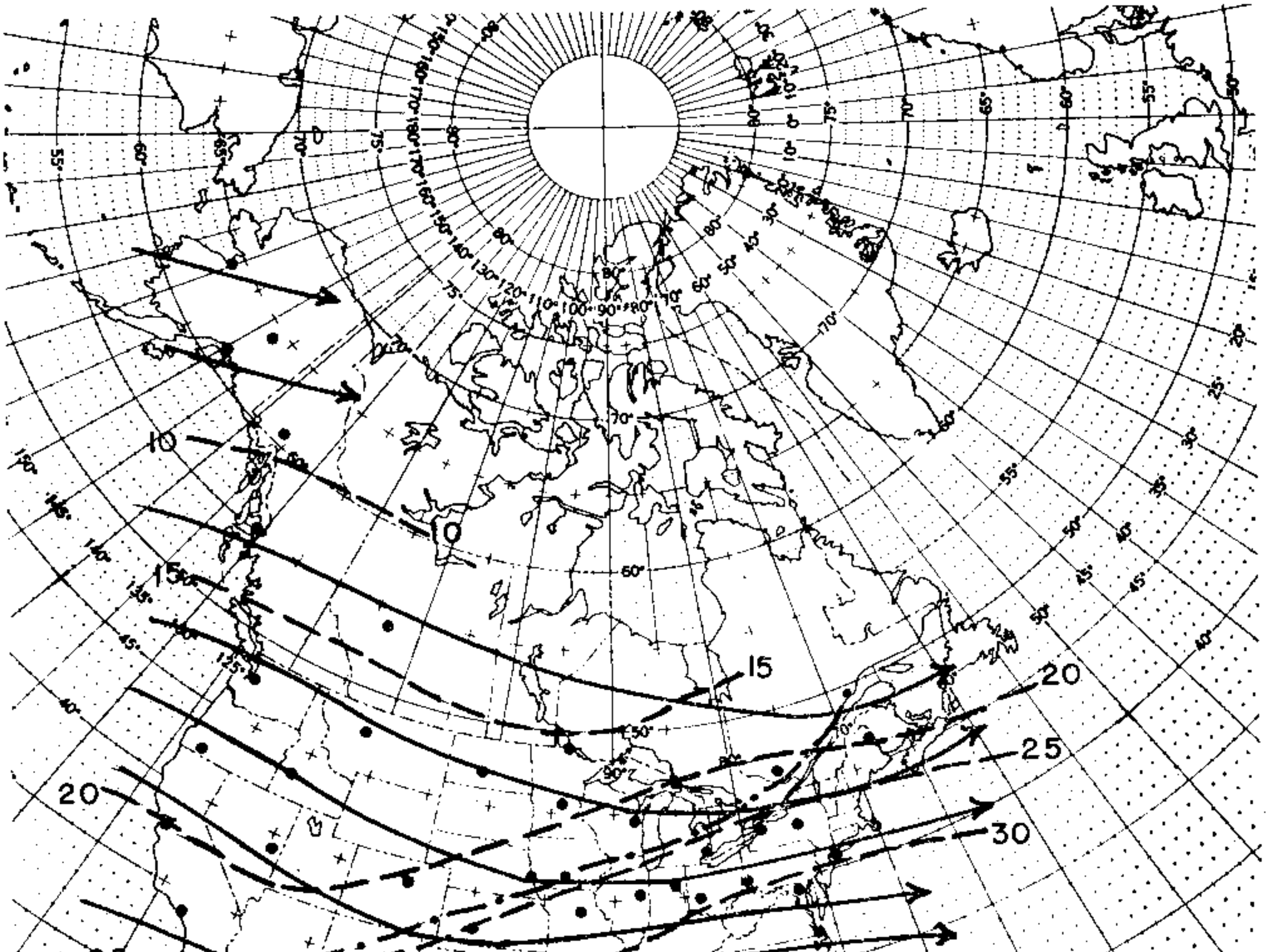

FIGURE 10.—Spring climatological wind direction and average speed.

