

## Chapter 5

# Monitoring, Survey, and Reconnaissance

## Planning, Conducting, Recording, and Reporting

As explained in Chapter 3, nuclear fallout may contaminate a large portion of the battlefield. In order to operate and survive on the nuclear battlefield, this contamination must be located, reported, and avoided if possible.

Terrain affects wind direction which in turn determines where fallout will be deposited. Fallout will deposit differently in a valley as with a reversed slope of a hill. The only sure way of determining where fallout has actually contaminated the surface is by conducting a radiological survey or by receiving NBC 4 nuclear reports from individual monitors. These reports are essential to report the actual contamination that is present.

Fallout predictions provide a means of locating probable radiation hazards (see Chapter 4). Militarily significant

fallout will occur within the predicted area. However, the prediction does not indicate exactly where the fallout will occur or what the dose rate will be at a specific location. Radiological contamination can also be created by rainout or washout. Areas of neutron-induced radiation also can be caused by low airbursts. Operations in a neutron-induced gamma activity (NIRA) area are explained in detail in Chapter 7. Before planning operations in a nuclear environment, commanders must be aware of residual contamination hazards and measure the dose rate. This is done by one of three methods—monitoring, survey, or recon and the results are transmitted to units in the form of an NBC 5 nuclear report.

## Monitoring

Radiological monitoring is done routinely to determine the presence and intensity of the residual radiation hazard. Monitoring is performed while in a stationary position. The radiation may be from fallout or neutron-induced areas. The IM174-series Radiacmeter or the AN/VDR-2 are the basic instruments used to monitor for radiation.

**Area Monitoring.** Since nuclear weapons may be employed at any time on the battlefield, all units monitor for radiation upon initial deployment. Monitoring is included in normal intelligence activities. It provides early warning and useful radiological information to units at all levels. There are two types of area monitoring—periodic and continuous. Both types of monitoring can be performed using the direct or indirect technique, discussed later in this chapter.

**Periodic Monitoring.** Periodic monitoring consists of frequent checks of the unit area for radiation. Periodic monitoring assures the commander that the unit area is not contaminated. It warns the unit if contamination arrives.

Periodic monitoring is initiated after the first use of nuclear weapons in theater, when a unit is out of contact with higher headquarters, when ordered by higher headquarters, or when the unit stops continuous monitoring.

During periodic monitoring, take a reading with the IM174 or an AN/VDR-2 radiacmeter at least once each hour. Unit SOPs may require more frequent readings and should provide detailed information on monitoring procedures. When a unit has more than one Radiacmeter, only one is required for periodic monitoring.

**Continuous Monitoring.** Continuous monitoring is the surveillance for radiation in the unit area or position. It is usually performed by units using the indirect technique. Frequency of readings will depend on the current situation and unit SOP. Units will initiate continuous monitoring—

- When a nuclear detonation is observed, heard, or reported in their area of operations.
- When an NBC 3 nuclear report is received and the unit is in the predicted area of contamination.

## FM 3-3-1

- When a dose rate of 1 cGyph is recorded during periodic monitoring.
- When ordered by the unit commander.  
Units return to periodic monitoring when the dose rate (unshielded) falls below 1 cGyph or when ordered to do so.

### Direct Monitoring

Direct monitoring is the simplest and most precise of the monitoring techniques. A radiacmeter is used to get an unshielded dose rate. Determine the unshielded (outside) dose rate by standing with the IM174 or AN/VDR2 held waist high, or 1 meter off the ground, and rotating your body 360 degrees. The highest reading observed is recorded as the dose rate. Take this reading in the open at least 10 meters away from buildings or other large structures or objects that may shield out a portion of the radiation. In cities or built-up areas, take readings in the center of the streets or at street intersections. If there are points of operational interest where you cannot get 10 meters away from interference, take additional readings. Thus, if a road through a narrow cut or defile is of operational interest, take readings both in the open near the cut and in the cut.

Direct monitoring is used—

- While monitoring for the initial detection or arrival of fallout.
- When in low dose rate areas.
- When determining unshielded (outside) ground dose rates for transmission or correlation factors.
- When verifying the contamination status of a new position.
- While moving through a contaminated area on foot.

Direct readings are used when conditions and operational exposure guidance permit.

### Indirect Monitoring

Indirect monitoring is done inside shelters or vehicles. This allows the unit to measure radiation levels and still keep exposure to a minimum. Indirect monitoring is the preferred technique when operating in a contaminated area. It is used whenever dose rates are high enough to be read inside the shielded location.

When the indirect technique is used, most of the readings are taken inside the vehicle or shelter. However, at least one outside reading is necessary to determine the correlation factor. Both the inside and outside readings must be taken within three minutes of each other. Both must also be taken after fallout is complete. Take both readings before determining the correlation factor. For those vehicles in which the AN/VDR2 has been installed, the user need only verify that the correct attenuation factor has been entered (IAW TM 11-6665-251-10) and then read the outside dose directly off the display.

Calculate the correlation factor using the following formula:

$$\text{Correlation factor (CF)} = \frac{\text{Outside dose rate (OD)}}{\text{Inside dose rate (ID)}}$$

**Note:** CFs are always greater than 1.0. CFs are rounded to the nearest hundredth.

Preprinted correlation factors are calculated for vehicles based on the “best” location for the radiac instrument. CFs may be reported in the NBC 4 nuclear report by line Zulu Bravo (ZB). CFs are the same as the attenuation factor when operating the AN/VDR-2.

### Survey Meter Location in Vehicles

Dose-rate readings are taken during a ground survey by mounted personnel using the route technique. These readings are taken inside the vehicle and later converted to outside dose rates, using a correlation factor. For operational situations, the correlation factor data should be obtained by the survey party for use by the unit NBC defense team in calculating ground dose rates. The survey meter should be located as indicated in Figure 5-1, next page.

If the vehicle being used is not one of those in which the location of the survey meter is designated in Figure 5-1, the survey meter should be held in a vertical position (face up) by the monitor, who is positioned in the assistant driver's seat. The monitor should take the readings with the survey meter consistently located in the selected position.

When the correlation factor data cannot be obtained by the survey party, published correlation factors may be used from Figure 5-1.

For a vehicle in which the AN/VDR2 has already been installed, using the appropriate installation kit, the user need only verify that the proper attenuation factor has been entered (IAW TM 11-6665-2571-10). It is not necessary to relocate the AN/VDR2.

### Correlation Factor Data

Correlation factor data are required in order to convert the reported readings taken inside the vehicle to ground dose rates existing outside the vehicle.

Data for the vehicle correlation factor are provided by the survey party and consist of a set of two readings taken at the same location. One reading is taken inside the vehicle with the instrument located as indicated in Figure 5-1. All subsequent inside readings reported for the survey must be taken with the meter in this same position. The other reading is taken immediately as a normal ground monitoring reading at the same location with the vehicle at least 10 meters away. One or two additional sets of data should be taken at different locations so that the NBC Defense Team can use an average vehicle correlation factor.

The sites for obtaining vehicle correlation factor data should be selected to approximate average foliage and

ground surface conditions for the contaminated area. New data must be obtained if these conditions change significantly or if the survey meter or vehicle is changed. Additional correlation factor data taken because of the aforementioned changes should not be averaged into previously collected data, but should be used for applicable routes or points. Accuracy of the correlation factor data is of paramount importance.

When taking readings inside a shelter, the monitor stands at the center of the shelter, holds the radiacmeter waist high, rotates 360 degrees, and notes the highest readings. All subsequent readings are taken the same way at the

same point. When readings are taken from vehicles, all readings are taken from one selected position.

The readings taken inside the vehicle or shelter represent inside shielded dose rates. These readings must be converted to outside unshielded dose rates by unit NBC defense team personnel before forwarding to higher.

Readings are converted using the following formula:

$$OD = ID \times CF$$

*OD = Outside dose*

*ID = Inside dose*

*CF = Correlation factor used.*

Here is an example of this procedure. A company monitor is located in an shelter which has an open front, dug into the side of a hill. A nuclear burst occurs several kilometers away. The monitor begins continuous monitoring on the outside of the shelter from a location that is at least 10 meters away from any object that might shield the reading. Upon noting a reading of 1 cGyph on the instrument, the monitor returns to the shelter and notifies the unit NBC defense team of the arrival of fallout. The monitor continues to observe the instrument, recording readings and providing other data per unit SOP. There is a steady rise in the dose rate. When the monitor is certain that the dose rate has peaked and is decreasing (fallout is complete), a reading of 20 cGyph is taken inside the shelter. This reading was taken from the center of the shelter, 1 meter above the floor. Within three minutes the monitor goes to the preselected location outside the shelter. A ground dose-rate reading shows 250 cGyph. Before entering the shelter, the monitor brushes off any fallout. The monitor reports to the unit NBC defense team. The report includes the inside reading, the outside reading, the highest (peak) reading noted in the shelter, and any other data required per unit SOP. The unit NBC defense team calculates the CF and submits all required reports to higher headquarters.

Environmental Shielding	Location of Survey Meter	Correlation Factor
<b>Vehicles</b>		
M60 tank	Turret, rear top	25.0
	Turret, front	53.0
	Chassis, near driver	23.0
M113 APC	Directly in front of driver on front wall	3.6
	Near first squad member on left facing forward	3.6
M1 Tank		20.0
M2 IFV		9.1
M3 CFV		9.1
M109 SP Howitzer	Near driver, left side	9.1
	Rear, right side	3.5
M88 Recovery Vehicle	Commander position	3.4
M577 Command Post Carrier	Near driver, right side	6.9
	Rear, left side	3.2
M551 Armored Recon Airborne Assault Vehicle	Near driver, right side	2.5
		4.6
<b>Trucks</b>		
1/4-ton		1.3
3/4-ton (M998) (HUMMWV)		1.7
2-1/2-ton		1.7
4-ton to 10-ton (also M1008) (HEMMT)		2.0
<b>Structures</b>		
Multistory building		
Top floor		100.0
Lower floor		10.0
Frame house		
First floor		2.0
Basement		10.0
<b>Underground Shelter (3-foot earth cover)</b>		5,000.0
<b>Individual Fighting Positions</b>		10.0

**Figure 5-1. Locations of survey meters and corresponding correlation factors for residual radiation.**

The precalculated list of CFs is shown in Figure 5-1 is not used by the unit NBC defense team when

calculating or reporting outside dose rates. Its principal use is to establish the relative shielding ability of one shelter, structure, or vehicle as compared to another. It is also used for instructional and practice purposes.

## Recording and Reporting Monitoring Data

The NBCC receives monitoring reports from subordinate units. These reports provide data essential to the construction and updating of the contamination overlay. This overlay is used by the entire command.

At unit level the primary purpose of monitoring is to warn all personnel of the arrival or presence of contamination. This allows the commander to take prompt action to minimize the hazard.

### Recording Monitoring Data

DA Form 1971-R (Radiological Data Sheet-Monitoring or Point Technique) is used to record monitoring data at unit level. Block headings are self-explanatory. Any heading not applicable to the situation should be lined out. Space is provided for the monitor to enter data for the CF. The monitor does not calculate the CF; this is done by the unit NBC defense team. The monitor uses the remarks block to provide any additional information of value to the NBC defense team. This block is also used by the NBC defense team to enter the time of burst and to calculate the CF.

A completed DA Form 1971-R showing monitoring data and unit NBC defense team calculation of CF is shown in Figure 5-2.

The DA Form 1971-R is also used as a copy sheet for monitoring data passed from one headquarters to another. Only outside dose rates are forwarded. The form can also be sent or carried directly to the NBCC. Use the remarks block to show normalizing factor calculations.

### Reporting Monitoring Data

The format for monitoring reports follows that found in NATO STANAG 2103/ATP45. Only that part of NBC 4 report which pertains to monitoring reports is discussed here.

**Note:** Correlation factors are based on the inverse of the transmission factor for the given vehicle at the prescribed location for the radiac instrument.

Monitoring reports contain the location of the reading, the dose rate, and the date-time the reading was taken. The location is sent as UTM grid coordinates; the dose-rate reading is expressed in cGyph. Only outside (unshielded) dose rates are reported by the unit NBC defense team, and the date-time is reported in Zulu time. Certain words are

associated with the dose rate that describes the circumstances surrounding the contamination. Note that the definition of line item Romeo has been expanded. Key words used in preparing the NBC 4 nuclear report are listed below. The following words are associated with line item Romeo:

Automatic Reports	Directed Reports	Any Report
initial	series	increasing
peak	summary	decreasing
special	verification	fallout
contact (used for recon only)		induced
		overlapping

**Note:** More than one word may be used on a single report.

### Radiological Data Sheet Notes

(See Figure 5-2)

A nuclear weapon has detonated. Continuous monitoring is initiated. Monitor awaits arrival of fallout in open areas.

Fallout arrives. Monitor reads 1 cGyph, notes it, and reports it to the unit NBC defense team.

Monitor enters the shelter. No dose rate is noted inside because of the shielding. Dose rate must build to equal the CF before a dose rate of 1 cGyph is apparent.

Dose rate on the outside now equals CF (of course, the monitor does not know the CF at this time). Monitor reads 1 cGyph on the inside. The dose rate continues to build. In this example the OD must reach 40 before ID will reach 2.

The dose rate builds. The OD now equals 40 (this can be seen once CF is applied to all previous readings).

The dose rate continues to build and starts slowing the rate of increase.

The dose rate is almost the same as the previous reading. This indicates peak or near peak. The dose rate is measured every 5 minutes now. The dose rate levels off. It appears that no more fallout will arrive. Decay now takes over. The peak reading is reported to the unit NBC defense team.

The decrease is noted. At this point, a collection of CF data is possible. The monitor notes the continuing decrease in dose rates. An OD of 180 is taken. The monitor reports a peak of 10 (shielded) at 1005 hours and the data for the CF (OD = 180 and ID = 9). The NBC defense team calculates a CF of 20 and applies this data to the peak reading.

The monitor continues to take readings at 30-minute intervals until dose rate decreases below 1 cGyph or told to stop.

The following instructions do not limit the scope or body of monitoring data. They attempt to show a large and

flexible system. The important consideration is that both the NBCC and the unit understand each other's needs. The format for NBC 4 nuclear reports is as follows:

RADIOLOGICAL DATA SHEET— MONITORING OR POINT TECHNIQUE					DATE	PAGE NO.	NO. OF PAGES		
For use of this form, see FM 3-3; proponent of this form is TRADOC.					10 January	1	1		
SURVEY PARTY OR MONITORING UNIT DESIGNATION				Co. B/1-11 INF	MONITOR (Print name) PFC I.M. Observer				
MAP USED		Series V259 1:50,000		TYPE OF VEHICLE OR OTHER SHIELDING		INSTRUMENT TYPE			
				Foxhole		IM - 174B/PD			
READING NO	LOCATION	TIME	DOSE RATE (cGyph)	DO NOT USE*	READING NO.	LOCATION	TIME	DOSE RATE (cGyph)	DO NOT USE*
1	AY123456	0600	0 (1)		16	AY123456	9		
2		0615	0		17		9		
3		0630	0		18		10 (7)		
4		0645	1 (2)		19		10		
5		0700	0 (3)		20		10		
6		0715	0		21		9		
7		0730	0		22		10		
8		0745	1		23		9		
9		0800	1 (4)		24		9 (8)		
10		0815	1		25		8		
11		0830	2 (5)		26		7 (9)		
12		0845	2		27		5		
13		0900	3 (6)		28		6		
14		0915	5		29		5		
15		0930	7		30		5		
REMARKS TOB 0555 $CF = \frac{180}{9} = 20$									
*DO NOT USE. For control party only									
CORRELATION FACTOR DATA									
LOCATION	READING NO.	DOSE RATE (cGyph)		CF*	LOCATION	READING NO.	DOSE RATE (cGyph)		CF*
		Inside	Outside				Inside	Outside	
AY123456	24	9	180	20					

DA FORM 1971-R, SEP 88

Replaces DA Form 1971 R, 1 Jun 63, which is obsolete

Figure 5-2. Completed DA Form 1971-R for monitoring.

Line Item	Meaning
Q	Location of reading.
R	Dose rate in cGyph. Additional descriptive words such as initial, increasing, peak, series, or summary, may be added.
S	Date and time of reading in local or Zulu time (state which).
ZB	Correlation factor data.

**Report Formatting Instructions**

Only the unit NBC defense team places monitoring data to be sent to higher headquarters in the NBC 4 nuclear report format. Unit monitors do not originate the NBC 4 nuclear report or send it to higher headquarters.

Line items Quebec, Romeo, and Sierra may be repeated as many times as necessary. When locations and times change, this gives a specific picture of the contamination throughout the area. A "zero" dose rate may be reported on line item Romeo.

The NBCC provides guidance on precedence for an NBC 4 nuclear report in the SOP or other instructions. This guidance is based on whether the report is an automatic or a directed report. The precedence depends on the urgency of the report. It is usually sent IMMEDIATE, but may be upgraded or downgraded as the situation dictates.

NBCC SOPs will detail in general terms how automatic NBC 4 nuclear reports travel from company level to the NBCC. When necessary, specified nets are used to allow timely flow and to avoid overload. Directed reports will be transmitted on the communications nets or other means specified by the NBCC.

Figure 5-3, shows examples of NBC 4 nuclear reports. These reports follow the format and report formatting instructions. Line item Quebec is the unit's location and should be encoded for OPSEC purposes. This data need not be encoded if the report is sent by secure means. Users of the NBC 4 nuclear report are not limited solely to the use of the line items shown in these examples. Other line items may be added at the user's discretion.

**Automatic Reports**

All units in the contaminated area submit certain monitoring reports automatically. These provide the minimum essential information for warning, hazard evaluation, and survey planning. Reports are sent through specified channels to reach the NBCC. Nondivisional and corps units in a division area submit reports to the division NBCC. Corps units send reports to corps NBCC.

It is emphasized that the purpose of establishing automatic reports is to prevent overload of communications. In this way units are obligated, yet limited, to certain types of reports. This also insures that only meaningful data are reported. The automatic reports are initial, peak, and special—those specified by the NBCC or required by intermediate commanders for operational purposes.

