AREA AND RESOURCE SURVEYS

1. GENERAL

Extensive radiation predictions and surveys will be required to identify and characterize the area for decontamination and to develop and evaluate remediation plans. During the initial hours of the response, available radiation survey instruments and monitoring personnel for survey operations will be limited. Determining whether contamination was released by the accident must be done immediately. If a release occurred, priority must be given to those actions required to identify and reduce the hazards to people. These actions include identifying the affected area (perimeter survey) to allow identification of potentially contaminated people. Each successive survey operation will be based in part on the information gained from earlier operations. Initial radiation surveys may be based on ARAC information, if available, or only on the knowledge that contamination is dispersed downwind. Later surveys will be based on the initial survey data and AMS plots. Days will be required to complete comprehensive contamination characterization.

2. GENERAL SURVEY PROCEDURES

Selection of instrumentation, identification of the edge of contamination, determination of the location of measurements made, and data recording procedures are similar for most survey operations.

a. Selection of Instrumentation.

(1) Alpha Instruments. Instruments that detect alpha radiation may detect lower levels of contamination than instruments that detect low-energy gamma radiation. Under field conditions, however, alpha radiation has an extremely short detection range and its detection may be blocked by nothing more than surface moisture. Decaying alpha particles emit low-level gamma radiation and may be detected with the ADM-300 with X-ray probe under dust or morning dew conditions. The fragility of the Mylar® probe face on most alpha instruments combined with the short detection range of alpha radiation results in a high rate of instrument failure when field use requires measurement of contamination on rough ground or other irregular surfaces. Alpha instruments should therefore be used primarily for personnel and equipment monitoring at the hot line. Field use should be limited to only smooth surfaces like pavement and buildings.

(2) Low-energy Gamma Instruments. Instruments capable of detecting the low-energy gamma ray and X-ray radiations from plutonium, and its americium progeny, may be used to detect contamination; an example of this is the Berkeley Nucleonic Corporation SAM-935 present at many Air Force installations. Low-energy gamma and/or X-ray instruments are not subject to damage by surfaces being monitored and field surveys may be rapidly conducted. Low-energy gamma instruments are, therefore, the recommended instruments for field surveys of plutonium contamination, while the SPA 3 probe is more useful for measuring the medium energy gamma radiation from uranium. For the best detection efficiency, low-energy X-ray surveys should be conducted before any rainfall and during the first five days after the accident before part of the measurable low-energy radiation present is screened by the plutonium migrating into the soil. The best instrumentation for low-energy gamma and/or X-ray surveys

uses FIDLER probes, which are not usually available until the specialized teams arrive. The type and amount of low-energy gamma and X-ray radiation present depends on the age of the plutonium. Many weapons contain plutonium more than 10 years old, resulting in higher signal strengths for the same level of contamination as that produced by a “new” weapon; therefore, the age of the plutonium and projected signal strength should be determined in order to quantify the relationship between the Am-241 measurements and the actual levels of weapons-grade Pu on the ground. The age of the plutonium in a weapon may be obtained from the DOE/NNSA ARG.

b. Perimeter Contamination Levels. Perimeter contamination levels should be below about 0.5 microcurie/square meter where possible. This equates to the following instrument readings:

Table 1. Contamination Instrument Readings

Instrument	**Probe (area in square cm)**	**Activity (microcurie/ square meter)**	**Instrument Indication†**
AN-PDR-56	*DT224B (17)	0.5	~850 cpm
ADM-300	#ASP 100 (100)	0.5	~2,200 cpm
E-600	‡SHP 380 (100)	0.5	~5,500 cpm

† Above background
* assumed α efficiency (4π) for DT224B is 45%
# assumed α efficiency (4π) for ASP 100 is 20%
‡ assumed α efficiency (4π) for SHP380 is 50%

If instrument efficiencies are different than those assumed, instrument indications will need to be corrected.

When low-energy gamma and/or X-ray instruments are used to establish the perimeter, a reading of twice the background is recommended to mark the perimeter. FIDLERs are recommended to perform perimeter surveys, with alpha instruments as the second choice. If FIDLERs are unavailable, and if weather or field conditions prevent the use of alpha instruments, the AN/PDR-56F or ADM-300, with the X-ray probe attached, may be used. If fission products were caused by the accident, priority should be given to establishing a 10 mR/hr perimeter.

c. Fixing Survey Points. For radiation monitoring data to be useful, the point where it is collected must be identifiable on a map or aerial photo of the area. Global positioning equipment may be unavailable to determine precise positions in the early phases of response, or the immediate need for radiological data may outweigh the time required to determine precise positions.

(1) Data points should be marked in some manner so that the point may be later relocated for other actions, or the position determined precisely for later correlation of the data with other information.

(2) A numbered or uniquely identified stake may be used to mark the location on soil and a similar unique identification painted or otherwise marked on pavement or other hard surfaces for later reference. When engineering survey equipment is not being used, the monitoring log, or data collection record, should show the identification marking used at each point, and an estimated position to use immediately after data collection.