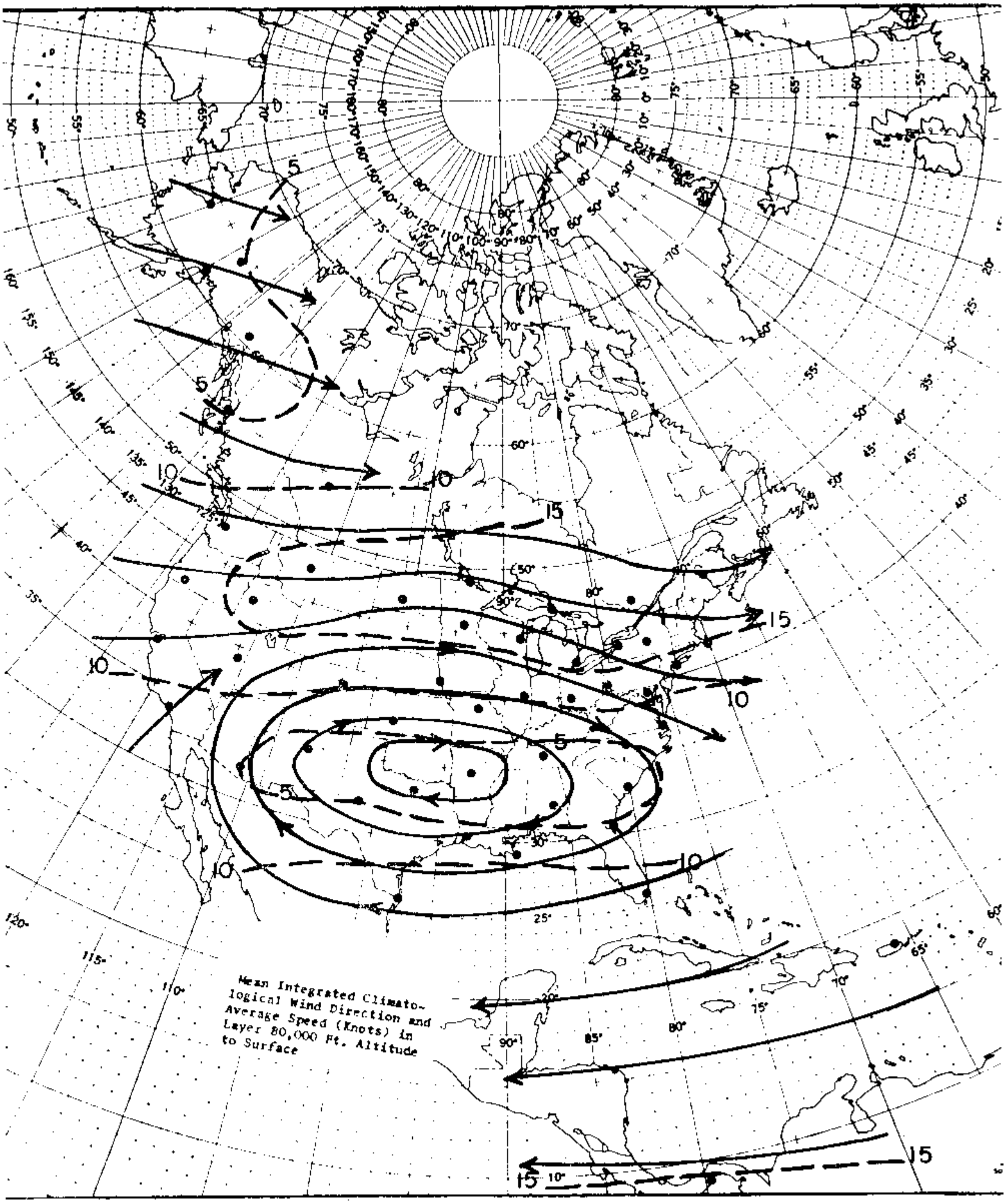

FIGURE 11.—Summer climatological wind direction and average speed.