**Initial Report.** The unit monitor normally conducts periodic monitoring. When conditions require continuous monitoring, that technique is used. After noting a dose rate of 1 or more cGyph outside, the monitor notes the time and moves directly to shelter. The monitor reports to the unit

Standard Format		USMTF Program Format	
NBC 4 Nuclear Report	NBC 4 Nuclear Report	MSGID/NBC4/NUC//	MSGID/NBC4/NUC//
Q LB193351	Q LB193351	NBCMSGTP/SPECIAL//	NBCMSGTP/SUMMARY//
R 1 Initial	R 35 Series	QUEBEC/32ULB193351//	QUEBEC/32ULB193351//
S 021200Z	S 021400Z	ROMEO/20//	ROMEO/8//
	Q LB193351	SIERRA/151200Z//	SIERRA/041200Z
	R 30 Series		QUEBEC/32ULB190360//
	S 021430Z		ROMEO/10//
NBC 4 Nuclear Report	Q LB193351		SIERRA/041205Z//
Q LB193351	R 27 Series		QUEBEC/32ULB195331//
R 40 peak	S 021500Z		ROMEO/4//
S 021330Z	Q LB193351		
ZB 20	R 25 Series		
	S 021530Z		
	Q LB193351		
	R 23 Series		
	S 021600Z		
	Q LB193351		
	R 21 Series		

Figure 5-3. Examples of NBC 4 nuclear reports.

NBC defense team that an outside dose rate of 1 or more cGyph exists and gives the time of reading. The unit NBC defense team warns and alerts all unit personnel of the arrival of fallout. Defensive measures per SOP are implemented. The defense team then formats an NBC 4 nuclear report to send to the NBCC. The word “initial” is used with line item Romeo to alert the NBCC to the value of the report.

Intermediate headquarters screen and evaluate the initial NBC 4 nuclear report. If the hazard has already been reported, the precedence of the report is reduced. The report may be eliminated if several reports have already been submitted. The initial report is used at the NBCC to confirm the fallout prediction. The dose rates cannot be converted to  $H + 1$ .

**Peak Report.** While performing continuous monitoring, the unit monitor records dose rates on DA Form 1971-R according to the time intervals specified in unit SOP. Dose rates should be recorded at 15-minute intervals while fallout is arriving. The dose rate steadily rises until it reaches a peak and then it decreases. In some cases, the dose rate may fluctuate for a short time before beginning a constant decrease.

Once there is a constant decrease, the monitor takes an inside reading and then an outside reading for the CF calculation. First, the inside reading is recorded on DA Form 1971-R as the next reading in sequence (in the main body of the form) and also in the CF data portion of the form. Other entries for the CF block are completed. Within three minutes, the monitor goes to the outside location previously used and takes an outside dose-rate reading. The monitor immediately returns to the shelter. Exposure to radiation during this short period of time is minimal.

The monitor records the highest outside dose-rate reading in the CF data block on DA Form 1971-R. The monitor then reports the location of the readings, the time of readings, the inside dose rate and the outside dose rate to the unit NBC defense team. The monitor does not calculate or apply the CF to this data. The unit SOP outlines the means of communication to be used. The monitor does not need to use the NBC 4 format to report this information. It is usually sent over unit radio or wire nets or presented in person. Any questions about the information are cleared up at this time. The monitor resumes continuous monitoring-recording dose rates at 30-minute intervals after the peak dose rate has been reported. This procedure is continued until the unit leaves the contaminated area or the radiation level drops to 1 cGyph or the commander directs that periodic monitoring begin.

The unit NBC defense team records the monitor’s information onto DA Form 1971-R. After all information is recorded, the team calculates the CF and applies it to the highest dose rate. It then formats the NBC 4 nuclear

report. The word “peak” is used with line item Romeo. Intermediate headquarters do not screen or delay peak reports. This information is extremely important to the NBCC.

**Special Reports.** FSOP/OPLAN/OPORD and other standing instructions may establish the requirement for special NBC 4 nuclear reports. These special reports are evaluated by the NBCC. They invite command attention to areas or conditions of serious concern. The operational situation, unit radiation status, and similar considerations determine the criteria for these special reports. They cannot be specified here. Generally, this report may be required when the ground dose rate goes above a specified value. When the dose rate increases after it has decreased, a special report may also be sent. In this case, the word “overlapping” could be used with line item Romeo. Special reports may be required after a specified period of time if the unit remains in the area.

### Additional Reports

In addition to the automatic reports-initial, peak, and special-units may be required or directed to submit other reports.

**Increasing and Decreasing Reports.** Dose rates reported on NBC 4 nuclear reports (line item Romeo) followed by the words increasing or decreasing are never sent unless requested. This cuts down on communications overload. It is logical to assume that the dose rate at a unit which sent an initial NBC 4 nuclear report will increase, peak, and then decrease. The computations used to normalize (convert to  $H + 1$ ) the peak dose rate also convert any decreasing dose rate at that location to the same  $H + 1$  dose rate. From this it can be seen that unsolicited increasing and decreasing reports clutter the reporting channels with useless information.

**Directed Reports.** Selected units in the contaminated area will be directed to submit additional NBC 4 nuclear reports. The NBCC uses these reports to evaluate a radiological contamination hazard-the decay rate of fallout and how long this decay rate (and the contamination overlay) will remain valid. They are used to determine the H-hour (if unknown) and the soil type in induced areas.

Reliable calculations are directly related to the precision of the dose rate measurement. Tactical decisions and personnel safety depend on the accuracy of these measurements. Further development of the contamination situation depends upon this data. An error in dose rate measurements means a similar error in calculating future dose rates and total dose.

The NBCC carefully selects locations for additional dose-rate readings. Close coordination with the G3 is required.

Selection is based on—

- How long the unit is likely to remain in the area.
- The training status of the unit.

- Comparison of average soil, vegetation, and terrain across the entire area and at the proposed monitoring location.
- The tactical situation.
- The need for representative information throughout the contaminated area according to its size and unit distribution.

There are three directed reports—Series, Summary, and Verification. Instructions for report frequency, precedence, reporting procedures, communications channels, and format are established by FSOP/OPLAN/OPORD and other written instructions. The names of these reports describe their purpose. To the monitor or unit defense team the name means a dose-rate reading taken in accordance with a specific procedure.

**Series Reports.** A Series report consists of dose-rate readings taken at the same location at 30-minute intervals for 2 ½ hours followed by hourly reports. This report begins after a peak dose rate has been noted at the monitor's location.

Requests to units selected to submit series reports come through intelligence channels. Requests must ask specifically for a Series report and are passed, ultimately, to the NBC defense team, which directs the monitoring. A request for a Series report alerts the monitor to take a series of dose rate readings at 30-minute intervals. Whenever possible, the readings are taken at 30-minute or hourly intervals from time of burst (TOB). If TOB is 0745, readings should be taken at 0815, 0845, 0915, and 0945. The location must remain constant. Readings are recorded on DA Form 1971-R. The monitor reports each reading and the time it was measured to the NBC defense team. The monitor continues the procedure until told to stop. The instrument used to measure dose rates should be zeroed before each reading.

The unit NBC defense team organizes the data into the NBC 4 nuclear report. The word "Series" is used with line item Romeo. As per FSOP/OPLAN/OPORD or other written instructions, the reports may be sent one at a time or held until several have been collected and then reported. Intermediate headquarters do not screen or delay these reports. They are needed at the NBCC for fallout decay rate and other calculations.

**Summary Reports.** A Summary report shows the radiation distribution throughout a unit's area of responsibility. The locations for readings are selected by the reporting unit according to the distribution of its elements and the extent or variety of the area's terrain. The

time each reading was taken is also given. Inside dose rates are converted to outside dose rates. Units may be directed to submit the Summary report or FSOP/OPLAN/OPORD or other written instructions may require the report to be submitted at a specified time (for example, H + 24 or H + 48).

The unit NBC defense team will direct its unit monitors to take dose-rate readings at several locations within their subunit boundaries. Unit monitors take these readings at locations specified either by the defense team or at locations they choose. The location, dose rate, and time of reading are recorded on DA Form 1971-R and the form returned to the defense team.

The defense team organizes this data into the NBC 4 nuclear Summary report. The word "Summary" is used with line item Romeo. The defense team ensures that enough readings are taken at various points so the coverage expresses the situation across its area. The report is sent to the NBCC through intermediate headquarters where additional data from other units are added if available. The report can be used to verify an overlay of shrinking contamination.

**Verification Reports.** The Verification report is a unit's response to a direct request from the NBCC. If data is lacking from a specified location near or in the unit area, the NBCC requests a Verification report. These reports also can be used to recheck an unusually high dose rate, a zero reading, or other abnormalities. The NBCC is aware that the previously reported dose rate is no longer valid because radioactive decay will have taken place. A Verification report is not a retransmission of previously reported readings, but a check of the actual condition of the area.

A unit tasked with submitting a Verification report will receive specific instructions. These will include the exact location for the readings, why the report is requested, and details about communications.

A unit monitor tasked to perform monitoring uses the direct technique to take the readings whenever possible. The monitor records all data on DA Form 1971-R and turns the form in to the unit NBC defense team when the mission is completed.

The team will format the NBC 4 nuclear report. The word "Verification" is used with line item Romeo. Intermediate headquarters do not screen these reports. They are passed without delay to the NBCC.

## Surveys

Nuclear surveys are conducted to find the extent and intensity of contamination. Radiological monitoring and reconnaissance provides general information about contamination for immediate operations. Surveys provide detailed information on which future operations are based.

Surveys require time and coordination. Men and equipment must be diverted from primary missions. Because of these circumstances, surveys are conducted only when the intensity of contamination must be known. Future dose rates can be predicted from the data provided by

monitoring or survey. Recon cannot provide sufficient data for this. Monitoring provides data only in areas occupied by troops.

If no operations are planned in the area, a survey is not required. However, if there is a remote chance that this is not the case, a survey should be conducted at the earliest opportunity. Current techniques are designed for reasonable safe survey of high dose rate areas. Once the contamination has decayed, the survey will be difficult. Often, a survey will be delayed until the area is under friendly control. Survey in the Covering Force Area (CFA) or forward of the Forward Line of Troops (FLOT) is not done unless knowledge is imperative and loss of survey team is acceptable. This will be an extremely rare case.

Calculations based upon survey data are a series of approximations. These are sufficient for field use; however, best accuracy is obtained by resurveying the area every few days. Theoretically, once a radiological hazard has been identified, the contamination existing at any future time can be calculated. However, weathering and inaccuracies in initial survey make this approach unrealistic. Frequent resurvey of contaminated areas is essential. The frequency and detail of resurvey will be determined by the reliability of the initial survey. Resurvey will be planned and conducted in the same way as the initial survey.

Surveys are not conducted by units unless directed. The NBCC will initiate surveys or request that a subordinate unit be directed to conduct a survey.

A survey is performed by a group comprised of a defense team and one or more survey teams. The defense team, consisting of one or more men, plans and directs the survey. It screens and transmits the data to the authority that ordered the survey. The survey team, organized within the company/troop/ battery NBC team, consists of a monitor and necessary support and security personnel. Only the minimum number of personnel are exposed to radiation. The defense team briefs the survey teams and controls their movements.

There are two types of surveys, aerial and ground. The type used depends on many factors. Aerial surveys are conducted for large areas and have advantages over ground surveys. They are faster and more flexible. They expose personnel to lower doses, and require fewer personnel and equipment to perform. However, aircraft may not always be available. Ground surveys can be done under unit control using unit equipment. They can be done in any type of weather, and they can be done when aircraft cannot fly. They are more accurate than aerial surveys. These points are considered by the NBCC when deciding the type of survey to use.

## Control of Surveys

There are two different methods of control over surveys, centralized and decentralized. Centralized surveys mean that the NBCC ordering the survey provides the defense team. The radiological data is reported directly to this team. The data is not screened, consolidated, or evaluated in any way by intermediate headquarters.

Decentralized control is used when the NBCC cannot or should not control the movements of the survey teams. Thus, decentralized control means that the NBCC has directed a subordinate unit to control a survey. This unit will report data directly to the NBCC. It will not screen, consolidate, or evaluate the data in any way.

The type of survey used is also a factor in determining which method of control is used. Aerial surveys can cover large areas. They also require air space management. The unit NBC defense team must be able to obtain information on the operational situation. This avoids directing the aircraft into hostile areas. This type of information is not available below NBCC level. Also, subordinate units do not normally have aircraft available for a survey. Thus, centralized control by the NBCC is used for aerial surveys. This may differ, however, based on the organizational composition of the unit.

During ground surveys, decentralized control is best. This is because the NBCC does not have radios or has only limited access to radios, which are necessary to control the ground survey teams. Also, distances may be too great from the survey area to the NBCC location for good communications. Control of a ground survey may require too much of the NBCC's time. For these reasons, the subordinate unit tasked to perform the ground survey provides the defense team. Therefore, decentralized control by the subordinate unit is used for ground surveys.

Table 5-1 shows the relationships between the NBCC and subordinate units, centralized and decentralized control, and the type of surveys.

**Table 5-1. Control of surveys.**

Centralized	Decentralized
NBCC	Subordinate Unit
Aerial	Ground

## Survey Planning at the NBC Center

Radiological contamination on the nuclear battlefield may cover large areas. It may occur in many locations with overlap of contaminated areas, and may be in varying stages of decay. Initial detection of new contamination will probably be in the form of NBC 4 nuclear Contact reports from recon elements. These reports will alert the command to the presence of a previously undetected hazard. This

will cause a new series of orders and requests to be initiated for radiological information. These orders and requests will be superimposed upon existing survey plans already functioning for older contaminated areas. Thus, the supervision and coordination of the radiological intelligence effort will be a continuing process.

The NBCC initiates all radiological surveys. This ensures that the right amount of data is obtained at the right time. It also ensures that surveys are not initiated when data is not required. This reduces the burden of subordinate units. Subordinate units execute only their assigned portions of the plan(s).

### Factors Influencing Reliability

With the guidance and procedures outlined, aerial surveys provide the defense team with adequate and sufficiently reliable data. Generally, the dose rate determined by aerial survey varies from the true dose rate at the ground location. This is because of survey meter errors, pilot errors, monitoring errors, errors due to contamination of aircraft at touchdown for ground reading, and the overall system errors.

The type and source of contamination will determine the survey requirements and sequence of calculations to be performed. The types and sources of radiological contamination are—

- **Induced contamination.** Contamination resulting from a nuclear burst where the contamination can be related to a specific nuclear burst where fallout did not occur, or contamination is localized around an obvious ground zero area.
- **Fallout (known weapon).** Contamination arriving or identifiable as fallout which can be related to a particular nuclear burst.
- **Fallout (unknown weapon).** Contamination arriving or identifiable as fallout which cannot be related to a particular nuclear burst.
- **Contamination (unknown source).** Contamination identifiable as induced or fallout which cannot be related to a known source.
- **Combination and multiples of the above.**

The radiological survey plan for a contaminated area will be based upon the estimation of many variables. The plan must establish, as a minimum, the amount of detail required, method of control (decentralized or centralized), type of survey (ground or air), and technique to be used (route, point, course leg, or preselected dose rate). The survey plan for a particular contaminated area will probably contain a combination of these methods, types, and techniques.

For example, a typical survey of a contaminated area may include an aerial survey and a ground survey. Each covers a different zone within the contaminated area, and all the techniques may be employed.

### Factors Influencing the Plan

The following paragraphs list some of the factors affecting survey planning with guidance concerning their major effects. In preparing the survey plan, each factor must be estimated and balanced against the need for information:

- **Knowledge of the Contamination.** Knowledge about the contaminated area which is available or expected to be available (such as recon data and monitoring reports) will help determine the size of the area to be surveyed and the amount of detail required.
  - **Operational Situation.** In rapidly changing situations, centralized control is necessary. Under such conditions, aerial survey is required for critical counterattack routes. A checkpoint overlay for aerial survey planning will be prepared as areas are assigned or as areas of interest change. Main supply routes and so forth may be surveyed using the ground technique later. The operational situation will dictate the availability of personnel and equipment.
  - **Urgency.** Aerial surveys are normally the most rapid means of obtaining information.
  - **Weather.** Aerial surveys may be precluded by poor visibility. Surveys should be delayed during precipitation and high winds. These conditions tend to change a contamination pattern. Ground surveys can be accomplished in any weather, except as noted. Aerial surveys may be precluded by bad weather.
  - **Terrain.** Lack of road nets or the inability of the soil to support ground movement may eliminate a ground survey. An aerial survey is of limited use in mountainous terrain. In areas such as arctic, desert, or jungle, where reference points are rare, marking reference points with cans of paint or bags of talc or flour may be required. The type of survey must be carefully selected. Often radio fixes and precise time, distance, speed, and direction calculations must be made.
- S Status of Training.** Inadequate training or losses of trained personnel may limit survey capability. The status of training must be considered in selection of the type of survey. Status of training of defense teams at subordinate headquarters will also affect this. A record of equipment status and training status of available monitors, survey teams, and subordinate defense teams must be maintained for survey planning. Aerial survey requires the best or most well-trained monitors.
- T Time-distance.** Time-distance factors must be estimated and considered when selecting the most appropriate type of survey to obtain data and allow evaluation within the commander's time limits. Survey operations are not initiated until fallout has ceased. Dependence upon monitoring reports is the primary method of obtaining a rough estimate of contamination information during arrival of fallout.
- **Dose.** Dose status of survey personnel and the operation exposure guidance set by the commander must be evaluated when planning the type of survey.

- **Communications.** Availability of communications will affect all phases of the survey plan. Aerial survey will normally impose the least communications load or risk.
- **Maps.** The NBCC must consider maps and the areas they cover. These maps must be available to units that will participate in the survey.
- **Area Coverage.** All helicopters have approximately the same survey area coverage capability of between 130 and 450 square kilometers per hour per aircraft, depending upon the detail required. Any powered vehicle is satisfactory for conducting ground surveys. All vehicles have approximately the same area coverage capability of between 15 and 40 square kilometers per hour per vehicle, depending upon the degree of detail required, the road network, and the trafficability of the contaminated area. However, because of the superior shielding and cross-country characteristics of the tracked armored vehicle, this type of vehicle is preferred. Regardless of the type of vehicle used, additional shielding (sand bags or metal plates) is always added to the vehicle. To determine how much additional shielding to add to the vehicle, refer to Appendix B and the vehicle data plate for load density. This will reduce the total dose of survey personnel. Selection of the type of vehicle used is based upon the relative shielding correlation factors of one vehicle compared to another. See Figure 5-1 to make these comparisons. The higher the number, the better the protection.
- **Contamination.** A listing or an overlay showing points, routes, or areas where contamination could seriously affect accomplishment of the mission will be maintained for survey planning. These areas, routes, and points are prioritized to help with survey planning.
- **Damage Assessment.** Often a helicopter will be deployed to conduct area damage assessment after an attack. When this occurs, survey and damage assessment can be combined.
- **Multiple Bursts/Sources of Contamination.** When multiple bursts occur, fallout can overlap other fallout areas or induced areas can interlock. Also, several sources can overlap one another such as a neutron-induced area overlapped by fallout.

