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... Documentation for an Environmental Impact Statement Regarding the Pantex Plant

... Methods and ... for Postulated Accidents

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Supplementary Documentation for an Environmental Impact Statement Regarding the Pantex Plant

Decontamination Methods and Cost Estimates for Postulated Accidents

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DECONTAMINATION METHODS AND COST ESTIMATES FOR POSTULATED ACCIDENTS

by

Walter Jay Wenzel

ABSTRACT

This report documents work performed in support of preparation of an Environmental Impact Statement regarding the Department of Energy's Pantex Plant near Amarillo, Texas.

Methodology and costs for decontamination following a postulated nonnuclear detonation of a nuclear weapon are presented for three land use categories: agricultural, suburban, and commercial. Seven postulated releases of plutonium are addressed: three at the Pantex Plant (120, 30, and 0.625 kg), three at the Iowa Army Ammunition Plant (IAAP) (120, 30, and 0.625 kg), and one at the Hanford Site (0.625 kg).

I. INTRODUCTION

This report documents work performed in support of preparation of an Environmental Impact Statement (EIS) regarding the Department of Energy's (DOE) Pantex Plant near Amarillo, Texas. The EIS addresses continuing nuclear weapons operations at Pantex and the construction of additional facilities to house those operations. The EIS was prepared in accordance with current regulations under the National Environmental Policy Act. Regulations of the Council on Environmental Quality (40 CFR 1500) require agencies to prepare concise EISs with less than 300 pages for complex projects. This report was prepared by Los Alamos National Laboratory to document details of work performed and supplementary information considered during preparation of the Draft EIS.

The only credible accidents associated with the nuclear weapons operation discussed in the EIS and determined to have significant potential offsite consequences for the general public or the environment involved accidental detonation of conventional high explosives resulting in the dispersal of radioactive materials. Uranium, tritium, and other radioactive contamination that could result from a detonation accident were found to be significantly less consequential than plutonium contamination. Weapons grade plutonium contains about 93% ^{239}Pu. Most contamination would be caused by aerosolization of the plutonium in the device, with deposition of the plutonium on site and on the surrounding farming area (Elder 1982B).

The plutonium deposited on the soil and other surfaces would be PuO_2, which is extremely insoluble in water (about 20 μg/ℓ in water at room temperature) and dilute acids (Langham 1969). Thus PuO_2 is relatively "inert" in the environment and can be removed from most hard surfaces by vacuuming or by scrubbing with water and detergents.

Currently, an official standard or limit for ^{239}Pu contamination in soil or on surfaces has not been adopted by the Environmental Protection Agency (EPA), Nuclear Regulatory Commission (NRC), or DOE. Therefore, two suggested cleanup levels were used in this study. One assumed level was the EPA suggested soil screening level of 0.2 $\mu Ci/m^2$ in the top 1 cm of soil (USEPA 1977A and 1977B). This screening level was calculated by EPA at low enough concentrations that the EPA proposed dose guidance would be met, and no remedial action would be necessary. The other assumed level was a limit of 100 pCi/g of dry soil to a depth of 5 cm (Healy 1977). Both proposed criteria are based upon limiting the amount of plutonium that could be inhaled or ingested by the general public living or working in areas contaminated with plutonium. A later report by Healy suggests a higher level, 200 pCi/g of soil in the top 5 cm, as equally acceptable from the standpoint of limiting the radiation dose and, hence, protecting the public from possible adverse health effects (Healy 1979).

Comparison of the levels based on the EPA and Healy limits shows that the EPA based level is about eight times more restrictive than that proposed by Healy. This comparison takes into account dry soil and assumes a soil density of 1.5 g/cm^3. Alternatively, recalculating the Healy level for a 1-cm depth yields 7.5 $\mu Ci/m^2$, which is about 38 times less restrictive than the EPA guidance on a square meter surface basis.