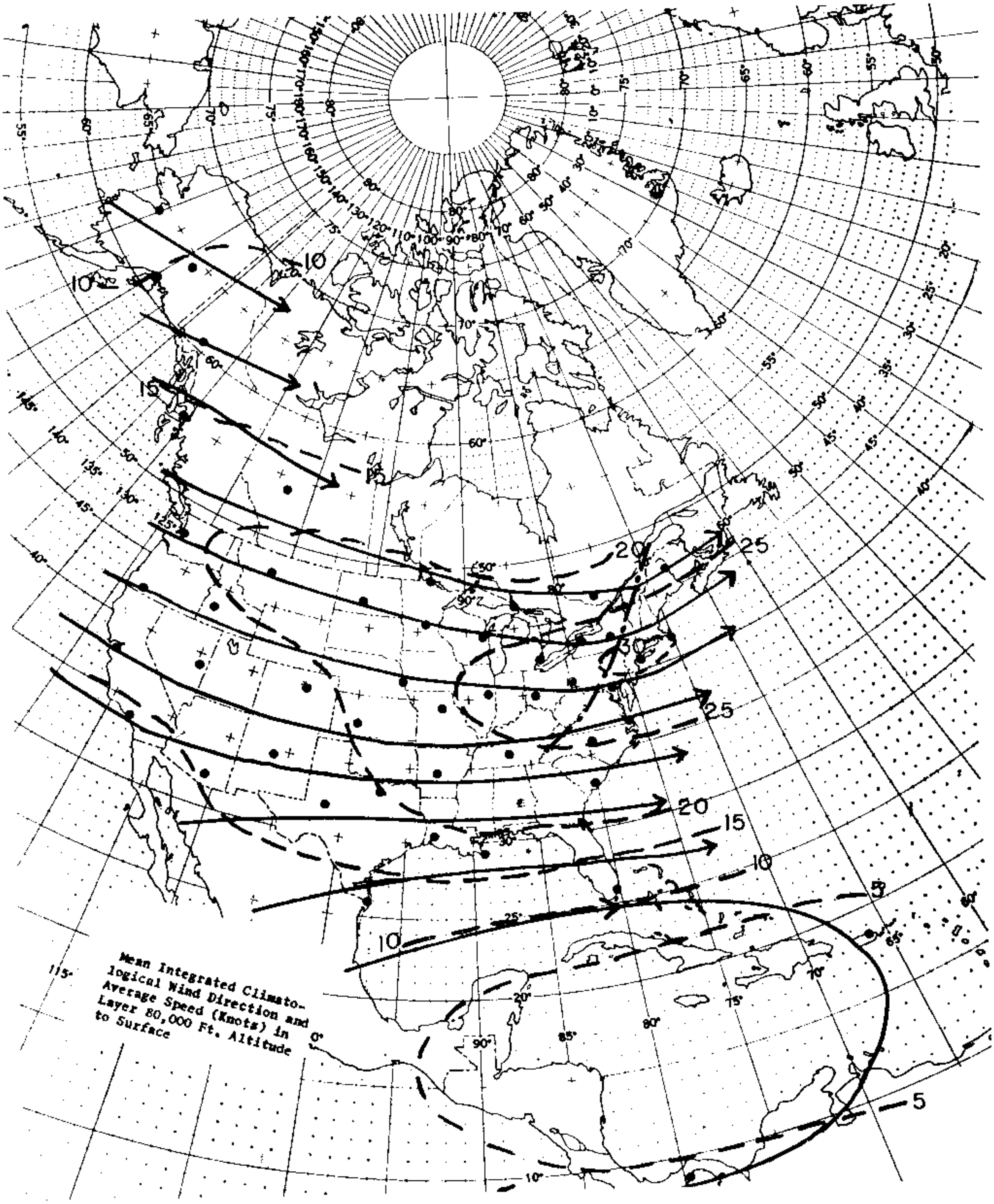

FIGURE 12.—Annual climatological wind direction and average speed.