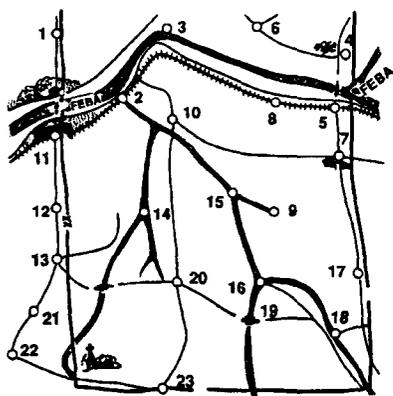


Figure 5-4. Sketch map of division area, showing preselected checkpoints.

Survey of these areas is not difficult; however, normal calculations necessary to present a clear picture will not work. The primary task in these calculations involves sorting dose rates of one contribution from the other. Prior knowledge about decay or soil type for an area before overlap occurs is critical. See Chapter 6 for more details on overlapping calculations.

The basis for planning an aerial survey is the checkpoint overlay. Checkpoints that are easily identified from the air and on a map (small bodies of water, streams, or road junctions) are selected for the entire area of responsibility by the NBCC in coordination with the aviation section. These checkpoints are maintained as an overlay by these two staffs. Then, when a survey requirement is established, the defense team selects a series of course legs, routes, and points where data will provide sufficient ground dose-rate information to evaluate the contaminated area.

Figure 5-4 illustrates a divisional area with preselected checkpoints. This overlay is used with the fallout prediction or neutron-induced prediction outlined in Chapters 4 and 7. Figure 5-5 shows an overlay plan for an aerial survey. Figure 5-6 (next page) shows an overlay plan for the ground survey portion of the plan. When survey of neutron-induced areas is required, a single course leg is selected which will pass directly through ground zero. The survey will begin at the edge of the contaminated area. Since the contaminated area is taken to be circular, survey ceases at ground zero.

Dose rates equal to those found on the course leg are assumed to be present on the other side of ground zero in reverse order. When conducting a survey of an induced area, use either the IM174 or AN/VDR2 Radiacmeter. Only this survey instrument is capable of detecting the entire radiation hazard. Thus, the find plot will be concentric circles. Figure 5-7 (next page) illustrates survey of neutron-induced areas. Only aerial survey is used. Ground survey will result in unacceptable total doses for survey personnel.

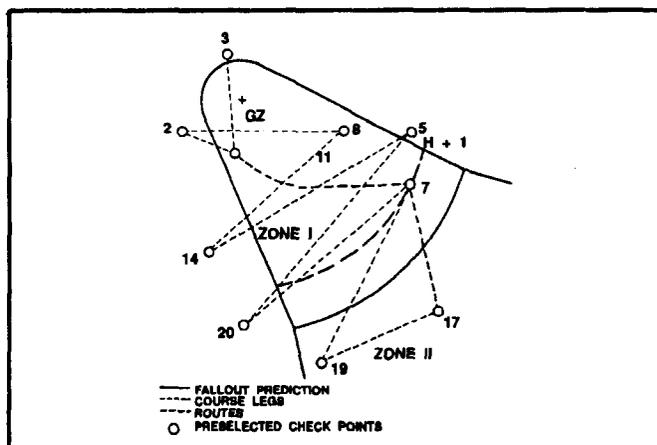


Figure 5-5. Fallout prediction and planned aerial survey overlay.

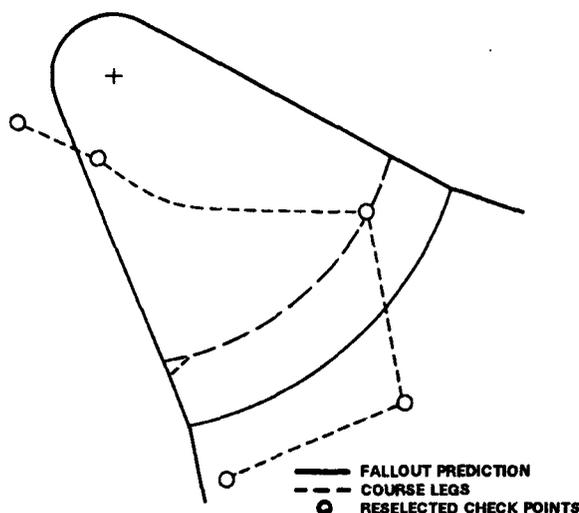


Figure 5-6. Fallout prediction and planned ground survey overlay.

## Personnel and Equipment Requirements

Personnel and equipment for ground survey teams and monitors for aerial survey teams are drawn from the company/troop/battery NBC teams subordinate to the authority directing the survey. Reconnaissance units have the capability (if provided aircraft) of performing aerial or ground surveys as a priority mission when required.

### Personnel

The number of ground survey teams required at any one time will depend on the situation, terrain, time available, detail desired, and other factors. Generally, more personnel are needed for large areas, if time is limited.

The same factors that influence the number of survey teams required for ground surveys apply to aerial surveys. Monitors for the aerial survey teams should be selected from units normally located near aircraft landing areas. This reduces the time needed to brief the survey teams and get them airborne. Primary sources for monitors are—

- NBC recon units.
- Other units with trained monitors.
- Aerial observers who regularly fly recon and surveillance missions.

NBC defense teams for ground survey established at all echelons use organic, school-trained personnel.

### Equipment

Units will require the following equipment to perform ground surveys:

- The IM174-series or AN/VDR2 radiacmeter used for measuring dose rates.

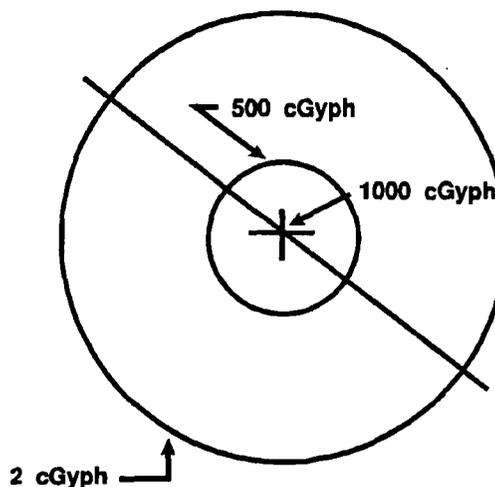


Figure 5-7. Illustration of neutron-induced survey.

- A dosimeter, such as the DT 236/PDR75, IM47, AN/UDR13/PD, or IM143/PD (USMC), must be carried for purposes of radiation exposure control. The IM47 or IM143 should be mechanically zeroed before use and all radiac equipment should be checked to see that it is serviceable. The AN/VDR2 can also be used to read accumulated dose, but the instrument must remain in operation for the entire mission.
- DA Forms 1971-R and 1971-1-R are used for recording information collected during the survey. Local reproduction of these forms is required.
- A watch is needed to determine the time when survey readings are taken. For aerial surveys, a stopwatch or a watch with a sweep-second hand is needed to time the interval between readings.
- Vehicles that have high radiation shielding characteristics (high correlation factors listed in Figure 5-1) should be selected for ground surveys.
- Communications equipment necessary for rapid reporting is required.
- Maps of the land areas to be surveyed must be available to the survey team.

## Coordination

The unit NBC defense team will coordinate the activities of the survey teams with the units located in or near the area to be surveyed. If coordination by the defense team cannot be accomplished because of lack of communications or other causes, the survey teams will be informed. The survey teams will then be directed to coordinate, provided the situation in the area and the required time of completion of the survey permit.

## Survey Team Briefing

Adequate control of the radiological survey, once initiated, will depend to a large extent upon proper briefing of the survey teams. Survey team briefings may vary from group to individual briefings. This depends upon space, time, and operational conditions; briefings may be given in oral, written, overlay, or other form. In any case, a briefing should always be conducted. The written or oral briefing is essentially an order. It should generally follow the form of the five-paragraph operation order. The following is a radiological survey party briefing order reference list (List any maps, charts, or other documents necessary to understand the order.):

### **Radiological Survey Party Briefing Reference List**

#### 1. Situation.

a. *Operational Situation.* Briefly describe the operational situation as it concerns conduct of the survey, to include enemy forces, friendly forces, and planned actions.

b. *Contamination Situation.* Present any factual information available about the contaminated area, to include limits, dose rates, sources of contamination, terrain, and weather.

#### 2. Mission.

Clear, concise statement of task to be accomplished (who, what, when, where, and why).

#### 3. Execution.

a. *Concept of Operation.*

b. *Specific Assignment of Each Team.* In subsequent separate lettered subparagraphs (such as a, b, c, d, and e) give a specific task of each survey party. Include the coordination required.

c. *Coordinating Instructions.* The last subparagraph of paragraph 3 of the order contains instructions applicable to two or more of the survey teams, such as—

- (1) Time of departure and return.
- (2) Routes and alternate routes to and from the contaminated area.
- (3) Coordination required.
- (4) Dose danger limitations. If the AN/VDR-2 is to be used to check for turnback dose (or dose rate), this value shall be entered as the alarm setpoint and checked prior to departure (turnback dose and operation exposure guidance).
- (5) Actions to be taken upon reaching limitations in (4) above.
- (6) Whether and when marking of contaminated areas is required.
- (7) Debriefing—where, when, by whom.
- (8) Decontamination - if required, when, where, and by whom.

#### 4. Administration and Logistics.

Contains information such as required equipment and forms.

#### 5. Command and Signal.

a. *Command.* Location of defense team.

b. *Signal.*

(1) *Data reporting procedure.*

(2) *Special instructions concerning SOI.*

(3) *Call signs, code to be used, and reporting times.*

(4) *Communications means (primary and alternate).*

## Aerial Survey

Aerial radiological survey information can be obtained by use of the IM1740/PD or AN/VDR-2 Radiacmeter held in a vertical position (face up), in rotary wing aircraft. Aerial surveys are conducted rapidly and at a distance from the radiation source. Hence, aerial survey teams are exposed to considerably less radiation than ground survey teams if an equivalent ground survey were conducted over the same area. Aerial surveys can be employed over areas that have dose rates unacceptably dangerous to ground survey teams. Because of speed and flexibility, aerial surveys can be employed over large areas, over unoccupied areas of operational concern, over enemy occupied areas, and over areas of difficult accessibility to ground troops. Aerial survey is preferable when conducting surveys of large areas. The advantages of aerial survey over ground survey are speed and flexibility of employment; lower radiation doses to survey team members, and minimum requirements for equipment, personnel, and communications. However, the dose-rate readings are not as accurate as those obtained by ground survey. Another disadvantage is that dose rates for specific points on the ground may not be provided by aerial survey.

## Techniques

The techniques used to conduct detailed aerial surveys include the route technique, the course leg technique, and the point technique.

In using the route technique, the pilot flies between two checkpoints, following the route of some predominant terrain feature such as a road that connects the two checkpoints.

In using the course leg technique, the pilot flies a straight line course (course leg) between two checkpoints. The procedure followed in obtaining dose-rate information between checkpoints is the same, using either the route technique or the course leg technique. When the dose-rate information obtained from either technique is processed, the result is a series of ground dose rates spaced at equidistant intervals along the path over which the aircraft flew.

The point technique is used to determine the ground dose rate at points of operational concern and is normally employed to obtain more precise dose-rate information at those points than can be obtained by use of other aerial survey techniques. Processed data from dose-rate

information obtained using the point technique are ground dose rates existing at each of the selected points.

**Procedures**

The course leg technique requires that the aerial survey party fly a straight line course (course leg) between two checkpoints. The pilot maintains as near as possible a constant height above the ground, a constant ground speed, and a straight flight direction between the starting and ending checkpoints of each course leg.

The pilot locates the starting checkpoint of a course leg to be flown and either locates the end checkpoint or determines the azimuth of the course leg.

The pilot flies the aircraft on the proper course to pass over the initial checkpoint on a straight path to the end checkpoint. When on course, the pilot alerts the monitor and gives him the height above ground. Shortly before reaching the initial checkpoint, the monitor records the time and height above ground. The monitor rechecks/rezeroes the survey instrument before each course leg, to assure proper operation.

The pilot commands "Mark" when the aircraft is directly over the starting checkpoint, at which time the monitor reads the survey meter, records the dose rate, and begins timing preselected time intervals.

The monitor reads the survey meter and records the dose rate at each preselected time interval (for example, every 10 seconds).

The pilot again alerts the monitor when the aircraft approaches the end checkpoint. When the aircraft is directly over the end checkpoint, the pilot commands "Mark". At this time, the monitor reads and records the final dose rate.

The procedures for a route survey are identical to those for a course leg survey. However, this may or may not require a straight flight direction.

Procedures for a point survey require the aircraft to land near the point of interest. The monitor dismounts, proceeds to the selected point, and takes the reading by using normal ground monitoring procedures. When high dose rates do not permit this procedure, aerial dose rates are taken and air-ground correlation factor (AGCF) data are applied by the NBCC.

**Survey Meter Location in Aircraft**

A specific location for the survey meter in the aircraft must be selected for each aerial survey.

The best survey meter locations for several aircraft are in Table 5-2. If the air-ground correlation factors from Table 5-3 are to be used, the survey meter **must** be located within the aircraft as specified in Table 5-2.

When air-ground correlation factor data are to be determined during the survey, the location of the survey meter may be as given in Table 5-2 or the location may be

**Table 5-2. Location of Survey Meter During Aerial Survey.**

Aircraft <sup>1</sup>	Survey meter location
OH-6A	Held in front of the left rear seat. <sup>2</sup>
UH-1	In the passenger compartment, held in front of the second seat from the left side of the aircraft.

<sup>1</sup> Order of preference of currently available aircraft for use in aerial survey is as listed.

<sup>2</sup> This location recommended in the OH-6A aircraft, for which air-ground correlation factors are not available, nor is information concerning the location for the instrument in the UH-60 and the AH-64.

**Table 5-3. Planning AGCF for survey height determination.<sup>1</sup>**

Height Above Ground		AGCF <sup>2</sup>
Feet	Meters	
100	30	2.2
150	45	2.7
200	60	3.2
250	75	3.9
300	90	4.5
350	106	5.4
400	120	6.2
450	136	7.2
500	150	8.2
750	227	18.6
1,000*	300*	29
1,500*	454*	80
2,000*	600*	300
2,500*	757*	1,450
3,000*	900*	2,600

<sup>1</sup> Some figures are rounded for practical use.  
**Note:** For wooded areas, multiply the AGCF by 0.8. For urban areas (in open) multiply the AGCF by 0.7. These will give you approximate ground dose rates.  
<sup>2</sup> Interpolation and extrapolation are valid.  
 \* The use of AGCF with readings taken at these heights results in approximations of ground dose rates.

selected for the convenience of the pilot and monitor. When aircraft not included in the table are used, such as the UH-60 or AH-64, the survey meter location must be

selected. All dose-rate readings in a survey must be made with the meter in the selected location.

$$\begin{aligned} \text{Ground dose rate} &= \text{Aerial dose rate} \times \text{AGCF} \\ &= 10 \text{ cGyph} \times 8.2 \\ &= 82 \text{ cGyph.} \end{aligned}$$

**Air-Ground Correlation Factors**

An air-ground correlation factor (AGCF) is required for calculation of ground dose rates from aerial dose rates taken in an aircraft during a survey. The AGCF is the ratio of a ground dose-rate reading to a reading taken at approximately the same time in an aircraft at survey height over the same point on the ground. There are two techniques for obtaining the AGCF.

The preferred technique is by direct determination of ground and aerial dose rates during the survey and subsequent calculation of the AGCF. The AGCF may be calculated as shown below, using the aerial dose rate taken at survey height and the ground dose rate:

$$\begin{aligned} \text{Ground dose rate} &= 20 \text{ cGyph.} \\ \text{Aerial dose rate (60-meter survey height)} &= 5 \text{ cGyph} \\ \text{Air-ground correlation factor} &= \frac{\text{Ground dose rate}}{\text{Aerial dose rate}} \\ &= \frac{20 \text{ cGyph}}{5 \text{ cGyph}} \\ \text{AGCF} &= 4. \end{aligned}$$

By multiplying the reading taken in the aircraft at a survey height of 60 meters by the AGCF, the 1-meter above ground level reading can be estimated. The procedure for determining the ground dose-rate reading involves landing near the selected point. The monitor proceeds to that point and takes the ground dose-rate reading, using normal monitoring procedures. AGCF data are obtained if possible for each two to four course legs or routes flown. The sites for obtaining AGCF data should be selected to approximate average foliage and ground surface conditions in the contaminated area. Accuracy of this AGCF data as to position, height above ground, and dose rate is of primary importance. New data must be obtained when survey height changes by 15 meters or more, when ground foliage or average ground surface conditions change significantly, if the aircraft or the survey meter is changed, or if weather conditions change drastically during monitoring.

When the tactical situation, terrain conditions, high radiation dose rates, or other factors do not permit the use of the preferred technique, the AGCF shown in Table 5-3 are used. To estimate a ground dose rate, multiply the aerial dose rate obtained by the correlation factor from Table 5-3 for the type of aircraft and the height above ground at which the reading was taken. In the following example, while flying at a 150-meter survey height in a UH-1, a reading of 10 cGyph was obtained; the AGCF for a UH-1 at a height of 150 meters is 8.2:

**Capability of Aircraft**

Light fixed-wing aircraft or helicopters are satisfactory for conducting aerial surveys; however, because of the slow speeds required, helicopters are the most desirable. Light fixed-wing aircraft and helicopters have approximately the same survey area coverage capability of between 130 and 450 square kilometers per hour per aircraft, depending upon the detail required. Order of preference of currently available aircraft for use in aerial surveys is in Table 5-2.

**Determination of Overall Correction Factor**

When calculating aerial survey data, an additional step reduces the number of required calculations. Multiply the AGCF by the normalization factor (NF, Table 6-5, on page 6-26) for the start time of the aerial route or course leg. The product is the overall correction factor (OCF). An OCF is calculated for each course leg, or route, of the survey. The OCF is used instead of the NF and is calculated by the NBCC after the survey is completed. The OCF will convert shielded readings to unshielded readings normalized to H+1.

Sample:  $\text{AGCF} \times \text{NF} = \text{OCF}$

When processing ground survey data, use the same procedures but use a vehicle correlation factor instead of an AGCF. Round dose rates to the nearest whole number. Vehicle correlation factors are discussed later in this chapter.

Figure 5-8 (next page) shows a completed DA Form 1971-1-R for an aerial survey. Note that an OCF was determined for each leg of the survey. The OCF was then used to multiply the dose rates on the legs to obtain the normalized readings. H + 1 readings are located in the control party column.