Decontamination of surfaces, such as roofs, asphalt, and paving, is assumed to reduce contamination levels to as low as reasonably achievable (ALARA), at or below the detection limits of the survey instruments. For example, the PAC-7 portable hand-held air proportional alpha survey instrument has a detection limit of <100 dis/min/60 cm^2, or about 0.01 $\mu Ci/m^2$.

The present report focuses on possible decontamination methods that could be used, for example, normal plowing or hand shoveling of surface areas to reduce the plutonium contamination and, thereby, decrease the radiological hazard to the public to acceptable levels.

Additional information about the initiating events leading to these accidental releases, subsequent dispersion and deposition of the plutonium contamination, inhalation doses from cloud passage, and long-term health effects with and without decontamination may be obtained in Chamberlin 1982, Dewart 1982, Elder 1982B, and Wenzel 1982E.

A. Plutonium Oxide (PuO_2) Decontamination

The current literature on the decontamination of large areas has been reviewed in several recent reports (McGrath 1975, USNRC 1975, Smith 1978, Finley 1980). Most studies have centered on farmland decontamination, based upon USDA and military experiments. The methods most frequently described for farmland include removal of crops and vegetation, removal of the top few inches of soil, and dilution of the surface contamination into deeper soil layers by plowing or heavy irrigation.

Some reviews have addressed the problem of urban decontamination of fission products, but definitive research on methods and costs in residential and urban areas has not yet been thoroughly investigated (McGrath 1975, USNRC 1975).

The methods of PuO_2 decontamination depend upon many factors, including

1. PuO_2 surface concentration,
2. surface decontamination limits to be used,
3. surface area,
4. surface characteristics and land use patterns,
5. manpower and equipment availability, and
6. specific activity of the waste generated and its disposal.

Following a widespread contamination accident, time is a major concern. That is, the sooner the area can be cleaned up, the less the public will be exposed. Decisions on methods used and actions taken must be made and initiated as soon as possible following the accident.

B. Decontamination Approaches

Two major methods for decontamination of large areas of soil are suggested: surface removal techniques, such as scraping off the top few inches of soil by conventional road or farm equipment, or fixation techniques, such as heavy irrigation of the soil with water to reduce resuspension and to dilute the contamination into deeper soil layers (Cobb 1973).

The method chosen depends on the permissible amount of residual surface contamination left after decontamination, which may be expressed either as a removal efficiency percentage or as a decontamination factor (amount before decontamination divided by the amount remaining after decontamination). For example, high-pressure water (firehose) will remove 99% of the PuO_2 from a 2-ft^2 "hot" spot on highway asphalt. This is considered a decontamination factor of 100 (McGrath 1975). For high levels of contamination, we assume that for PuO_2 a decontamination procedure can be repeated a number of times to effect a higher decontamination factor. Repeated applications of the same decontamination procedure usually give lower removal efficiencies each time. Thus, the second, third, and fourth decontamination passes give lower decontamination factors.

II. LAND USE CATEGORIES

Three land use categories were addressed--agricultural, suburban, and commercial. To develop decontamination methods and costs for suburban and commercial land use categories, the building size and number of buildings per unit area in each land use category were estimated using Table I, which is based on Taylor's 1982 data.*

Suburban areas were estimated from regional topographical maps and apportioned from overlay of computer generated deposition isopleths. Commercial areas were assumed to be one-fourth of the suburban areas. All other areas were considered farmland for the three sites.

Decontamination methods and cost tables (Tables A-I through A-VIII) were developed for each of the three land use categories based on the data from the reports by McGrath, Finley, USNRC, and Smith. Some modifications of the decontamination methods were necessary due to the ease of PuO_2 (as compared with fission product) decontamination. Decontamination methods were selected

*This information was supplied by J. M. Taylor, Sandia National Laboratories, Albuquerque, New Mexico, 1982.