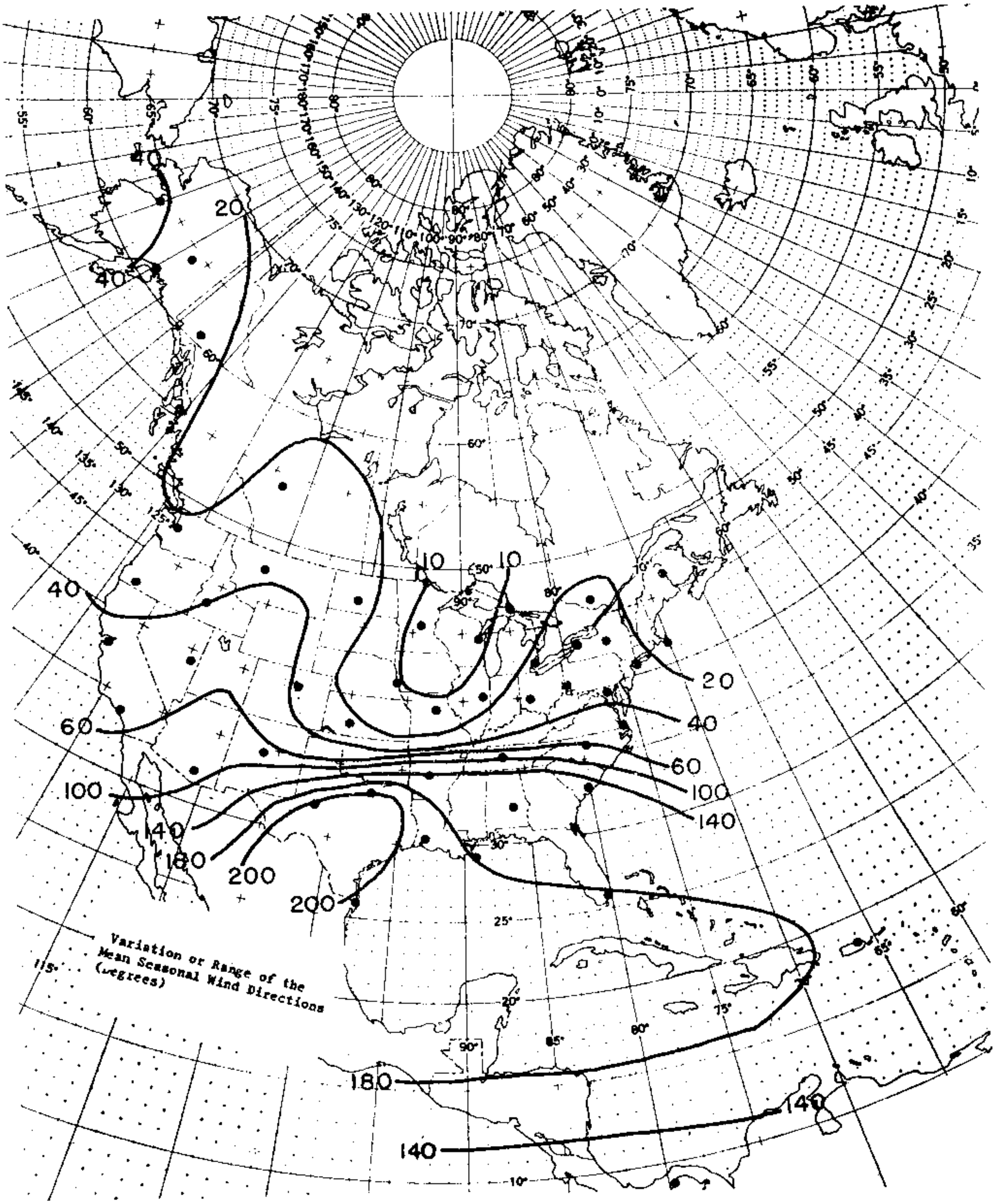

FIGURE 13.—Variation of the mean seasonal wind directions.