A special circumstance can arise whenever a survey or recon is made over wooded or urban areas. In this case, the AGCF does not properly represent the air-to-ground ratio. This is because the fallout is much closer to the aircraft and the radiac instrument. The fallout is on the tops of trees and on rooftops. To adjust for this situation, a correlation factor, as shown in Figure 5-1, must be applied to the readings which were taken over trees or urban areas.

During recon and some survey operations, the decay rate will be unknown. Thus, two different OCF will be calculated for the survey/recon data. One will be based on n = 1.2 to provide a rapid means of developing a picture.

RADIOLOGICAL DATA SHEET - <del>ROUTE OR COURSE LEG TECHNIQUE</del> (Ground and Aerial Survey)					DATE	PAGE NO.	NO. OF PAGES				
For use of this form, see FM 3-3-1; proponent of this form is TRADOC.					20 JULY	1	1				
SURVEY PARTY DESIGNATION B-2.9			MONITOR (Print Name) PFC FARES								
MAP USED BIERHOFEN 1:50,000		AIRCRAFT OR VEHICLE TYPE UH1		INSTRUMENT TYPE AN/VDR2							
ROUTE OR COURSE LEG DESIGNATION			CK-CE	CE-CB	CB-CD						
TIME AT START OF LEG OR ROUTE			0950Z	0955Z	1005Z						
TIME ROUTE COMPLETED (Ground) OR SURVEY HEIGHT (Air)*			200FT	200FT	200FT						
DISTANCE OR TIME INTERVAL USED			10 SEC	10 SEC	10 SEC						
REMARKS TIME OF BURST 200730Z N = 1.2 CK-CE AGCF = 3.8 NR = 2.767 OCF = 10.515 CE-CB AGCF = 3.8 NR = 2.884 OCF = 10.559 CB-CD AGCF = 3.8 NR = 3.123 OCF = 11.867			READING NO.	DOSE RATE (cGyph)	DO NOT USE**	READING NO.	DOSE RATE (cGyph)	DO NOT USE**	READING NO.	DOSE RATE (cGyph)	DO NOT USE**
			1	12	126	1	2	22	1	0	0
			2	12	126	2	2	22	2	0	0
			3	11	116	3	2	22	3	1	12
			4	10	105	4	3	33	4	2	24
			5	9	95	5	3	33	5	3	36
			6	8	84	6	3	33	6	3	36
			7	7	74	7	3	33	7	3	36
			8	6	63	8	4	44	8	3	36
			9	5	53	9	4	44	9	2	24
			10	5	53	10	5	55	10	1	12
			11	5	53	11	5	55	11	1	12
			*Times of start and stop are reported for each route or portion of route completed at one time by ground survey. If a route is done in parts, use a separate column for each part.			12	4	42	12		
**DO NOT USE. For control party use only.			13	4	42	13			13		
AIR-GROUND OR VEHICLE CORRELATION FACTOR DATA			14	4	42	14			14		
LOCATION	HEIGHT (feet) AIR ONLY	DOSE RATE (cGyph)		CF **	15	3	32	15			
		INSIDE AIR	OUTSIDE GROUND		16	3	32	16			
BF	200	5	19	3.8	17	2	21	17			
					18			18			
					19			19			
					20			20			

DA FORM 1971-1-R, JAN 94

Replaces DA Form 1971-1-R, Sep 86, which is obsolete.

Figure 5-8. Completed DA Form 1971-1-R for an aerial survey sheet.

The second OCF will be based on the decay rate actually present. This may or may not be  $n = 1.2$ .

### Plotting Data

Contaminated areas are shown on the radiological situation map. Only minimum essential information about detected and identified areas of contamination are shown. This allows interpretation of the contamination situation. Each contaminated area is shown by a pattern of dose-rate contour lines and a few key dose rates for points, routes, or areas of particular concern. Eventually all monitoring, survey, and recon information for a contaminated area is plotted as ground dose rates. This information is corrected

to unshielded ground dose rates at the reference time (normally  $H + 1$ ) for the particular pattern.

Determination of dose-rate contours and key dose-rate locations requires large quantities of dose-rate information. However, much of the information is not needed on the radiological situation map. So, worksheet overlays are prepared for the initial identification and surveillance of each contamination hazard. Only the necessary identification information is transferred to the radiological situation map.

Monitoring reports and point surveys are processed and plotted into ground dose rates for the points at which the readings were taken.

## Airborne Radioactivity

Most contaminated particles in a radioactive cloud rise to considerable heights. Thus, fallout may occur over a large area. It may also last for an extended period. A survey conducted before fallout is complete would be inaccurate; because, contaminants would still be suspended in the air. For this reason, as well as the hazard to surveying personnel, radiological surveys are not accomplished before completion of fallout.

An estimate of the time of completion ( $T_{comp}$ ) of fallout for a particular location may be determined using a mathematical procedure. The time ( $T$ ) in hours after burst when fallout will be completed at any specific point is approximately 1.25 times the time of arrival (in hours after burst). Add the time in hours required for the nuclear cloud to pass over.

This is expressed by using the formula:

$$T_{comp} = 1.25 \times T_{arrival} + \frac{\text{cloud diameter}}{\text{effective wind speed}}$$

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

- Time arrival =  $H + 2$  hours  
(Determined by dividing the distance from GZ to the given point by the effective wind speed.)

- Cloud diameter = 4 km

(Determined from the radioactive cloud and stem parameters nomogram in Figure 5-9, next page. (Lineup yield on both sides—read cloud radius-multiply by 2).)

- Effective wind speed = 20 kmph  
(Determined from line Zulu of the NBC 3 report.)

Apply the formula to this data as follows:

$$T_{comp} = 1.25 \times 2hr + \frac{4 \text{ km}}{20 \text{ kmph}} = 2.5 + .2 = H + 2.7hr$$

**Note:** To convert 2.7 hours into clock time, multiply .7 by 60. The product in this example is 42. Therefore,  $T_{comp}$  is 2 hours and 42 minutes.

Thus, fallout for the given location is expected to be complete by  $H + 2.7$  hours, or  $H + 2$  hours and 42

minutes. Actual completion of fallout can be determined if a peak NBC 4 nuclear report is received from the area of interest.

Dose-rate information from an aerial survey using the route or course leg technique is processed into normalized ground dose rates that existed at certain points along the route. To plot this information—

- Before receiving the dose-rate information, mark and label the checkpoints for the route or course leg on the worksheet overlay. Trace out the preselected route or course leg that the survey party actually traveled.
- After the survey data is received, count the number of readings taken for the route or leg. The number of time intervals used during the flight is required, so be sure to include all readings, including zero readings. Since the aircraft flew at a constant ground speed, taking readings at equal time intervals, the distance covered between any two consecutive readings will be the same. If the route or leg is divided into a number of equal length segments, the total number of segments will equal the number of time intervals. Each division point on the route or leg will represent a location over which a dose rate reading was taken. The interval between readings equals the length of the course leg or route divided by the number of readings minus one.

For example—Figure 5-10 shows the points along route over which readings were taken. In this case, seven readings were taken (#1—#7); but the route is divided into only six segments (A—F)—one less than the number of readings taken by the survey party. The formula is—

$$\text{interval distance} = \frac{\text{route or course leg distance (km)}}{\text{number of readings} - 1}$$

As the dose-rate readings are processed, post the normalized dose rates to the worksheet overlay besides the location point for the route,

Dose-rate information from an aerial survey conducted using course legs is plotted basically the same as the aerial route technique.

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

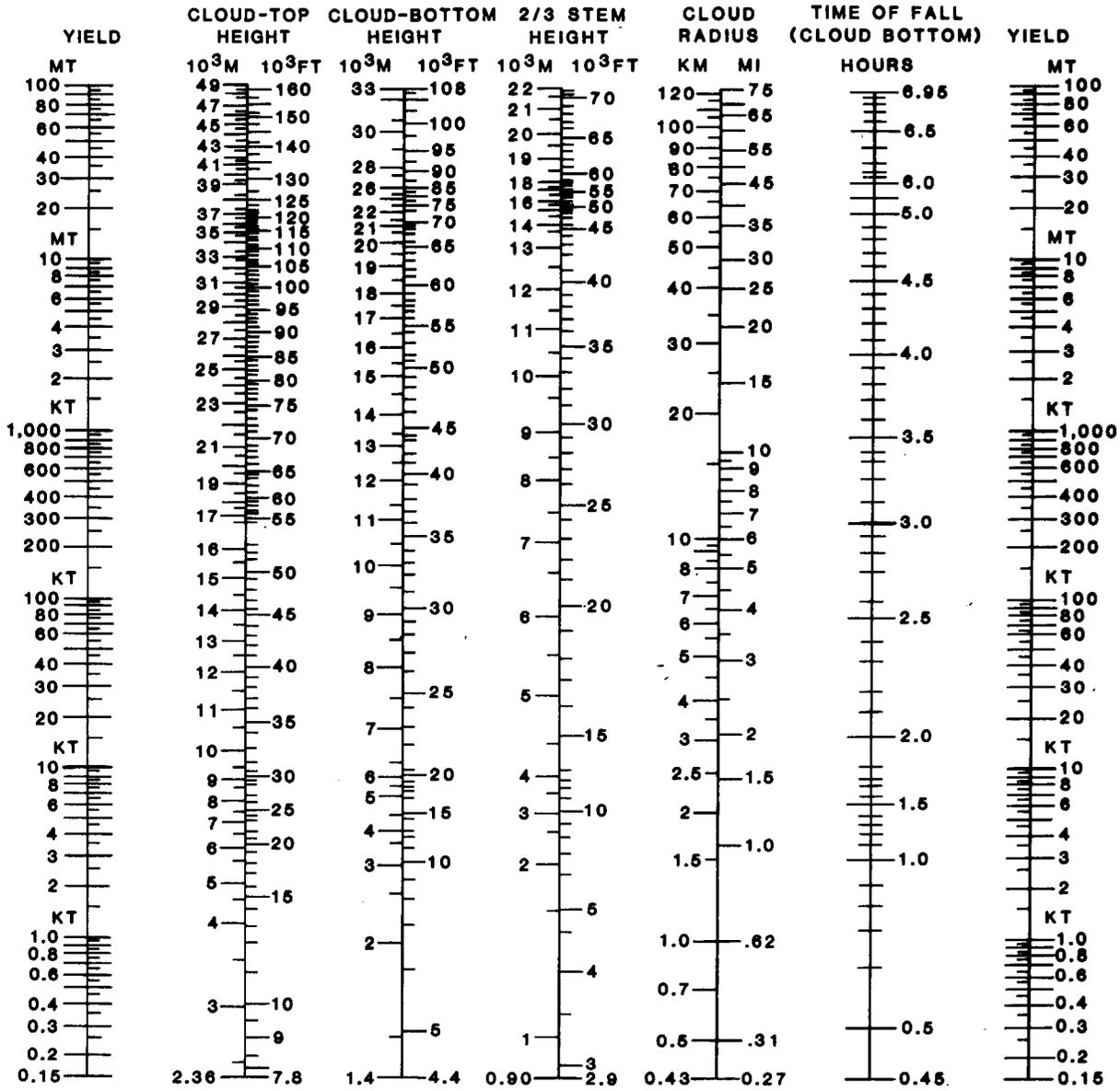


Figure 5-9. Radioactive cloud and stem parameters nomogram.

## Contour Line Plotting

Once we have the information gathered by the survey team or individual monitor, as presented in the NBC 4 report, normalized H + 1 (R.) readings, the data may be plotted on the situation map (Figure 5-11, Part 1, next page). Draw a contour line connecting all 20-cGyph or near-20-cGyph readings (Figure 5-11, Part 2, next page). This contour line should be black. Use a contour line of 30 cGyph for NATO use. Label this contour line and mark GZ with a "+."

When constructing the radiological contamination overlay, there are factors that locally affect the contamination pattern. This is particularly true between points in an aerial survey. These include terrain features, such as bluffs or cuts, heavily built-up or wooded areas, and bodies of water. For example, a large river will carry away any fallout landing in it, leaving its path relatively free of contamination. Also, the contamination hazard near a lake will be lower than expected. The fallout particles will sink to the bottom of the lake and the water will provide shielding. In wooded areas or built-up areas, a measure of the reduction of dose rate can be obtained by using the transmission factors (see Table 6-1) for these areas.

Draw a contour line connecting all readings of 100 cGyph or near 100 cGyph (Figure 5-11, Part 3, page 5-19). Label this line 100 cGyph. For colored overlays, this contour line should be blue. Using lines Whiskey and Xray, record this overlay or plot information as an NBC 5 nuclear report.

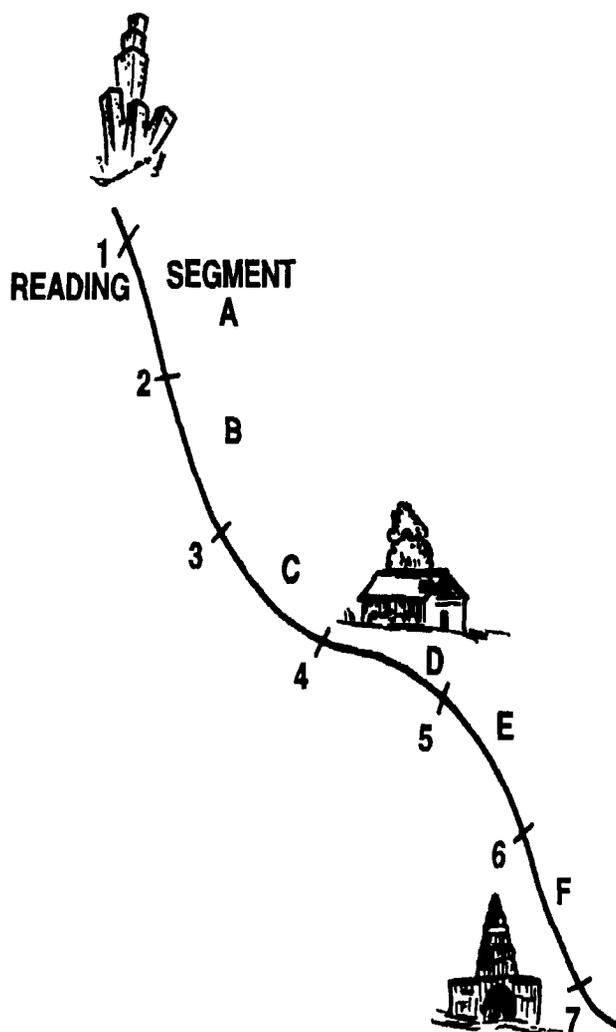
Higher readings probably would be present (300-1,000 cGyph); but for this example, only plot the readings shown in Figure 5-11 (pages 5-18 and 5-19).

The following NBC 5 report supports the overlay in Figure 5-11:

Priority  
261840 local  
Unclass  
NBC 5 Nuclear  
A 25  
F NB201251  
R 1.2  
T 261600 Zulu  
W NB195250; NB204270; NB206290;  
NB209269; NB195250  
X NB200241; NB216264; NB224285;  
NB217302; NB200303; NB196285;  
NB191250; NB200241

The NBC 5 report states where the contamination is and at what dose rate—unlike the NBC 2 or 3, which reports where the contamination is expected or predicted to land. This gives the ground commander information required to plan operations, while limiting or avoiding radiation exposure.

Dose-rate contour lines showing the contamination hazard in an area can be drawn when all the dose-rate information in the area is posted. To do this—



**Figure 5-10. Plotting of aerial survey route.**

- Determine the H + 1 dose-rate contour lines to be plotted (for example, 30, 100, 300, 1000 cGyph). These contour lines may be required for NBC 5 purposes or for anticipated calculations to be made from the data.
- Determine the points along the various survey routes, course legs, and near monitoring locations where the desired dose rates are located. Mathematically estimate between dose rates, if necessary.
- Connect with a smooth line all the points having the same dose rates. Use all plotted monitoring data as additional guides in constructing these contours.

The plotter must use care and judgment in plotting these contours and must visualize the probable general shape and direction of the pattern. Any dose rates disproportionately higher than other readings in the immediate area indicate possible hot spots. When such readings are reported, that area should be rechecked. If dose rates are confirmed, these hot spots should be plotted and clearly identified.

Plotted contours may be extended to downwind areas where fallout has not arrived. The contours may be extended if necessary to complete the fallout pattern. As

peak reports or surveys are submitted from downwind locations, the pattern is altered accordingly and thus kept up to date. Figure 5-12, next page, shows a typical plot that might be developed from survey data.

Radiological contamination overlays used for evaluation must provide the most detailed information possible. The minimum information required is—

- Map designation and orientation data.
- Nuclear burst and GZ identification.
- H-hour.
- Reference time.
- Decay rate/soil type.
- Time-of preparation and validity time.
- Source of the contamination-fallout or neutron-induced contamination.
- Militarily significant contamination perimeters—
  - New fallout (H-hour to H + 48 hours)—20 cGyph at H + 1 for short-term (24-hour) occupancy, 10 cGyph at H + 1, if longer occupancy of a contaminated area is expected.
  - Old fallout (H + 48 hours)—1 cGyph at the time of preparation.
  - Neutron-induced contamination—2 cGyph at H + 1 hour.
- Dose-rate, information-contour lines and key dose rates, if possible.

Additional information that is desirable but not essential—

- Time-of-completion lines for fallout.
  - Dose at reference time for key crossings or probable stay times.
- The preferred method for transmitting a radiological contamination overlay is by facsimile channels of electrical communications. It is fast and accurate. Facsimile devices normally are available at battalion and higher headquarters. Three devices are used to transmit contamination overlays to lateral and higher commands. When liaison or messenger service is not available, the information can be sent as an NBC 5 nuclear report.