(3) Estimated positions may be street addresses in urban areas, the estimated distance down a street or road from an identifiable intersection, compass bearings taken on two or more identified reference points, or any other reference that may be located on the maps being used. If a vehicle is used during the initial perimeter survey, the odometer mileage from an intersection or other known point may be adequate for identifying positions in sparsely populated areas.

d. Recording Survey Data. If an engineering survey is being performed concurrently with the radiological survey, recording procedures must ensure that positional data being recorded at the transit position and radiological data being recorded by the monitors may be correlated. Monitoring and survey teams' records should include the following information:

(1) Team member names.

(2) Type instrument and serial number.

(3) Date and start and stop times of survey.

(4) Data location mark (stake number or other marking) when used.

(5) Estimated or surveyed position.

(6) Instrument reading indicating if the reading is "Gross," meaning the background radiation reading has not been subtracted or "Net," meaning the background radiation reading has been subtracted from the instrument reading.

e. Perimeter Surveys.

(1) Initial Perimeter Survey. Rapid identification of the perimeter of the contaminated area is required to prevent undue alarm, to help identify affected people, and to establish controls to prevent the spread of contamination. The IC and civil authorities need at least a rough plot of the perimeter as soon as possible on which to base their actions. The urgency of perimeter definition is directly related to the population in the area. Streets and roads usually provide rapid access to populated areas, although the location of rivers or other terrain features that may hinder access to parts of the potentially contaminated area must be considered when directing the perimeter survey. The contaminated area may be a mile or more wide and several miles long, therefore use of widely separated monitoring points and a vehicle to move between monitoring points should be considered when directing the initial perimeter survey. ARAC projections, if available, shall help determine the area and distance the perimeter survey teams may be required to cover, and perimeter survey procedures may be adjusted accordingly. If perimeter survey teams are equipped with a radio, a position report at the perimeter locations on each traverse shall provide an immediate location of the perimeter to the command center and allow team progress to be tracked. While not classified, transmission of radiation readings should be discouraged on unsecured nets. Results of the perimeter survey (measurement data, pattern sketch, etc.) should be sent to the ARAC, which may then be used to refine the source term and the disposition pattern.

(2) Full Perimeter Survey. FIDLERs should be used when performing a full survey of the perimeter. This may not be possible until after the specialized teams arrive and may take weeks to complete. The procedure most likely to be used consists of monitoring in and out along

the edge of the area with readings being taken about every 50 feet. If weather or terrain requires the use of the AN/PDR-56 or ADM-300 X-ray probe on the initial perimeter survey, the full perimeter survey may result in an expansion of the perimeter. If an alpha instrument was used for the initial perimeter survey, the perimeter established by the full perimeter survey should be about the same size or slightly smaller.

f. Area Surveys. Radiological surveys of the contaminated area are required to identify areas requiring the application of fixatives, to support decontamination and remediation planning, and to determine decontamination effectiveness. The first survey covering the entire area is provided most times by the AMS. The initial AMS helicopter data are expected be available four to five hours after completion of survey flights. Fixed wing survey results are usually available one hour after flight completion. The AMS plot requires interpretation by trained analysts. Ground survey data are required to confirm and support analysis of the plot. Some of the supporting ground data may be provided by the initial perimeter survey. Ground surveys to support decontamination planning should be performed with FIDLERs. Usually some form of grid survey is used with the grid size determined by the desired accuracy of estimated activity between grid points and measurement errors associated with the instruments. Several days to over a week may be required to complete a ground survey of the entire area. Ground surveys confirming decontamination effectiveness may require several months to complete due to the low levels of contamination remaining and the desired precision.

g. Building Surveys.

(1) Radiological surveys of buildings within the contaminated area will be required to determine the appropriate decontamination actions. Alpha instruments may be used on most building surfaces; however, use of FIDLERs may be necessary on surfaces that may damage alpha instruments, or on materials such as carpets, where contamination may be below the surface and screened from alpha instruments. The amount of removable contamination present must be determined by wiping surfaces with a piece of material, or swipe, which is then monitored for contamination. Laboratory counting equipment should be used to determine the amount of removable contamination picked up on the swipe. Initial building surveys should be done only on the exterior unless the building is in use.

(2) Civil authorities should establish procedures for either building owners and/or tenants, or an appropriate civil authority, such as a policeman, to accompany monitors when surveying building interiors. If interiors are surveyed before the surrounding area has been decontaminated, methods that reduce tracking of contamination into buildings should be used (for example, cover shoes with plastic bag immediately before entering buildings and ensure gloves are uncontaminated). Interior contamination levels shall vary because of the time of year, the type of heating or cooling system used, and whether people were in the building during, or following the accident. Interior contamination levels are expected to be only a fraction of the exterior levels at the same location. The primary source of interior contamination is expected to be airborne contaminants entering the building through heating or cooling systems, and doors, windows, or other openings during the initial cloud passage; or contamination tracked or carried into the building by people or animals. The sealing of doors, windows, chimneys, and ventilators on evacuated buildings in highly contaminated areas may reduce further contamination of the interior during decontamination of the surrounding area. When monitoring the interior of a building, initial monitoring should be on the floor in the main traffic pattern (doorways, halls, and stairs), and on top of horizontal surfaces near heating or cooling duct outlets, windows, and other

openings into the building. If no contamination is found at these locations, it is very likely no contamination entered the building. If contamination is found, additional monitoring should be performed. Monitoring results from furnace and air-conditioning filters should be included in building survey records.