RADEF DATA FOR TESTS AND EXERCISES

(Not for Postattack Operational Use)

Periodically, radiological defense exercises should be planned and scheduled as a basis for the practice and training of RADEF personnel and as a basis for measuring capability and testing procedures. Hypothetical dose rate contours should be prepared as indicated in subsequent paragraphs to simulate the exercise fallout situation. Dimensions of the theoretical patterns assume typical (a) air density, (b) particle density and shape, (c) range of particles sizes, and (d) distribution of radioactivity with respect to particle size. All of these would vary from day to day, or with weapon yield, height of burst, and nature of soil at the point of detonation. However, the dose rate contours would have sufficient validity for test and exercise purposes, but would not have operational application. Operationally, the fallout situation would be determined by monitoring as indicated in FG–E–5.9, "Handbook for Radiological Monitors."

Particle Sizes, Associated Radioactivity, and Fall Rates

In a surface burst weapon, large quantities of earth enter the fireball at an early stage and are fused or vaporized. When sufficient cooling has occurred the vaporized soil and rock, fission products, and other radioactive residues condense forming particles, or become incorporated with the earth particles as a result of condensation onto their surfaces. The majority of the contamination of earth particles is found mainly in a shell near the surface. The amount of radioactivity associated with particles of different sizes may vary considerably with the design of weapon and the type of soil over which the weapon is detonated. As the violent disturbance due to the explosion subsides, the contaminated particles gradually fall back to earth. This effect is referred to as "fallout." The fallout particles resemble cinders, sand, or ashes and will vary considerably in size and shape. Some particles that are extremely small, less than 1 micron in diameter, will remain suspended in the stratosphere for many months to possibly a year or longer. Larger particles, with diameters exceeding 500 microns, may fall back to earth within 25 to 30 minutes after detonation.

Figure 14 indicates typical distribution of radioactivity with particle size and approximate fall times for spherical particles of different sizes. Particles of irregular shape would fall more slowly. It is emphasized that the data summarized in the figure may not be strictly valid in any given case and have no direct operational application. However, study of the figure can lead to a better understanding of radioactive fallout deposition.

Dimensions of Hypothetical Dose Rate Contours

Tables 6 and 7 provide theoretical dimensional data for specific dose rate contours in statute miles as of H + 1 hours and dose contours for different weapon sizes detonated at the earth's surface and under different wind speed situations. Data are provided for 4 weapon sizes— 1 MT, 3 MT, 10 MT, and 30 MT. For each weapon size the dimensions are indicated for the contours indicating the degrees of contamination equivalent to dose rates of 10, 30, 100, 300, 1,000, and 3,000 R/hr as of H + 1 hour, and approximate 2-week doses of 30, 100, 300, 1,000, 3,000, and 10,000 R. For each contour the data indicate the maximum upwind and downwind distances, the halfwidth at point of origin, and the maximum halfwidth of each contour, with the maximum halfwidth occurring at about one-half the distance between ground zero and the maximum downwind extent of the contour. Data are shown for four wind speeds—10, 20, 40, and 60 knots.

The dimensions of the contours are based upon an assumption of 100% fission yield. Although this assumption may be valid for some low kiloton yield weapons, it would not be valid for the megaton yield weapons. For exercise purposes, it is generally assumed that the design of megaton yield weapons is half fission—half fusion. To account for the above assumed fission-fusion ratio, the dose rate and dose values of the contours should be halved to 5, 15, 50, 150, 500, and 1,500 R/hr, and 15, 50, 150, 500, 1,500 and 5,000 R, respectively. For different fission-fusion ratio assumptions, the values of the dose rate contours would be modified accordingly.

The axis of the hypothetical dose rate contours should be oriented in the direction of the 100-millibar DF vector. It should be emphasized that these hypothetical contours should be used for test and exercise purposes only. They have no validity for operational use. Furthermore, fallout from a weapon detonation may be extremely irregular, not in smooth elongated ellipses as indicated by these hypothetical contours.