### Reporting Data

Facsimile channels of electrical communications are not always available. If this is the case, the radiological contamination overlay must be converted into a series of readings and coordinates for transmission as an NBC 5 nuclear report. From the division NBCC the readings should be transmitted to the three brigades; the division artillery; the armored cavalry squadron, the aviation, signal, and engineer battalions; the chemical company; the MP company; the support command and attached units; and any other units designated by the commander. This method has a disadvantage. It requires the addressee to replot data from the NBC 5 nuclear report and draw dose-rate contours, a time-consuming process. Staff planners must consider that the shapes of dose-rate

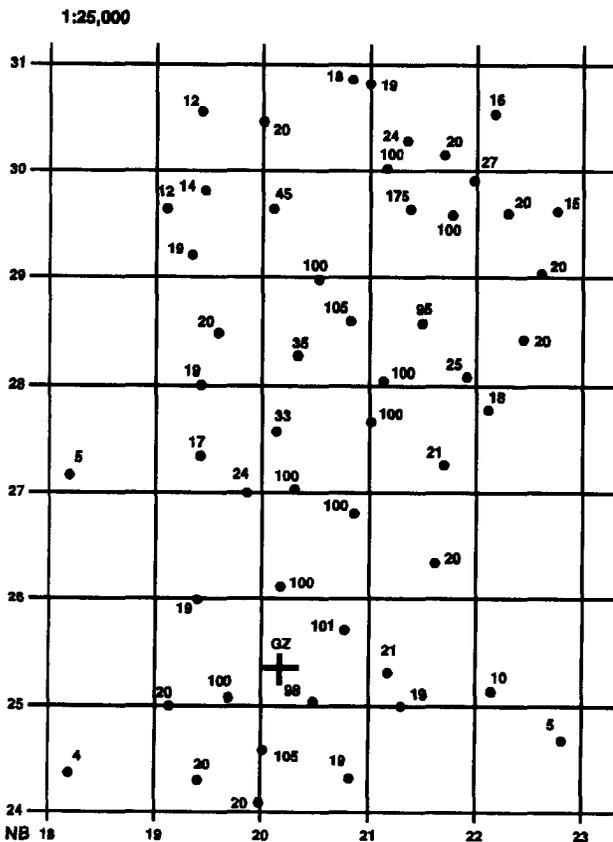


Figure 5-11 (Part 1 of 4).  
Plotting NBC 4 nuclear report readings.

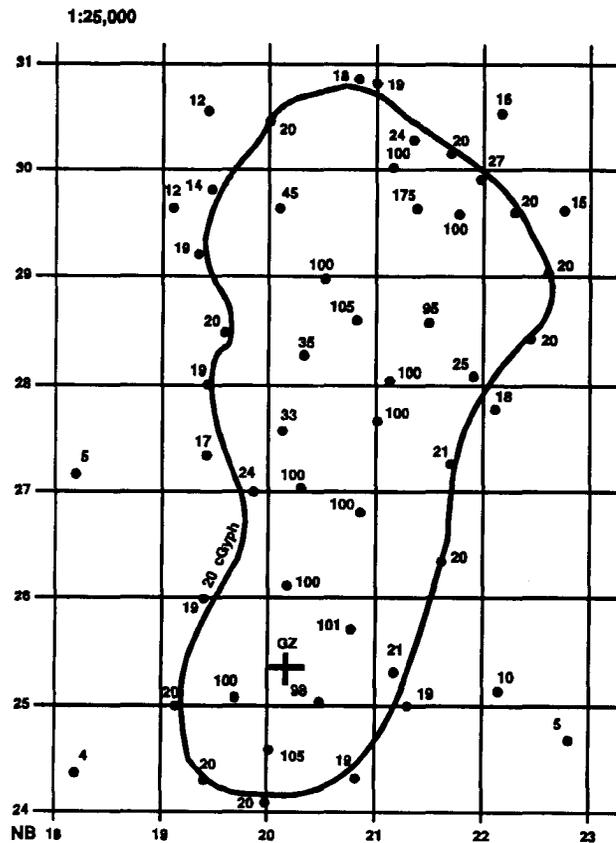


Figure 5-11 (Part 2 of 4). Plotting NBC nuclear 4 report readings—20-cGyph readings connected.

contours drawn to correspond with a relatively brief series of readings and coordinates can vary significantly.

If electrical communications for hard copy are not available and if time and distance permit, radiological contamination overlays are sent by messenger. Data is transmitted by the NBC 5 nuclear report as a last resort.

When the contamination comes from a single burst, the dose rates will be normalized to H + 1. But if there have been several detonations at different times and no single H + 1 is possible, the dose rates are reported for a specific time. Line item Oscar is used instead of line item Tango on the NBC 5 nuclear report.

It is not necessary or even desirable to report all four line items (Uniform, Victor, Whiskey, and Xray) on the NBC 5 nuclear report. Four lines have been provided for flexibility. Line item Xray should always be sent for avoidance purposes.

On the NBC 5 nuclear report, coordinates are listed sequentially around the contour. A contour line that completes a plot is represented by repeating the first coordinate. NBC 5 nuclear reports having incomplete contours are sent in sequence, with the first and last coordinate different, indicating the break in the contour.

Report the decay rate on line Romeo. Users of the NBC 5 nuclear report are not confined to predetermined lines. Any line described in Chapter 2 may be added.

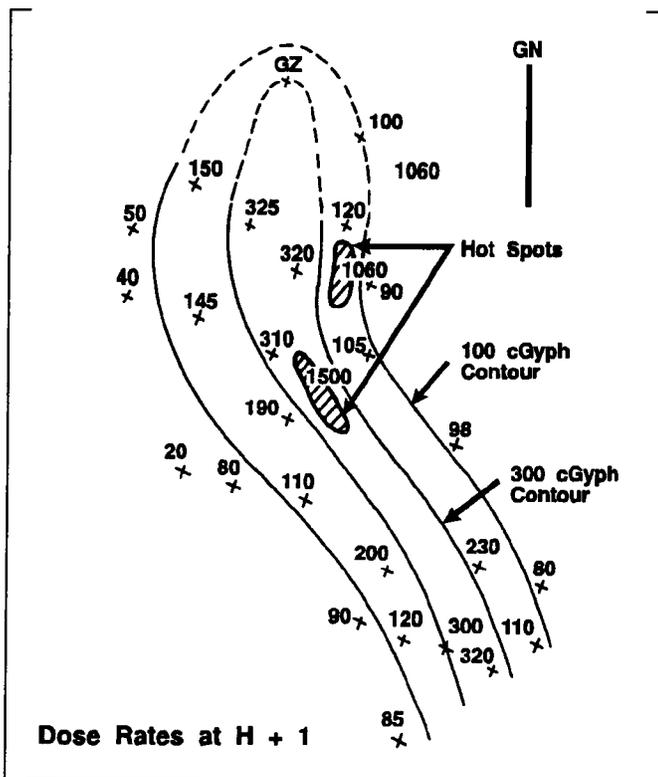


Figure 5-12. Example of fallout pattern plotted from survey data.

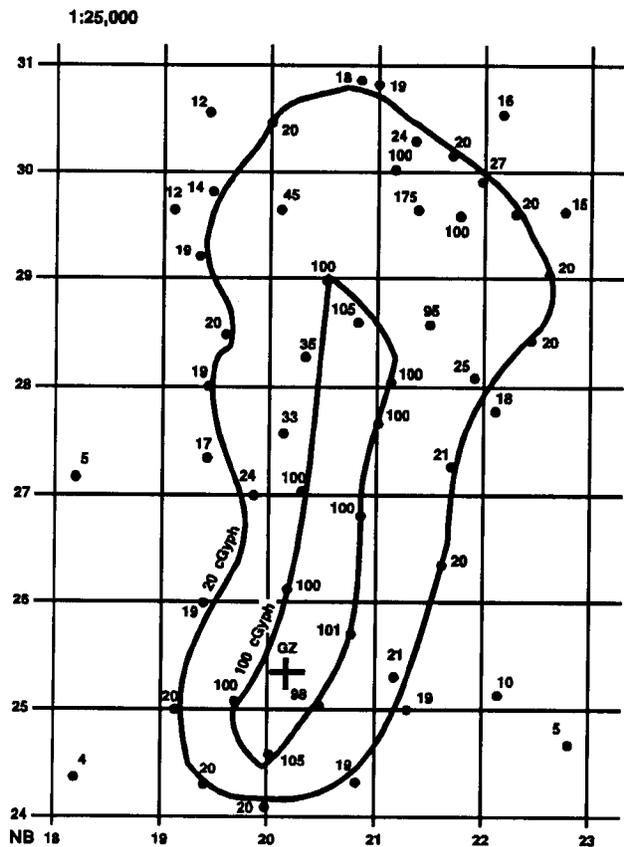


Figure 5-11 (Part 3 of 4). Plotting NBC 4 nuclear report readings—100-cGyph contour line.

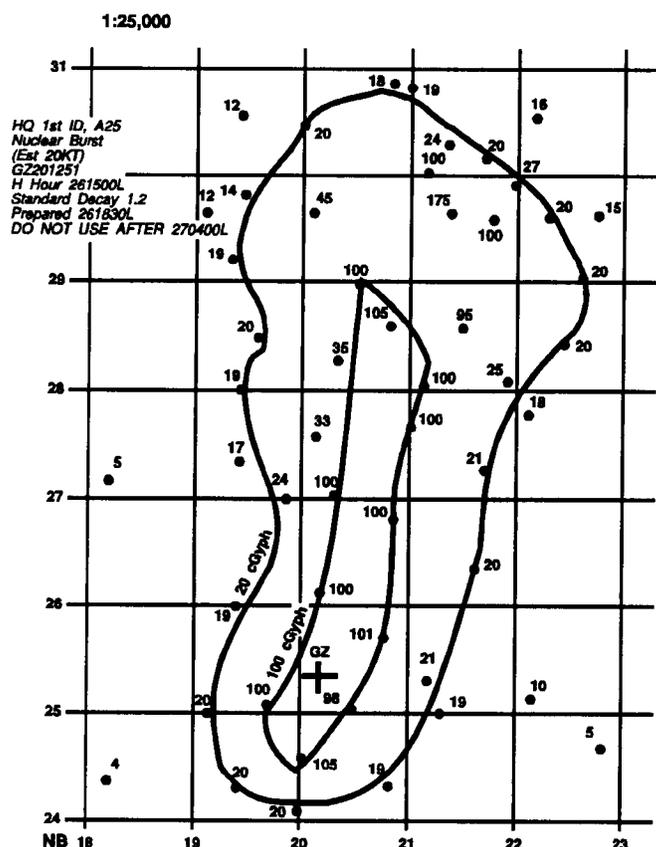


Figure 5-11 (Part 4 of 4). Completed NBC 4 nuclear report, including marginal information.

### Evaluation Contamination Overlays

Figure 5-13 (next page) illustrates an evaluation contamination plot showing H + 1 dose rates. The H + 1 dose rate plot is the beginning point for developing a plot that will show the contaminated area shrinking. The first step is to determine what is to be illustrated. An examination of Figure 5-14, page 5-22, reveals the 30- and 100-cGyph contour lines have been shown at H + 7 and H + 11. The 10-cGyph contour line has been shown at H + 1, H + 7, and H + 11. H + 11 is the latest time, because it equals the do-not-use-after date-time group 171600Z.

Since a dose rate at H + 1 will decay to a lesser value, a decay nomogram must be used. Thus, the solution involves solving for a higher dose rate that will decay to the preselected dose rate at the specified time. The selected dose rates are diagramed below for clarity:

R	t	R <sub>1</sub>	n=1.2
10	7		
10	11		
30	7		
30	11		
10	7		
100	11		

Use of then = 1.2 decay nomogram results in—

R	t	R <sub>1</sub>	n = 1.2
10	7	103	
10	11	170	
30	7	300	
30	11	325	
100	7	1,000	
100	11	1,700	

The next step is to return to the H + 1 dose-rate plot and mathematically estimate these dose rates. Place a piece of transparent material over the H + 1 plot and trace the estimated dose rate contour lines. Label each contour line with dose rate and time. Thus, for 10 cGyph, three contour lines are drawn and labeled. Figure 5-14 (page 5-22) shows the process to this point.

Repeat the process for the 100- and 300-cGyph contour lines. Note that the NBC 5 nuclear report cannot be used to disseminate this plot.

A contamination overlay prepared for estimation purposes, showing total dose areas for various times of stay, is in Figure 5-15 (page 5-23). This plot shows the consequence of occupying or crossing the area. The plot assists in planning future operations and goes to the staffs and down to battalion commander. (See Figure 5-16, page 5-24.) The plot is marked in color or contrasting patterns to identify hazard areas.

Again, Figure 5-15 is used as the start point along with guidance concerning the times of entry and times of stay. For Figure 5-15, a time of entry of H + 7 was used for all calculations. Time of stay was selected as 1, 2, 3, and 4 hours. Note that the plot is divided into four areas-A, B, C, and D.

The maximum H + 1 (R<sub>1</sub>) dose rate encountered in each of the areas is used as part of the dose calculations. A diagram of the data is shown in Figure 5-17 (page 5-25).

Using the n = 1.2 total dose nomogram, the solution is shown as the inset to Figure 5-15 (page 5-23).

Total dose calculations should not be projected beyond the do-not-use-after date-time group. In the above example, entry is H + 7, and maximum stay time is four hours. Thus, time of exit is H + 11. Note that neither the plot nor the data can be sent in an NBC 5 nuclear report.

### Estimation Contamination Overlays

A radiological contamination overlay prepared for estimation purposes does not lend itself to briefings and similar requirements. A briefing requires a presentation of the current radiological contamination picture that lets the viewer picture the current hazard and the decay of the hazard over a short period (three to six hours). This type of presentation is of particular use for staff analysis of the area, and for rapid visualization of the contamination hazard.

A contamination overlay showing dose rates for estimation purposes, is shown in Figure 5-14 (page 5-22). The overlay attempts to show a shrinking contaminated area. This may be done by color contrast, overlay flips, or the use of dashed, dotted, and solid lines.

### Aerial Survey Team Actions

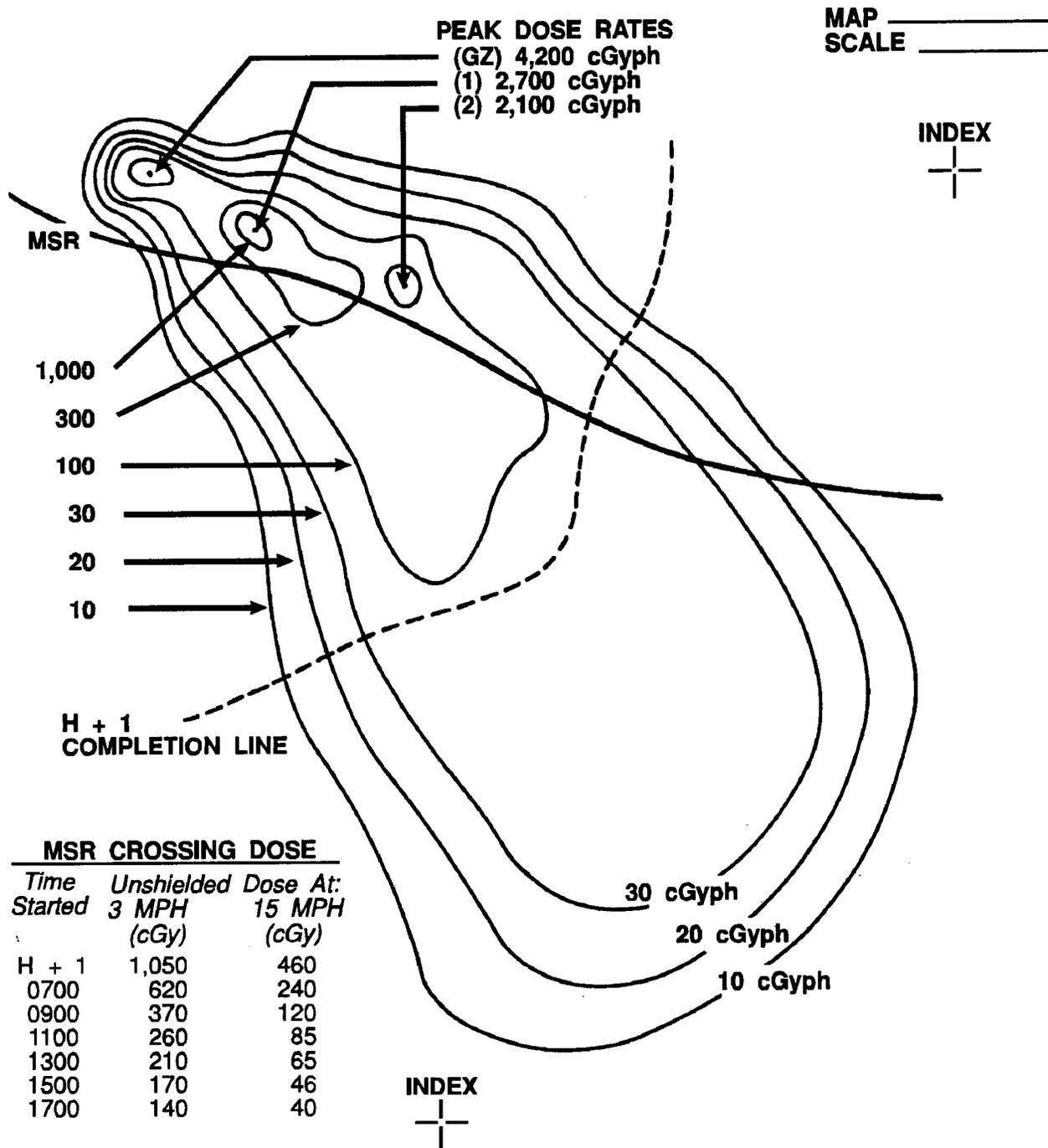
The NBC defense team has ready access to the latest information available concerning the survey area. The defense team provides this information to the survey team at a briefing. In addition to information about the contaminated area, the defense team provides the aerial survey team with the identification of the course legs or routes to be flown, the tentative survey height, and the approximate times during which groups of the course legs or routes are to be flown. The unit NBC defense team will furnish the survey team with the operation exposure guidance and the turnback dose. For an explanation of turn-back dose rate (D<sub>tb</sub>) refer to Appendix A.

The aerial survey party determines, as applicable—

- Actual height above ground at which each course leg or route is to be flown.
- Ground speed for each course leg or route.
- Direction of flight for each course leg or route.
- Locations for determining AGCF data.
- Time intervals between readings.
- Whether to delay the flight of a particular course leg or route.

Upon arrival over the contaminated area, the survey team has several decisions to make before the actual survey begins. Four of these decisions and a discussion of each follow:

*Direction of flight for each course leg or route.* Factors that could influence this decision include weather, sun glare, fuel economy, the aircraft's duration of flight, and completion of fallout.



HQ...Inf Div  
 Nuclear Burst (30 KT)  
 GZ MN671355  
 H-hour 170500Z  
 Reference Time H + 1 (0600)  
 Standard Decay (n = 1.2)  
 Prepared 171000Z  
 DO NOT USE AFTER 191000Z

All Fallout Completed by  
 H + 2 Hours (0700)

All Dose and Dose-rate Data  
 are as of H + 1 (170600Z)  
 Unless Otherwise Specified

Figure 5-13. Evaluation-type nuclear contamination overlay.