TABLE I

COMPOSITION OF HABITATION TYPES WITHIN TWO LAND USE CATEGORIES

Category of Habitation	Suburban (720 people/km^2)	Commercial (3900 people/km^2)
Undeveloped land	20%	10%
Single family units	30%	20%
Buildings <6 floors	10%	10%
Buildings >6 floors	5%	10%
Commercial buildings	10%	20%
Parks and cemeteries	20%	10%
Public buildings	5%	20%

that, in general, did not alter the surfaces--generally hosing with water under pressure, hand decontamination with detergents, and soil removal were assumed adequate to remove the loose dust-like PuO_2 contamination from surfaces. Costs were taken from the above references and adjusted for inflation by assuming a 7.5% compound inflation rate from 1975 to 1979 and a 10% yearly inflation rate for 1980 and 1981. Two costs were computed: low and high cost/acre. The high cost/acre was used to calculate the decontamination costs.

A. Agricultural Land Use Area Decontamination

Table II lists the estimated 1981 cost per acre for decontaminating farmland. The decontamination methods described in Tables A-I and A-II reflect research done by Menzel 1971 and James 1973 for removal of radioactivity from farmland at Bushland, Texas, and Bethesda, Maryland, as well as estimates from several military and literature sources summarized by McGrath (1975).

Table A-III lists the decontamination factors used to establish the decontamination methods. The decontamination philosophy is removal of the contamination and disposal of waste according to specific activity. Retrievable waste [a transuranic (TRU) specific activity >10 nCi/g] is handled and packaged differently than nonretrievable waste. For example, to decontaminate a crop contaminated to 750 $\mu Ci/m^2$, trained radiation workers, wearing suitable safety equipment such as coveralls, fullface masks, rubber

TABLE II

DECONTAMINATION COST PER ACRE (1981 DOLLARS) FOR FARM, SUBURBAN, AND COMMERCIAL LAND

Initial Condition ($\mu Ci/m^2$)	Farm		Suburban		Commercial	
	Healy	EPA	Healy	EPA	Healy	EPA
>750	48 160 (15 700)*	48 520 (15 700)	76 700	86 000	93 200	108 300
75-750	5 350 (7 900)	5 640 (7 900)	22 200	25 600	27 240	31 640
7.5-75	720	5 410	4 500	5 700	5 600	6 700
0.2-7.5	480	3 070	480	3 160	480	3 400

*Values in parentheses are cost for decontamination of single family residences. Number of homes in rural areas is estimated to be total population divided by four.

gloves, and boots, remove vegetation by hand. This vegetation would be packaged in drums for shipment to a repository. Then, soil would be scraped carefully with shovels, packaged in drums, and shipped to the repository. Highly contaminated areas would require continual health physics support to monitor the cleanup. For less highly contaminated areas, <75 $\mu Ci/m^2$, removal of vegetation and a top 4-in. layer of soil would be necessary. This nonretrievable waste would then be trucked to pits to be buried. For areas <7.5 $\mu Ci/m^2$, removal of vegetation would depend on specific conditions such as type of crop and time until harvest. Surface soil PuO_2 concentration could be reduced by normal plowing. For each soil contamination level, the decontamination method used would depend on choosing an appropriate decontamination level.

B. Suburban Land Use Area Decontamination

For suburban decontamination, the building densities from Table I (J. M. Taylor, Sandia) were used to estimate the fraction of buildings per acre. Decontamination costs for buildings were scaled from Appendix VI of USNC 1975 and McGrath 1975. Table II gives the decontamination costs for suburban land use. Tables A-IV and A-V describe the decontamination methods for suburban areas.

Table A-VI lists the decontamination factors assumed for the major decontamination methods.

Decontamination of buildings at the >75-$\mu Ci/m^2$ level was envisioned as a two-step process. First, building exteriors are decontaminated by lawn removal, firehosing surfaces, and hand decontamination with detailed monitoring. Second, the interior is decontaminated by a trained crew of radiation workers. Carpets are vacuumed (or removed); floors, walls, ledges, and ceilings are scrubbed; and portions of heating and ventilation systems are removed. Contaminated liquids from firehoses and hand decontamination would be processed as low-level liquid waste (LLLW).