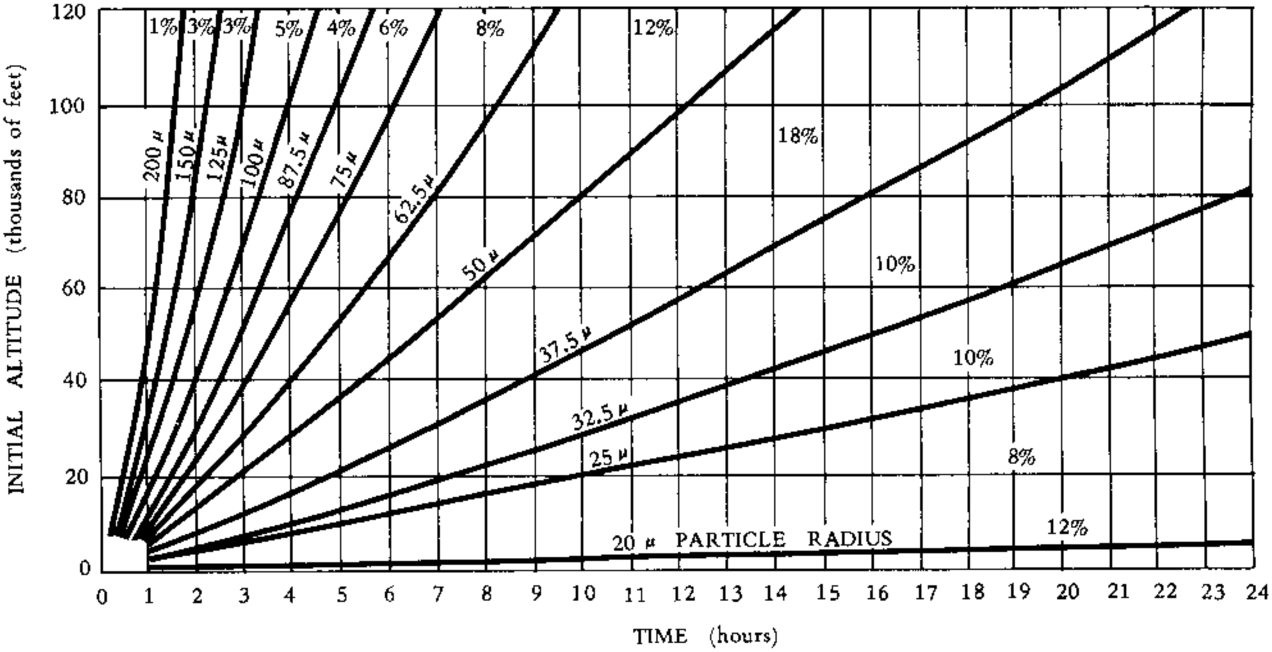

FIGURE 14.—Fall times of particles from various altitudes, and percentages of total activity carried.

TABLE 6.—*Dimensions of hypothetical dose rate contours—normalized to H + 1 hour*

(100% fission assumed) [1]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R/hr)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
1 MEGATON YIELD					
10	10	5	160	11	115
10	30	4	120	9	75
10	100	3	80	8	45
10	300	2	45	6	20
10	1,000	1	15	3	7
10	3,000		--	--	--
20	10	4	325	6	60
20	30	3	250	4	40
20	100	2	150	3	20
20	300	1.5	90	2.5	10
20	1,000	0.7	30	1.5	3
20	3,000	--	----	--	----
40	10	3	550	4	45
40	30	2	400	3	30
40	100	1.5	225	2	15
40	300	1.0	110	1.5	6
40	1,000	[2]-3.0	30		2
40	3,000			--	---
60	10	2	800	3	25
60	30	1.5	650	2	15
60	100	1.0	350	1.5	10
60	300	0.5	175	1.0	4
60	1,000	[2]-8	25	--	1
60	3,000		----	--	----
3 MEGATON YIELD					
10	10	6	250	12	120
10	30	5	200	10	85
10	100	4	150	8	55
10	300	3	100	7	35
10	1,000	2	55	5	15
10	3,000	1	20	3	7
20	10	5	500	10	60
20	30	4	400	8	45
20	100	3.5	300	7	30
20	300	3.0	200	6	15
20	1,000	2.0	100	4	10
20	3,000	[2]-0.5	35	--	4