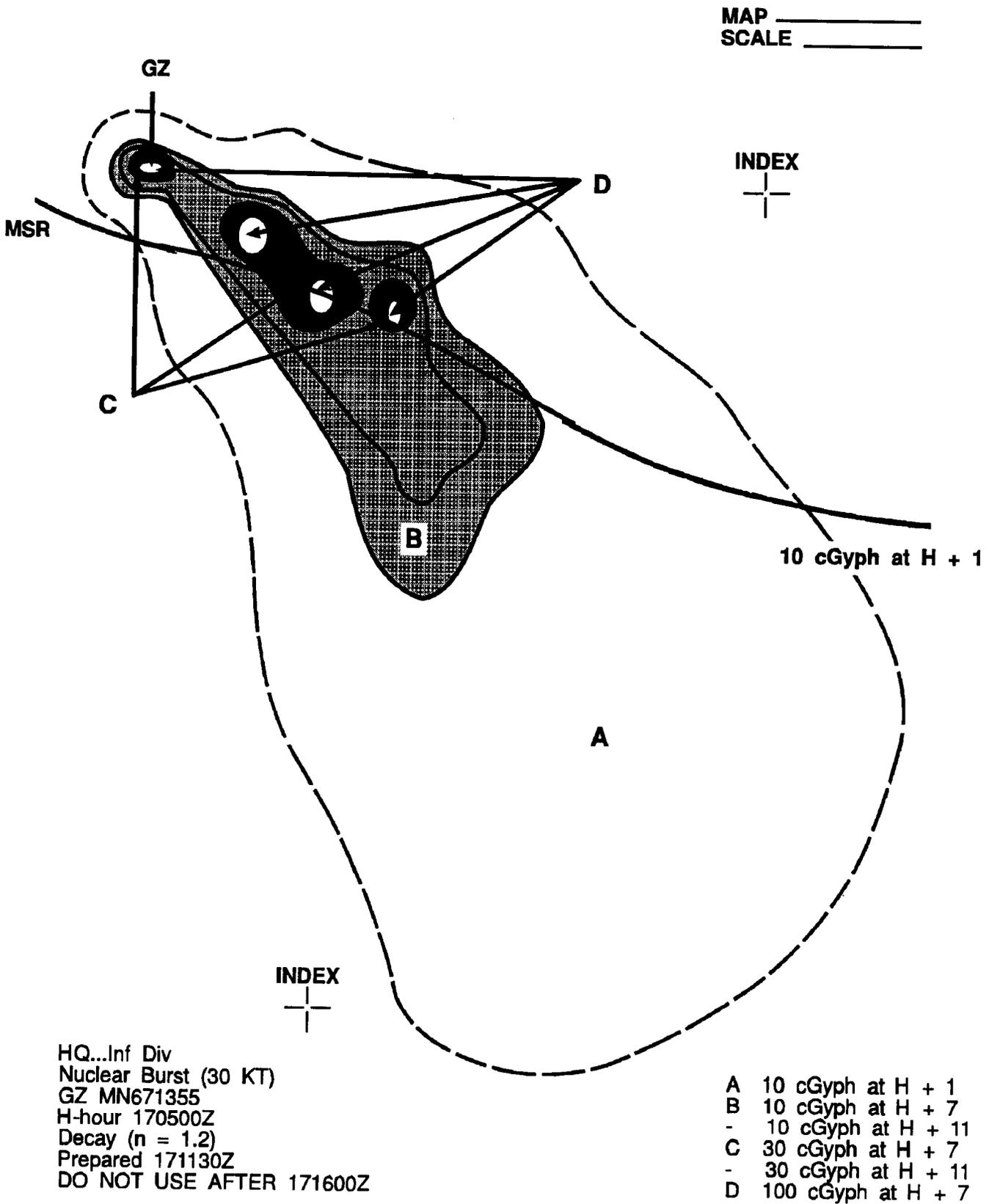
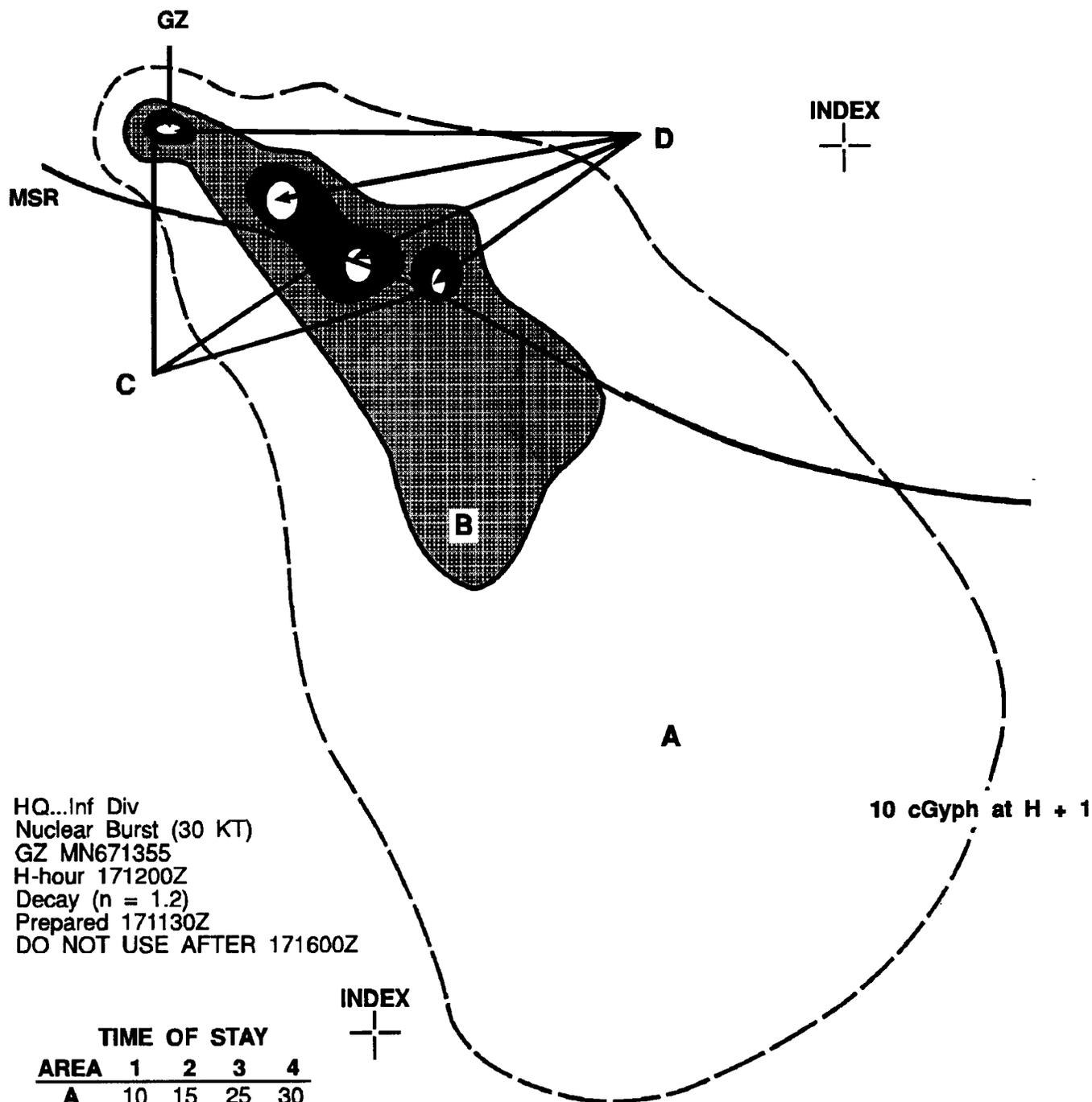


Figure 5-14. Current estimated radiological contamination overlay (dose rate).

MAP \_\_\_\_\_  
 SCALE \_\_\_\_\_



HQ...Inf Div  
 Nuclear Burst (30 KT)  
 GZ MN671355  
 H-hour 171200Z  
 Decay (n = 1.2)  
 Prepared 171130Z  
 DO NOT USE AFTER 171600Z

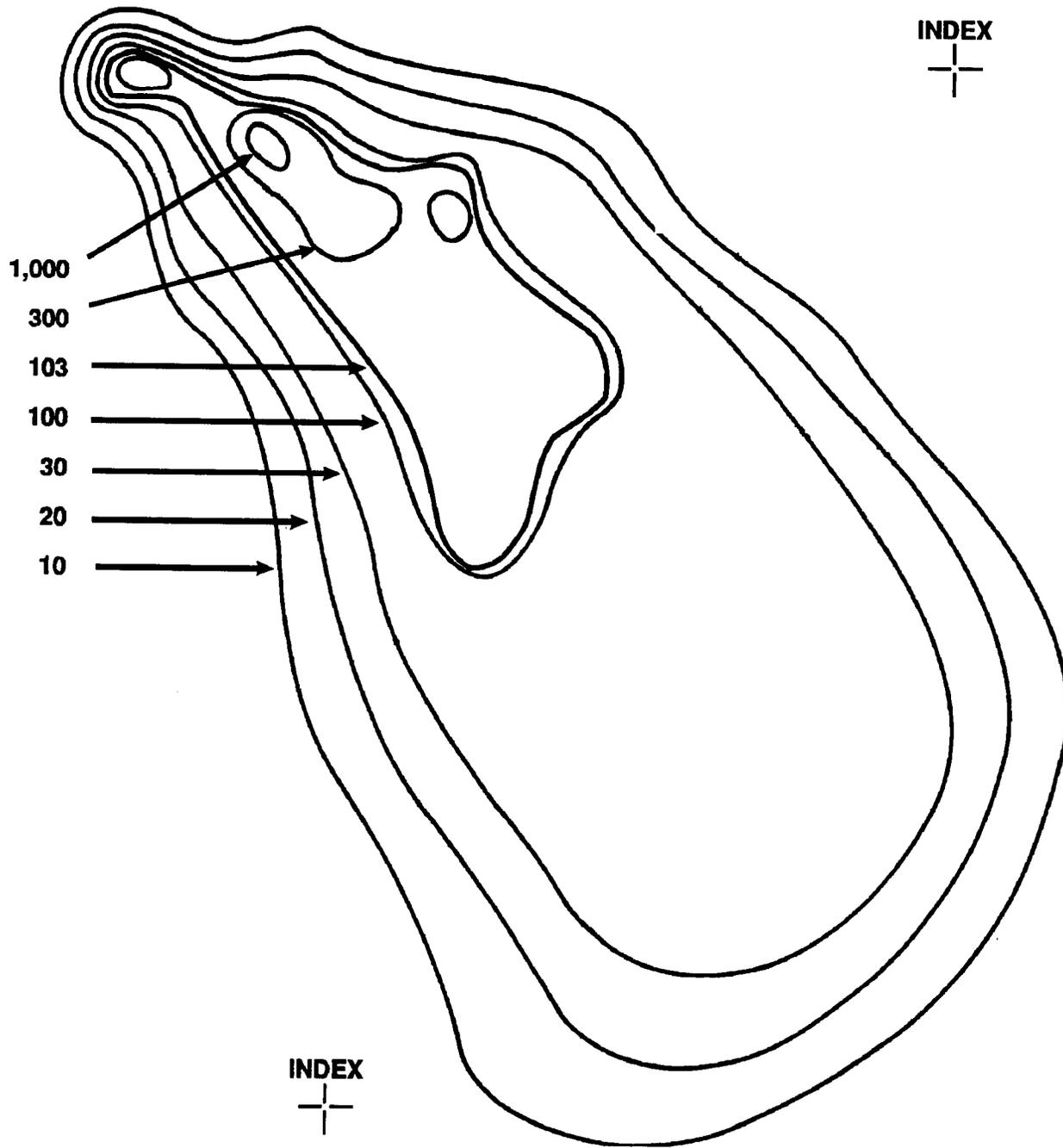
10 cGyph at H + 1

AREA	TIME OF STAY			
	1	2	3	4
A	10	15	25	30
B	25	50	70	85
C	90	165	240	290
D	180	335	460	580

$T_e = H + 7$  (Dose rounded to nearest 5 centigray)

Figure 5-15. Sample evaluation-type nuclear contamination overlay.

MAP \_\_\_\_\_  
SCALE \_\_\_\_\_



*Figure 5-16. Sample estimated radiological contamination overlay (dose rate).*

Actual height above ground at which course leg or route is to be flown. The NBCC will provide tentative guidance on survey height. Survey data obtained at heights above 500 feet above ground level (AGL) (150 meters) is unreliable. A height of 200 feet AGL (60 meters) is considered optimum. Actual survey height calculation is done by the team. To do this, the team makes an initial pass over the fallout area along a course leg at 1,000 feet. The monitor observes the radiacmeter and notes the highest dose rate at that height. The monitor multiplies this dose rate by the AGCF for this height—found in Table 5-3 (page 5-14). After the ground dose rate is found, consult Table 5-3 again. This time the monitor looks for an AGCF which, when divided into the ground dose area will result in a dose rate that can be easily read on the instrument. For example, the highest dose rate noted over a course leg at 200 feet was 30 cGyph. The AGCF from Table 5-3 for this height is 3.2. This results in 96 cGyph at 1 meter above the ground:

$$\begin{aligned}
 OD &= ID \times AGCF \\
 &= 30 \times 3.2 \\
 &= 96 \text{ cGyph}
 \end{aligned}$$

Next, the monitor selects a higher altitude that will give a lower dose rate reading on the instrument. The monitor confirms this selection by dividing the AGCF for that height into the ground dose rate. To continue the example, if the monitor selected a height of 400 feet, the AGCF would be 6.2. When this is divided into the ground dose rate, the highest dose rate the monitor will read on this course leg is 15 cGyph:

$$ID = \frac{OD}{AGCF} = \frac{96}{6.2} = 15.48 \text{ or } 15 \text{ cGyph}$$

Data for Table 5-3 was developed from Cobalt-60. Use of the data provides a good estimate. In actual fallout situations, the NBCC will task survey teams to determine raw data for an actual table of fallout data. After the actual AGCF table has been determined, it is used in place of Table 5-3. The calculation technique described above will be valid for the actual fallout data. Survey heights are

expressed in feet when working with US aircraft—US altimeters are graduated in feet. Most NATO aircraft use meters.

**Ground speed for each course leg or route.** The slower the aircraft speed and the shorter the time between readings, the more accurate the results. The NBCC will provide general guidance on distance between readings for certain high-interest areas. These may be areas near GZ or in areas a unit is required to occupy. Final selection of speed and interval is the judgment of the survey team. The maximum acceptable interval between readings is 500 meters. The slow response time of the IM174()/PD family of radiacmeters reduces reliability of the data obtained at ground speeds above 53 knots (98 kilometers per hour).

For best plotting accuracy, at least 10 readings between checkpoints is required. Table 5-4 (next page) shows all practical combinations of speed and time intervals. Inspection of Table 5-4 reveals that any combination of speed less than 53 knots and 15-second time interval will yield a distance between readings of less than 500 meters.

**Locations for determination of AGCF data.** The NBCC provides recommendations on locations during the survey briefing. The team makes the final selection of sites based upon several factors. These factors are average foliage and ground conditions, dose rates, and number of course legs or routes to be surveyed. AGCF dose rates should be taken where they can be read on the low end of the scale of the radiacmeter (1 to 10 cGyph). This ensures accuracy. The aerial dose-rate portion of AGCF data must be taken at the survey height for the course leg or route. Actual determination of ground dose rate for the AGCF requires the aircraft to land near the point of interest. The monitor dismounts, proceeds to the selected point, and takes the reading by using normal ground monitoring techniques.

The survey team must determine new AGCF data for every two to four course legs or routes flown, when average surface conditions change (for example, from an area with little snow to a lot of snow coverage or from an area with much standing water to an area with little or no standing water), when terrain conditions change (from hilly areas to flat lands), and when average foliage conditions change (for example, from wooded areas to open areas or from grasslands to wooded areas). Selected sites for AGCF data must approximate the survey area.

New data must be obtained when survey height changes by 15 meters or more, when ground foliage or average ground surface conditions change significantly, if the aircraft or the survey meter is changed, or if weather conditions change drastically during monitoring.

Ground survey involves considerably less planning or action on the part of the survey team. Essentially, the team follows the instructions given during the survey briefing.

Area A				Area B			
D	R <sub>1</sub>	T <sub>s</sub>	T <sub>e</sub>	D	R <sub>1</sub>	T <sub>s</sub>	T <sub>e</sub>
	100	1	7		300	1	7
	100	2	7		300	2	7
	100	3	7		300	3	7
	100	4	7		300	4	7
Area C				Area D			
D	R <sub>1</sub>	T <sub>s</sub>	T <sub>e</sub>	D	R <sub>1</sub>	T <sub>s</sub>	T <sub>e</sub>
	1,000	1	7		2,000	1	7
	1,000	2	7		2,000	2	7
	1,000	3	7		2,000	3	7
	1,000	4	7		2,000	4	7

Figure 5-17. Total dose calculations.

### Recording and Reporting

The radiological data sheet is used for recording data obtained in aerial surveys. Data obtained using the route or course leg technique are recorded on DA Form 1971-1-R

**Table 5-4. Interval between aerial survey readings.**

Interval Table (Meters)													
Ground Speed		Time (Seconds) Between Readings											
Knots	Kmph	5	10	15	20	25	30	35	40	45	50	55	60
53	98	136	272	408									
51	95	132	264	396									
49	90	125	250	375	500								
46	85	118	236	354	472								
43	80	111	222	333	444								
40	75	104	208	312	416								
38	70	97	194	291	388	486							
35	65	90	180	270	361	451							
32	60	83	166	249	333	416	500						
30	55	76	152	229	305	382	458						
27	50	69	138	208	277	347	416	486					
24	45	63	125	188	250	313	375	438	500				
22	40	55	111	166	222	277	333	388	444	500			
19	35	48	97	146	194	243	291	340	388	437	486		
16	30	42	83	125	166	208	249	291	333	375	416	458	500

(Radiological Data Sheet-Monitoring or Point Technique). (See Figure 5-18, next page.) Data obtained by the point technique are recorded on DA Form 1971-R. Block headings are self-explanatory. Any headings not applicable to the situation are lined through by the monitor. Space is provided for use of the control team—the DO NOT USE\* blocks—for entry of the AGCF and normalized readings. The Remarks block is used by the monitor to provide any additional information of value to the unit NBC defense team. This block also is used by the defense

team to enter time of nuclear burst and computations of the AGCF, normalizing factor, and overall correction factor.

A radiological data sheet completed by the monitor and showing data collected by use of the course leg technique during aerial survey is shown in Figure 5-18.