C. Commercial Land Use Area Decontamination

Decontamination of commercial land is similar to suburban decontamination, except the cost in commercial areas is greater because of higher building density. Table II shows the decontamination costs for commercial land use areas. Tables A-VII and A-VIII describe the decontamination methods.

Note that, for PuO_2 concentrations >75 $\mu Ci/m^2$, the cost difference between the EPA and Healy limits is small for all land use categories. However, major differences occur at the low concentrations. This difference in cost at the low concentrations dominates the summed cost estimates for each accident. This is because of the large land areas contaminated at low levels resulting from the high initial cloud height and large source terms.

D. Decontamination Analysis Procedure for Each Site

Concentration isopleths generated from the DIFOUT code were listed for each accident. Individual accident scenarios are identified in the same way as used in the report covering the meteorological dispersion and deposition analysis (Dewart 1982). The average concentration in microcuries per square meter between any two isopleths was assumed to be five times the outermost isopleth line concentration. Another conservative assumption involved isopleth 1; the highest concentration given for isopleth 1 by DIFOUT was assumed to cover one-half of the area within isopleth 1. This high area within isopleth 1 was analyzed separately during the cost analysis.

The DIFOUT contamination isopleths (Dewart 1982) for each postulated accident were scaled to a topographical map of each site. Population density data from Greenwood 1982 were added to the isopleths, and the population average at each isopleth concentration was estimated. Areas of land in each use category were also estimated. The concentration, land areas, and the associated population data for each accident analyzed are given in the Appendix, starting with Table A-IX and Figure A-1.

Once the population density, PuO_2 concentration, land use, and land area were estimated, the decontamination costs were tabulated for each accident and summed to represent the total cost for decontamination and restoration following an accident. The high decontamination costs were used for each accident. The cost data can be considered an upper bound of the decontamination cost. The long-term effects of the residual contamination left at the chosen decontamination limit for each of the accidents in this report are addressed in another report (Wenzel 1982E) for the EPA, Healy, and no decontamination cases.

III. POSTULATED ACCIDENT DECONTAMINATION AT PANTEX

For the Pantex Plant and Iowa Army Ammunitions Plant (IAAP), three representative accidents were chosen for in-depth analysis to delineate the major differences due to the source term range of 0.625-120 kg of plutonium released. The scope of this analysis is limited to cost comparison for potential accidents between sites and the source term. The actual cost incurred, if such an accident were to occur, would probably be within an order of magnitude, and the decontamination methods used would depend on the political, economic, and scientific guidance available at that time.

Evacuation costs were estimated on a per capita basis for each accident and found to be less than 1% of the overall decontamination costs.

Each postulated accident was evaluated separately using the DIFOUT code for site specific meteorological conditions. The wind speed in meters per second, the wind direction, the Pasquil stability class, and the final cloud height are major variables influencing the deposition pattern (isopleth) (Dewart 1982). Areas within each isopleth and their associated average concentrations were estimated.

A. Decontamination and Cost Estimates Following Release of 120 kg of Plutonium from Accident I at Pantex Plant

Figures A-1 and A-2 depict the DIFOUT isopleths for the largest postulated accidental release of 120 kg of plutonium. Note that isopleths 3 and 4 do not converge within 80 km. Table A-IX gives population estimates for the isopleths based on Greenwood 1982. The fraction of annular isopleth area was estimated from Figs. A-1 and A-2 to give the population per isopleth. Table III gives the decontamination cost estimates for the 120-kg-plutonium release as well as the other postulated accidents. Tables A-X and A-XI provide additional data for Table III.