TABLE 6.—*Dimensions of hypothetical dose rate contours—normalized to H + 1 hour* (Continued)

(100% fission assumed)[1]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R/hr)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
3 MEGATON YIELD					
40	10	4	850	8	50
40	30	3	675	6	35
40	100	2.5	475	5	20
40	300	2.0	300	4	12
40	1,000	1.0	115	2	5
40	3,000	-	---	.	----
60	10	2.5	1,300	4	30
60	30	2.0	1,000	3	20
60	100	1.5	700	2	15
60	300	1.0	400	1.5	8
60	1,000	0.1	150	0.5	3
60	3,000	-	-- -	--	----
10 MEGATON YIELD					
10	10	10	300	20	175
10	30	8	250	16	130
10	100	6	200	12	100
10	300	5	150	10	65
10	1,000	4	100	8	35
10	3,000	2	50	4	20
20	10	8	600	15	90
20	30	6	500	12	75
20	100	5	400	10	50
20	300	4	300	8	35
20	1,000	3	200	6	20
20	3,000	1.5	100	4	10
40	10	6	1,100	12	80
40	30	5	900	10	60
40	100	4	700	8	40
40	300	3	500	6	25
40	1,000	2	250	4	10
40	3,000	0.1	80	0.5	5
60	10	4	1,700	7	50
60	30	3	1,400	5	35
60	100	2.5	1,000	4	25
60	300	2	700	3	20
60	1,000	1	300	2	9
60	3,000	[2].5	65	..	3
30 MEGATON YIELD					
10	10	16	400	30	250
10	30	14	300	27	200
10	100	12	250	24	150
10	300	10	200	22	100
10	1,000	8	150	18	70
10	3,000	6	100	14	40

TABLE 6.—*Dimensions of hypothetical dose rate contours—normalized to H + 1 hour* (Continued)

(100% fission assumed) [1]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R/hr)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
30 MEGATON YIELD					
20	10	14	800	18	130
20	30	12	650	16	110
20	100	10	500	14	80
20	300	8	400	12	60
20	1,000	6	300	10	35
20	3,000	4	150	8	20
40	10	10	1,400	12	120
40	30	8	1,200	10	90
40	100	6	900	8	65
40	300	4	700	6	45
40	1,000	3	400	5	25
40	3,000	2	200	4	13
60	10	6	2,000	8	75
60	30	5	1,800	7	60
60	100	4	1,400	6	45
60	300	3	1,000	5	30
60	1,000	2	600	4	20
60	3,000	1	250	2	10

[1] Contour dose rate values to be adjusted for other fission/fusion assumptions.

[2] Minus sign in front of upwind distance indicates that contour originates downwind of ground zero.

TEST AND EXERCISE DATA

TABLE 7. —*Dimensions of hypothetical dose contours—approximate dose to D + 14 days*