Survey data is delivered to the defense team, upon completion of the survey, by physical drop, radio, or telephone from the nearest landing zone. The NBCC must specify in the survey briefing how this is to be done.

### Ground Survey

Ground radiological surveys are normally performed by personnel in M93 NBC reconnaissance systems (NBCRSs) or FOXs. Armored vehicles also may be used. These

vehicles reduce doses received by personnel and must be used whenever possible. Ground surveys lack the speed and flexibility of aerial surveys. They result in higher nuclear radiation doses to personnel, place larger load on communication facilities, and require division of more personnel and equipment from the mission. However, a ground survey is independent of weather conditions. It provides more accurate information than an aerial survey. All echelons can perform ground surveys within their areas of responsibility, using regularly assigned personnel and equipment.

The techniques used to conduct ground surveys include the route technique, the point technique, and the preselected dose-rate technique. For a detailed explanation on these techniques and specific movement formations to use while conducting ground surveys, refer to FM 3-19.

Most ground surveys are performed using the route technique. In this technique, dose-rate readings are taken inside the vehicle at selected intervals between checkpoints along a route. The unit defense team uses a correlation factor to determine ground dose rates. The dose rate information is then processed into normalized ground dose rates. The route, checkpoints, and interval are determined prior to the survey. The plotting procedure can be done before the survey information is received. To plot this information—

Radiological Data Sheet - <del>Route or</del> Course Leg Technique (Ground and Aerial Survey)					Date	Page No.	No. of Pages						
For use of this form, see FM 3-3-1; the proponent agency is TRADOC.					20 JULY	1	1						
Survey Party Designation B-2-9				Monitor (Print Name) PFC FARES									
Map Used BIERHOFFEN 1:50,000		Aircraft or Vehicle Type UH-1		Instrument Type AN/VDR-2									
<del>Route or</del> Course Leg Designation		CK-CE	CE-CB	CB-CD									
Time at Start of Leg or <del>Route</del>		0950Z	0955Z	1005Z									
<del>Time Route Completed (for Ground)</del> or Survey Height (for Aerial)		200 FT	200 FT	200 FT									
<del>Distance or</del> Time Interval Used		10 SEC	10 SEC	10 SEC									
Remarks: TIME OF BURST 200730Z N = 1.2 CK-CE = AGCF = 3.8 NR = 2.767 OCF = 10.515 CE-CB = AGCF = 3.8 NR = 2.884 OCF = 10.959 CB-CD = AGCF = 3.8 NR = 3.123 OCF = 11.867  * Times of start and stop are reported for each route or portion of route completed at one time by ground survey. If a route is done in parts, use a separate column for each part. ** Do Not Use--for control party use only.					Reading No.	Dose Rate (cGyph)	Do Not Use**	Reading No.	Dose Rate (cGyph)	Do Not Use**	Reading No.	Dose Rate (cGyph)	Do Not Use**
					1	12	126	1	2	22	1	0	0
					2	12	126	2	2	22	2	0	0
					3	11	116	3	2	22	3	1	12
					4	10	105	4	3	33	4	2	24
					5	9	95	5	3	33	5	3	36
					6	8	84	6	3	33	6	3	36
					7	7	74	7	3	33	7	3	36
					8	6	63	8	4	44	8	3	36
					9	5	53	9	4	44	9	2	24
					10	5	53	10	5	55	10	1	12
					11	5	53	11	5	55	11	1	12
					Air-Ground or Vehicle Correlation Factor Data					12	4	42	12
Location	Height (Feet) (Air Only)	Dose Rate (cGyph)		CF**	13	4	42	13		13			
		Inside Air	Outside Ground		14	4	42	14		14			
BF	200	5	19	3.8	15	3	32	15		15			
					16	3	32	16		16			
					17	2	21	17		17			
					18			18		18			
					19			19		19			
					20			20		20			

DA Form 1971-1-R, JAN 93

Figure 5-18. Example of DA Form 1971-1-R completed for course-leg survey.

- Mark and label the checkpoints on the worksheet overlay. Trace the preselected routes.
- Divide the route between checkpoints into the preselected intervals. Move in the same direction as that assigned the survey party.
- Enter the normalized ground dose rate beside the proper location as processed data is available on DA 1971-1-R.

In using the point technique, the ground dose rate is determined at a selected point. The reading is obtained by dismounting from the vehicle and taking a direct ground dose-rate reading or by taking the dose-rate reading inside the vehicle. For accuracy, the first method is preferred. If the dose rate is taken inside the vehicle, the ground dose rate will be determined by the unit NBC defense team by using a CF. When taking readings while dismounted, monitors should move at least 10 meters from the vehicle to take the readings. This prevents undue shielding of the radiation by the vehicle. Enter the normalized ground dose rates beside the proper location on the DA Form 1971-R.

With the preselected dose-rate technique, locations of preselected dose rates are determined along assigned routes. This technique normally is used only for resurveying old fallout contamination (after H + 48 hours) where the decay is very slow. Enter the normalized ground dose rates beside the proper location on the 1971-R.

Most dose-rate readings taken during a ground survey by mounted personnel using the route technique are taken inside the vehicle. These readings are converted later to ground dose rates by the NBCC. The survey meter should be located as indicated in Figure 5-1. If the vehicle being used is not listed in Figure 5-1, the survey meter should be held in a vertical position (face up) by the monitor sitting in the assistant driver's seat. The survey meter should remain in the same position for all the readings.

Correlation factor data are required to convert the reported readings taken inside the vehicle to ground dose rates outside the vehicle. Data for the vehicle CF are provided by the survey team. It consists of a set of two readings taken at the same location within three minutes of each other. One readings is taken inside the vehicle. All subsequent inside readings must be taken with the meter in the same position as the first. The other reading is taken immediately at the same location as a normal ground monitoring reading (the vehicle is pulled away at least 10 meters). Accuracy of the CF data is very important.

**Notes:** 1. Average ground survey vehicle speed is 15 miles per hour.

2. Use midtime for ground survey for NF calculation.

Record data obtained using the point or preselected dose rate technique on DA Form 1971-R. Record data obtained using the route technique on DA Form 1971-1-R. (See Appendix H for reproducible forms.)

Report survey data to the unit NBC defense team or the authority directing the survey as rapidly as possible. Intermediate headquarters do not screen or evaluate this data. The communications means and reporting procedure for the data are specified by the NBCC during the survey briefing. Careful consideration must be given to signal security SIGSEC and enemy electronic warfare (EW) capabilities.

Radiological survey information is of intelligence value to the enemy. Proper security procedures for the reporting of these data are established by the defense team. For example, location coordinates must be encoded if sent over unsecured nets, or sent clear text on secure land lines. The more detailed the briefing of the survey parties, the more easily security can be maintained.

## Reconnaissance

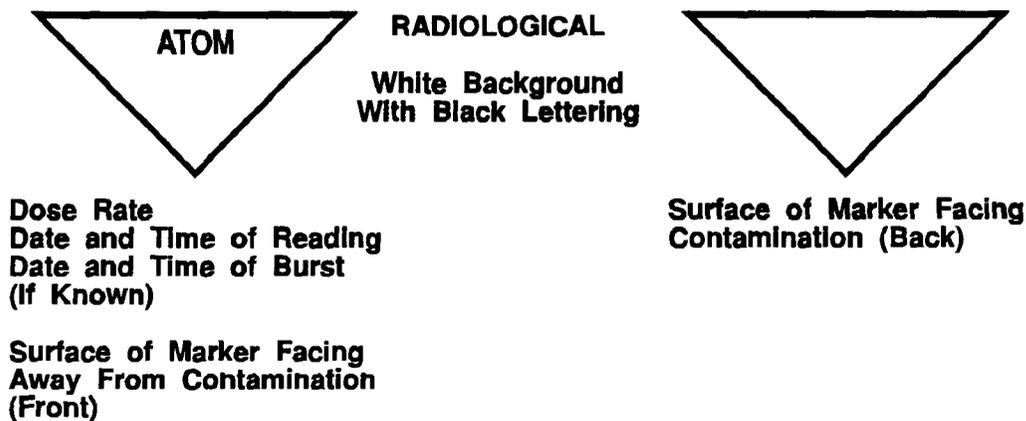


Figure 5-19. Nuclear contamination marking signs.

**FLAG CONTAINERS**

Each container holds 20 marking flags:

20 white flags for marking nuclear contamination.

20 blue flags for marking biological contamination.

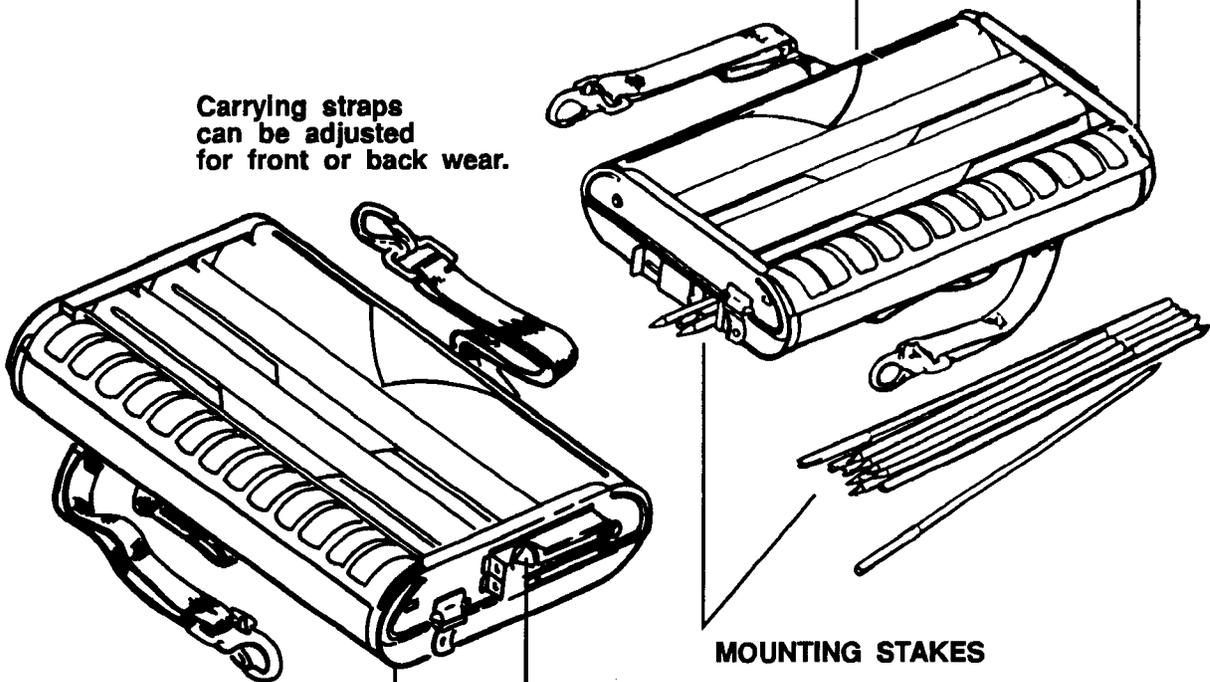
20 yellow flags for marking chemical contamination.

**RIBBON CONTAINER**

Holds 13 separate rolls of yellow-marking ribbon.

Ribbon used to provide a way to hang flags between poles or other objects.

Carrying straps can be adjusted for front or back wear.



**CARRYING CONTAINER**

Holds all individual parts of set.

**MOUNTING STAKES**

48 stakes stored in bottom of carrying container.

Used to make poles for hanging flags and attaching marking ribbon.

**CRAYONS**

Red crayons used to mark information on flags.

*Figure 5-20. NBC contamination marking set.*

Radiological reconnaissance is the act of detecting the presence of radiation and measuring it with radiac instruments while moving. It is done before the main body of the unit encounters the hazard. Reconnaissance differs from monitoring and survey in that reconnaissance maybe used when—

- A maneuver unit is required to move through or occupy an area where the presence of NBC contamination is unknown.
- The boundaries of a known contaminated area must be determined.
- A clear route through or around a contaminated area is required.

This contamination could be the result of fallout, rainout, or neutron-induced contamination. Regardless of the source, recon concentrates on location rather than intensity or dose rate. Once plotted, recon data provides the minimum essential information needed to evaluate the impact the contamination will have on current operations. Stated another way, recon provides information about uncontaminated or clean areas. Recon, then, permits avoidance of hazard areas.

Often, contamination avoidance of radiological contamination is a matter of accepting the least amount of radiation rather than none at all.

Radiological recon may be performed on the ground or in the air. Ground radiological recon (GRR) is conducted by all units when moving. Aerial radiological recon (ARR) is conducted only when an area is known to be contaminated. The best vehicle available for GRR is the NBCRs, or, as it is more commonly called, the Fox. This vehicle is especially designed and equipped to operate in a contaminated environment and to perform NBC recon missions. The system has an added advantage in that the operator does not have to leave the vehicle to take a reading or sample. For more information concerning this vehicle, refer to FM 3-19 and the operator's manual.

Also, this vehicle gives a commander the ability to quickly determine the extent of contamination by using those techniques outlined in FM 3-19. Operators of this vehicle are also able to mark the contaminated area with the standard NATO NBC markers depicted in Figure 5-19, without leaving the vehicle.

If the unit does not have this vehicle, follow the procedures outlined next for contamination marking.

### **Contamination Marking**

Once contamination is found, mark the area and report to higher headquarters. Marking contaminated areas and equipment warns friendly units and helps them avoid the contamination. Marking a contaminated area merely indicates the presence of a hazard. The extent of a hazard is determined by a detailed survey.

### **Standard Signs**

Signs used for marking contaminated areas are standard throughout NATO in color and size. This permits easy identification. The color of the sign indicates the type of contamination. The primary or background color indicates the general type of hazard. The secondary color gives specifics as to what the hazard is.

In addition to color, signs are also a standard size and shape. The sign is a right-angled isosceles triangle. The base is approximately 28 centimeters (11-½ inches), and the sides are approximately 20 centimeters (8 inches). The signs can be made of wood, plastic, metal, or any other available material. Place each sign with the point of the triangle down.

For radiological contamination, you need the dose rate, date and time of reading, and date and time of detonation, if known.

US forces mark contaminated areas with the NBC contamination marking set. It contains everything needed to mark a contaminated area: flags, ribbon, crayons, mounting stakes, and a carrying container. TM 3-9905401-10 describes the kit and its use. Figure 5-20 (next page) shows the kit and its major components.

If units do not have this kit available, they can make the signs out of available metal, plastic, or wood. Field expedient signs must be of standard shapes, sizes, and colors.

### **Marking Procedures**

Marking warns friendly troops of contamination. Therefore, the signs are placed where they most likely will be encountered by friendly units. In rear areas the entire circumference of the hazard area may need to be marked. Individuals who find the contamination place the signs. They are placed where the contamination is detected. Adjacent signs should be within sight of each other (25 to 100 meters apart depending on terrain). This prevents units from missing the signs and entering a contaminated area. Recon elements mark the area at the point of entry. Unit survey teams are then responsible for determining and marking the extent of the contamination.

Some areas may contain more than one type of contamination or hazard. Mark these areas with the appropriate signs placed near each other. For example, if an area is both chemically and radiologically contaminated, both signs are used and placed near each other.

For rear areas in, around, and behind the division support area (DSA), and while in open terrain (desert, plains, rolling hills, etc.), it is possible to raise these contamination markers on poles. The poles may be camouflage support poles, extra tent poles, or any other such material. The intent is to raise the contamination marker up high enough so it can be seen for at least 200

meters. This is done so that follow-on forces and support troops can be aware of the hazard.

In these rear areas, clear areas or lanes also maybe marked for easy identification. One method of marking this lane is using the NBC contamination bypass marker depicted in figures 5-21 and 5-22 page 5-31.

Placing markers on poles or using the bypass marker in forward areas is considered tactically unsound and should be avoided. It would only provide a roadmap for the enemy.

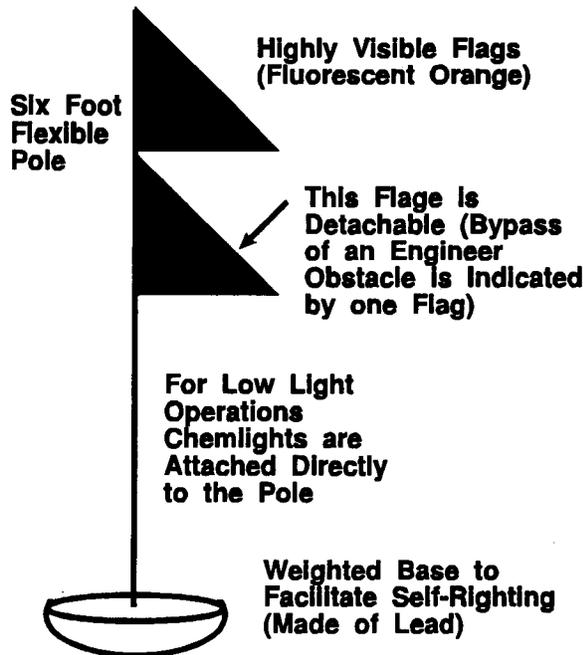
**Marking Contaminated Materiel.** Special procedures are used when marking and handling contaminated materiel. Materiel is marked to keep personnel from accidentally becoming contaminated. This means that markers placed on materiel have to be visible from any angle. The disposition of the materiel depends on the situation. If it can be left in place to weather, that might be the best solution. If contaminated materiel is collected in a holding area, then the area has to be marked and monitored for residual hazards. Since vapor hazards are additive, several pieces of like contaminated equipment together could create a serious vapor hazard when located near each other. This could be a problem in areas such as maintenance holding areas.

Since residual hazards can collect in inaccessible places, contaminated vehicles and equipment must be marked or identified. Otherwise, maintenance personnel could be injured by hidden contamination. One way of doing this is to attach a marker to the outside of the vehicle.

**Radiological Procedures.** Radiological contamination marking signs are usually placed by unit recon teams. The signs are placed on principal routes of entry into the contaminated area where the dose rate is 1 cGyph at 1 meter above the ground. Signs are not placed in the interior portion of the area. This defeats the purpose of the warning. They are only placed on the perimeter of the area. Signs are moved periodically as the contamination decays.

If a military advantage will be lost by marking a contaminated area, the commander may order that the area not be marked. When this occurs, unit defense team personnel must be placed at principal entry points if the tactical situation permits.

Traffic control personnel normally are positioned so they can inform personnel entering the contaminated area about the extent of the hazard. Defense team personnel should not be positioned too near the contaminated area and they should wear a tactical dosimeter. Generally, they should not receive a dose greater than 1 cGy per day.