(100% fission assumed)[1]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
		1 MEGATON YIELD			
10	30	4	210	7	35
10	100	4	145	6.5	25
10	300	3	95	5.5	15
10	1,000	2	50	4.5	8
10	3,000	1.5	25	3.0	4.5
10	10,000	[2]-0.8	5	0.0	1.5
20	30	3	340	6	30
20	100	3	225	5	15
20	300	2	140	4.5	10
20	1,000	1.5	70	3.5	5.5
20	3,000	0.5	25	2.0	3.0
20	10,000				-
40	30	2.0	685	5.0	15
40	100	2.0	450	4.0	9.5
40	300	1.5	265	3.5	6.5
40	1,000	1	105	2.0	3.5
40	3,000	[2]-0.3	25	0.0	2.0
40	10,000			-	--
60	30	1.5	900	4.0	12.5
60	100	1.3	565	3.5	8.0
60	300	1.0	310	2.5	5.0
60	1,000	0.4	110	1.5	3.0
60	3,000	[2]-1.0	7.5	0.0	0.5
60	10,000			-	--
		3 MEGATON YIELD			
10	30	7.0	280	12	60
10	100	6.0	205	11	40
10	300	5.0	140	9	25
10	1,000	4.0	85	8	15
10	3,000	2.0	45	6	9
10	10,000	0.5	15	2.5	4
20	30	5.5	560	10	30
20	100	5.0	405	8.5	20
20	300	4.0	280	7.5	14
20	1,000	3.0	160	6.0	9
20	3,000	1.5	70	4.0	6
20	10,000	[2]-0.8	14	0.0	2.5

Table 7.—*Dimensions of hypothetical dose contours—approximate dose to D + 14 days* (Continued)

(100% fission assumed) [2]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
		3 MEGATON YIELD			
40	30	4.0	940	8.0	24
40	100	3.5	650	7.0	16
40	300	2.5	420	6.0	11
40	1,000	2	200	4.5	7
40	3,000	0.5	70	2.0	4
40	10,000		.		.
60	30	3	1,260	7.0	20
60	100	2.5	840	6.0	14
60	300	2	515	5.0	10
60	1,000	1	210	3.5	5.5
60	3,000	[2]-0.1	60	0.0	3.0
60	10,000		.		.
		10 MEGATON YIELD			
10	30	12	375	20	90
10	100	10	285	18	65
10	300	9	210	16	45
10	1,000	7	135	14	28
10	3,000	5	80	11	18
10	10,000	2.5	35	7	10
20	30	10	645	16	75
20	100	9	470	15	50
20	300	7	335	13	35
20	1,000	6	205	11	20
20	3,000	4	110	8	13
20	10,000	1	35	4	7
40	30	7.5	1,280	14	40
40	100	6.5	935	12	27
40	300	5.5	650	11	20
40	1,000	4.0	375	8.5	14
40	3,000	2.5	155	6.0	9
40	10,000	[2]-0.7	30	0.0	4
60	30	6	1,740	12	35
60	100	5	1,240	11	24
60	300	4	830	9	18
60	1,000	3	435	7	11
60	3,000	1.5	160	4.5	7
60	10,000	[2]-3.5	15	0.0	1
		30 MEGATON YIELD			
10	30	18	470	33	135
10	100	16	370	30	100
10	300	14	285	27	70
10	1,000	12	200	23	47
10	3,000	9.5	130	20	31
10	10,000	6.0	65	14	19

TABLE 7.—*Dimensions of hypothetical dose contours—approximate dose to D + 14 days* (Continued)

(100% fission assumed)[1]

Average wind speed (in knots) to 60,000 ft. alt.	Contour value (R)	Dimensions (in statute miles)			
		Upwind	Downwind	Halfwidth at origin	Max. halfwidth
30 MEGATON YIELD					
20	30	16	825	27	110
20	100	14	630	24	80
20	300	12	470	22	55
20	1,000	10	310	18	35
20	3,000	8	190	15	24
20	10,000	4	80	10	14
40	30	13	1,640	22	58
40	100	11	1,250	20	43
40	300	10	920	18	32
40	1,000	8	585	15	24
40	3,000	5	315	11	16
40	10,000	2	90	6	10
60	30	11	2,260	20	53
60	100	9	1,690	18	38
60	300	8	1,210	16	29
60	1,000	6	725	13	21
60	3,000	4	335	9	14
60	10,000	0.5	80	2.5	8

[1] Contour dose values to be adjusted for other fission/fusion assumptions.

[2] Minus sign in front of upwind distance indicates that contour originates downwind of ground zero.

Distribution:
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