**BASIS OF ISSUE:**

- 6/Infantry, Scout, and Engineer Platoon
- 6/NBC Recon Vehicle
- 6/Smoke Generator and Decon Squad

Figure 5-21. Contamination bypass marker.

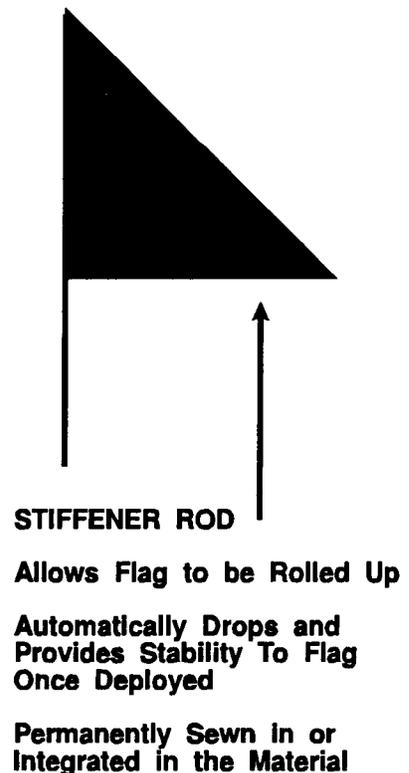


Figure 5-22. Contamination bypass marker flag.

### Vehicle Correlation Factor

In addition to the initial set of vehicle correlation factor (VCF) data, presented in Figure 5-1 and discussed earlier in this chapter, one or two additional sets of data should be taken at different locations so that the defense team can use an average VCF. Sites for obtaining VCF data should be selected to approximate average foliage and ground surface conditions for the contaminated area. New data must be obtained if these conditions change significantly or if the survey meter or vehicle is changed. Additional correlation factor data taken because of these changes should not be averaged into previously collected data, but should be used for applicable routes or points.

Meter readings for VCF data should be taken within three minutes of one another. Note that the monitor never calculates or applies the VCF to his data.

If the vehicle in question is equipped with the AN/VDR2 radiacmeter, this correlation factor is used and is referred to as the attenuation factor for this meter. Mounting instructions for the AN/VDR2 are in TM 11-6665-251-20.

### Unit Procedures

Unit involvement in radiological recon consists of GRR. The unit plots contamination locations for local use only. Units do not normalize GRR data; they are concerned with location, not amount.

Scouts and unit recon parties have principal missions of gathering information about specific facets of the battlefield. These missions could be bridge classification, fording locations, enemy strength and composition, or site evaluation for headquarters elements or other activities. GRR is an inherent part of this recon. On occasion GRR could be a principal mission. This would occur when contamination is known to exist.

The overall objective of the recon team is to locate a clean path or a path acceptable to the commander. The path may, however, be in another unit's area of operations. Use of this path would require approval from and coordination with higher headquarters. If a contaminated path in the unit's area that would result in low exposure to troops can be found, the commander may choose to use it. The amount of contamination that can be crossed safely is relative to the type of unit. An armor unit can safely cross an area with high dose rates; while a dismounted infantry unit must avoid such an area. Crossing should be done as quickly as possible to reduce stay time, but at an appropriate extended interval or slightly different parallel routes to minimize radioactive dust pick-up from traffic movement.

### Ground Radiological Recon

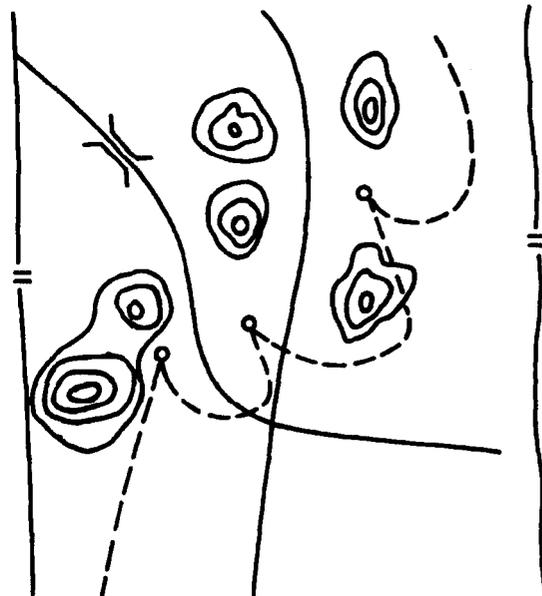
GRR is included in normal recon activities and provides the following:

- Warning of a hazard that otherwise might go undetected. Thus, GRR alerts units on the move when they contact a contaminated area.
- Information to the unit commander about the extent or size of the hazard just encountered.
- Information to the unit commander about the location of clean or uncontaminated areas.
- Information about routes that can be used to avoid the contaminated area. If total avoidance cannot be accomplished, GRR may be able to determine the lowest dose-rate route to be used while crossing the area.

**Attack Indications.** When reconnoitering for a radiological hazard, the team surveys the surroundings for indications of the reason for its existence and additional damage or obstacle indications. Some indicators areas follows—

- Arrival and settling of dust-like particles.
- Tree blowdown.
- Scorching on one side of an object.
- Overturned objects.
- Evidence of treetop fires.
- Dead animals and birds.
- Rain or snow after an airburst occurs.

**Radiological Samples.** When directed, the GRR team takes samples of the contamination. This sampling is required when the dose rate or decay rate is unpredictable. Samples are taken in low dose rate areas. These samples



○ = RADIATION DETECTED

Figure 5-23. In-and-out recon technique.

are forwarded through channels specified by the NBCC. Units do not automatically take such samples.

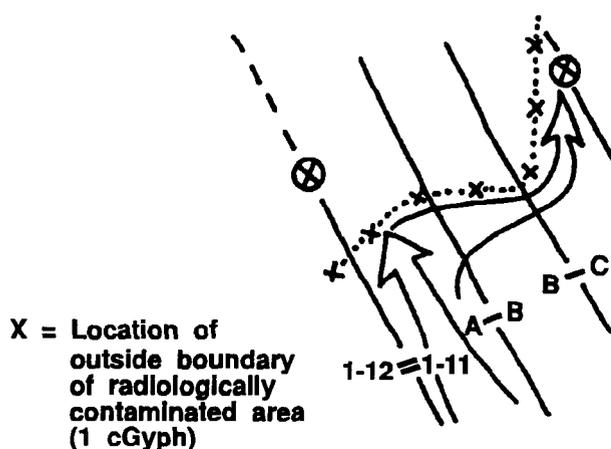
**Conditions for GRR.** Nuclear weapons may be used on the battlefield at any time. This could produce extensive fallout areas or more localized neutron-induced contamination areas. Even the total use of fallout-free airbursts can create residual contamination hot spots because of rainout.

These hot spots could be in the vicinity of GZ or at distant locations. Because of the constant threat, all units, upon initial deployment, must conduct GRR. Thus, GRR is conducted during all tactical operations, patrols, and unit movements.

**Limitations of GRR.** When a mission is given to conduct an area, zone, or route recon, the anticipated hazards are considered. Avoidance techniques and methods for complete protection from enemy action, minefield, and chemically contaminated areas exist. However, since radiation presents a penetrating hazard, the only complete protection from radiological contamination is avoidance of the area entirely. At this stage of recon, when radiological hazards are initially located, there is no indication of the maximum dose rate that may be found.

The process of determining the highest dose rate may be lethal to the GRR team. The GRR team cannot conduct detailed assessment of the contamination. Keep in mind that the GRR teams also must locate other contaminated areas during other operations. These teams must have a very low dose limit or operational exposure guidance (OEG). The arbitrary setting of a high OEG will result in the loss of the team. These limitations restrict the GRR team to locating only the outer limit of a contaminated area. Further reconnaissance for terrain trafficability, enemy activity, obstacles, chemical contamination, and so forth, must stop if a low dose limit is to be maintained.

$D_b$  is specified for each mission. (Refer to Appendix A for further discussion of  $D_b$ .) This total dose is low enough to permit additional exposure to the contamination at later times.



**Figure 5-24. Contact contamination plot.**

**Ground Radiological Reconnaissance Techniques.** In GRR, the most desirable information is the location of uncontaminated areas. GRR is rarely concerned with the determination of the dose rates inside contaminated areas. This task is left to radiological survey. (Surveys were previously discussed in this chapter.)

Dose rates found during GRR are usually of secondary value. The location of the perimeter of the contamination or paths around or through the contamination is of principal value and importance. Knowledge of the perimeter location allows units to avoid the hazard completely.

Prior to the GRR, scouts or NBC teams must have a specified dose-rate level. During GRR, this dose rate serves as the threshold for contamination. This dose rate may be a matter of SOP or may be provided in mission briefings. The dose rate should be inside dose rate. Further, the dose rate should be low enough to be easily read on radiac instruments while moving. This is not a turnback dose rate. This threshold dose rate must be carefully considered and compared to the TF for the vehicles. The threshold dose rate may be entered into the AN/VDR2 after which the VDR2 will automatically alarm every time this dose rate is reached.

When scouts or GRR teams discover contamination, they report its location. They may also report dose rates and time of detection. The NBC 4 nuclear report format can be used to report these data; however, most expeditious reporting requires only a simple statement that contamination is present at a specific location. When the NBC 4 nuclear report format is used, the word "CONTACT" is used with the dose rate or line item Romeo. The word "INITIAL" is not used.

The in-and-out process is used by the GRR team after discovery. Upon detecting contamination, the team records the reading, time, and location on DA Form 1971-R. A report is rendered to alert the main body or unit. The team then withdraws to an uncontaminated area. The team flanks the contamination, repeating the in-and-out process within the team's assigned area, section, or zone. Figure 5-23 illustrates this process. Additional methods of determining the location of radiological contamination are outlined in FM 3-19.

**Marking Areas.** GRR teams mark the outer boundaries of the contamination unless told not to do so. In some cases, this may provide benefit to the enemy about troop movements. NATO markers are erected only at logical points of entry facing away from the contamination. Data are not normally recorded on the signs due to time limitations in keeping with the expeditious nature of reconnaissance operations. Writing on the signs does not enhance the warning afforded by sighting or recognition.

**Washout or Rainout.** The washing out of radiological fallout particles from the air can vastly affect GRR operations. For more information on washout and rainout

refer to Chapter 6. If the condition is caused by rain, the resulting contamination will collect in low areas, streams, ponds, and rivers, creating hot spots. However, large still bodies of water will allow heavier fallout particles to settle and provide shielding. If snow causes the rainout, the area will initially be evenly blanketed. Heavy snowfall may shield indications and readings of radiation levels, but it will eventually melt, and the result will be the same as that caused by rain.

A rainout area can be larger or smaller than a fallout area when given the same size attack employed as a surface burst. There is no satisfactory rainout prediction system. Essentially, the prediction involves determining when it will rain, how much it will rain, and how large the raindrops (sleet, hail, or snow) will be. Rainout can also cause a significant hot spot in an otherwise normal fallout pattern. The GRR team should be aware of rainout and its effects on the mission. Rainout can cause residual contamination from what should have been a fallout-free burst.

**Unit NBC Defense Team Actions.** The unit NBC defense team plots reports from the GRR team. The plot attempts to outline the contaminated area. The NBC defense team does not attempt to normalize the GRR data. Avoidance rather than evaluation is the objective. Figure 5-24 shows a contact contamination plot made by a unit NBC defense team. The NBC defense team may be required to exchange data with lateral units to obtain a larger picture of the contamination. It also must submit its data to the NBCC for evaluation. Such data consist of dose rates, locations, and times of measurement. The NBC 4 nuclear report format should be used.

### Aerial Recon

The NBCC directs all aerial radiological recon (ARR) as well as all radiological surveys. This centralizes control of the teams and provides data for command-wide use. Only the NBCC has dedicated personnel who can evaluate and analyze ARR data and rapidly convert it into usable form.

ARR is a highly specialized operation, which requires trained personnel and careful planning. In most cases, ARR is conducted at or ahead of the FLOT. This requires air defense artillery planning as

well as aerial security, fire support, communications, and airspace coordination.

Fallout also must be complete before ARR can begin at a given location. Completion time may be calculated or it may be indicated by NBC 4 nuclear peak reports from the area or an area further downwind. Given the scope of the operation, only the NBCC can effectively coordinate these matters. This centralized control permits greater flexibility in moving the aerial teams to suspect areas. It also eases coordination across unit boundaries and provides data to the organization best equipped to convert, plot, and disseminate the results—the NBCC.

The product of ARR is a simplified contamination plot. This plot, illustrated in Figure 5-25 also reflects the results of unit monitoring and GRR reports. The plot has a short life span. It is constantly updated and refined as the intelligence cycle feeds in additional information. Ultimately, an aerial survey will be conducted; however, the tactical situation must be stable for this to occur.

Finally, aircraft coordination, specifically helicopter support, is required. In these circumstances, division-level taskings for helicopters will be required.

### ARR Techniques

The techniques for conducting ARR are the same as for radiological surveys, with the following exceptions:

- The ARR team selects the checkpoints, routes, and course legs when they arrive over the area. The NBCC preplans only the general area over which the ARR is conducted. Under hostile air defense artillery (ADA) conditions, route and course leg techniques are not recommended because of their unique signatures. In this case, the point technique with nap-of-the-earth flight at appropriate speed is recommended.

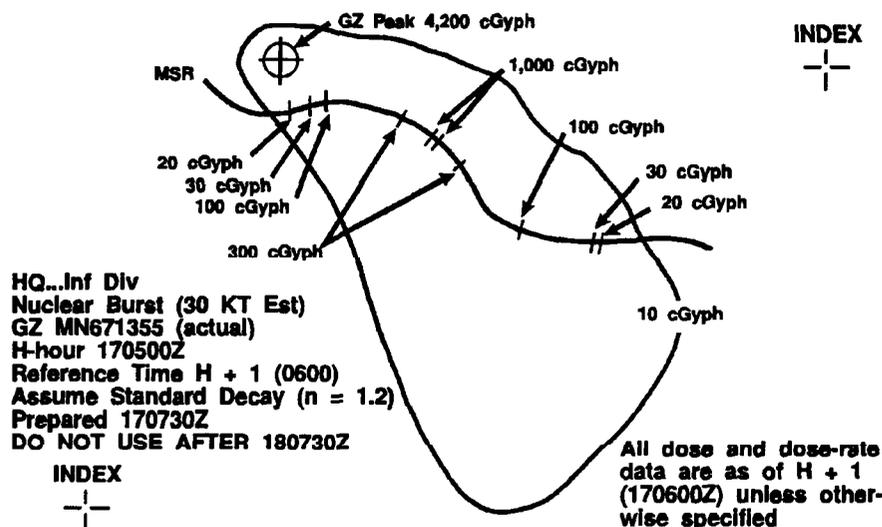


Figure 5-25. Sample simplified contamination plot.

- The ARR provides relatively little detail, covering only those parts of the contaminated area that are of immediate operational concern. Other portions of the area can wait until surveys are conducted.
- A debriefing is held by the NBCC's centralized defense team after the ARR is complete.

Upon arrival over the contaminated area, the ARR team locates the edge of the area. Once the edge is located, the team determines checkpoints that can be identified from the air and on the map. Often the team flies on an azimuth from a known point, as a modification of the course leg technique. The altitude and air speed are determined by the team as explained for aerial survey. These team-selected check-points are used for route, course leg, and point techniques. An additional technique involves flying from a checkpoint along a compass heading. Constant airspeed is maintained. This airspeed and the flight duration is also recorded on DA Form 1971-1-R.

The point technique may be the only viable way to perform ARR at or ahead of the FLOT. This technique permits nap-of-the-earth flight at appropriate speeds and evasive maneuvers. It reduces the ADA threat. It also permits shielded readings if accurate AGCF dose rates are determined for the aircraft. All shielded readings must be taken from the same height as the aerial dose rate of the AGCF data.

### ARR Limitations

Under hostile ADA conditions, route and course leg techniques for ARR are not recommended. These techniques create a unique signature and predictable movements.

ARR in **arctic, desert, or jungle** regions with few or no landmarks for checkpoint identification is difficult. The quickest way to identify a location under such conditions is to mark the spot on the ground by dropping bags of talc, flour, or paint from the helicopter. Specialized communications support may also be required to establish locations from radio fixes while the helicopter hovers.

The **status of training** of the ARR team must also be considered. The best source of ARR teams is the aviation unit that supplies the helicopter. In general, ARR teams must be better trained than survey teams. ARR teams are essentially autonomous. They must understand all facets of the operation. They must also be capable of independent and innovative action to accomplish their missions.

The **previous dose** of the ARR team is another important factor. The ARR team carries an IM147/PD (USA) or IM143/PD (USMC) dosimeter. This dosimeter is checked frequently to ensure the OEG is not exceeded. Other type dosimeters are unacceptable because of their large scales. Usually the OEG given to ARR teams will be around 10 cGy. Large-scale dosimeters do not permit readings in this range. Because of the maneuverability of the helicopter, the team can immediately remove itself from high dose rate areas, if necessary.

**Communications** play a large part in the ability of an ARR team to quickly accomplish its mission. The NBCC does not have organic radios. It may not have assigned frequencies or call signs. Thus, the NBCC must rely on other nets. ARR teams will monitor these nets awaiting mid-mission changes. Because the NBCC must borrow a radio, real-time transmission of data may be impossible. Under hostile EW conditions, it may not be recommended. Range of radios must also be considered. Face-to-face delivery of data is preferred. However, pilots must be briefed so they do not inadvertently disclose the NBCC location. This OPSEC measure may require the pilot to land at a location and send the data by telephone.

### NBCC Actions

The NBCC converts shielded dose rates to ground dose rates by application of the AGCF. Further processing involves normalizing dose rates to H + 1 or other reference time. At early stages, the decay rate of fallout is assumed to be  $n = 1.2$ . If neutron-induced contamination is present, soil type 11 is assumed to be present. Outside dose rates may be normalized using normalizing factors or the M1A1 radiac calculator for fallout or decay nomograms for induced contamination. Subsequent actions for plotting are identical to those used to plot survey data.

Contamination plots are for immediate operations and are valid, at best, for a few hours after creation. Each plot consists of the perimeter of the contamination and dose rates at points of operational interest. See Figure 5-25 for an example of a plot developed from reconnaissance data.

The NBC 5 nuclear report format is not used to disseminate a contamination plot. This avoids confusion with line item Xray contour line. When the plot must be sent to other units and messengers or facsimiles are not available, the corner coordinates of a box outlining the area may be sent. The NBCC should establish this procedure in the FSOP.

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