Land use patterns were estimated from Figs. A-1 and A-2 for the median meteorological case. Suburban areas represent about 1% of isopleths 1 through 3 and 5% of isopleth 4 areas. For the unfavorable meteorological case, suburban areas were about one-third of isopleth 2 and one-sixth of isopleths 3 and 4. Isopleth 1 was about 5% suburban. Commercial areas were assumed to

TABLE III

SUMMARY OF DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR POSTULATED ACCIDENTS AT PANTEX

Land Use and Meteorological Conditions	120 kg Pu		30 kg Pu		0.625 kg Pu	
	Healy	EPA	Healy	EPA	Healy	EPA
Agricultural						
Median	160	720	77	490	2.9	18
Unfavorable	120	680	75	480	2.3	15
Suburban						
Median	3.6	15	2.4	14	0.033	0.18
Unfavorable	53	160	16	78	0.73	4.9
Commercial						
Median	1.3	5.4	1.6	5.1	0.0068	0.048
Unfavorable	16	45	5.6	28	0.24	1.7

be 25% of the suburban areas for both meteorological cases and for each accident source term.

B. Decontamination and Cost Estimates Following Release of 30 kg of Plutonium from Accident H at Pantex Plant

For a 30-kg-plutonium release, the isopleths are shown in Figs. A-3 and A-4. Table A-XII gives the 1990 population estimates for both meteorological cases. Similar land use patterns were used for the 30-kg case and for the 120-kg case.

Table III gives the decontamination cost estimates for the 30-kg-plutonium release. Tables A-XIII and A-XIV provide additional calculation data for Table III.

C. Decontamination and Cost Estimates Following Release of 0.625 kg of Plutonium from Accident K at Pantex Plant

Figures A-5 and A-6 depict the 0.625-kg release isopleths. Note that only isopleths 2, 3, and 4 occur offsite for the median meteorology case, and only isopleths 3 and 4 occur offsite for the unfavorable meteorology case. Table A-XV estimates the population density for this accident.

Table III lists the decontamination cost estimates for the 0.625-kg-plutonium release. Cost is primarily due to radiation surveys. Additional data for this accident are in Tables A-XVI and A-XVII.

IV. POSTULATED ACCIDENT DECONTAMINATION AT IOWA ARMY AMMUNITIONS PLANT

The same three accident releases were analyzed for IAAP as for the Pantex Plant. A major difference is the proximity of Burlington (9 km) to the IAAP, whereas Amarillo is much farther away from Pantex (25 km). The higher biomass per unit area at IAAP would probably result in higher cost of vegetation removal in Iowa than at the other two locations. This difference is not readily apparent in the cost estimates because the high-range costs were used throughout the analysis at each location.

A. Decontamination and Cost Estimates Following Release of 120 kg of Plutonium from Accident R at IAAP

Figures A-7 and A-8 show the isopleths for the typical and unfavorable meteorological cases. Table A-XVIII gives the 1990 population estimate for the 120-kg-plutonium isopleths based on Greenwood 1982.

Table IV gives the cost estimates for the three land use categories. Note the increased cost for the unfavorable meteorological case because of proximity of the town of Burlington. This increase is balanced by the smaller total areas within the lower level (3 and 4) isopleths. Tables A-XIX and A-XX give additional data for Table IV.

B. Decontamination and Cost Estimates Following Release of 30 kg of Plutonium from Accident Q at IAAP

For the 30-kg-plutonium release, the first isopleth barely touches the IAAP boundary for the unfavorable meteorological case. For the typical meteorological case, the first isopleth is about 0.5 km beyond the boundary. Thus, the costs reflect the lower contamination levels for agricultural and suburban land use areas. Figures A-9 and A-10 depict the 30-kg-plutonium isopleths. Table IV gives the cost estimates. Table A-XXI gives the 1990 population estimate and Tables A-XXII and A-XXIII give additional data.

C. Decontamination and Cost Estimates Following Release of 0.625 kg of Plutonium from Accident S at IAAP

Figures A-11 and A-12 depict the 0.625-kg-plutonium release isopleths. Note that isopleths 2 through 4 for the typical meteorological case and 3 through 4 for the unfavorable meteorological case extend beyond the IAAP boundary. Table IV summarizes the decontamination cost estimates with Tables A-XXIV and A-XXV giving additional population and cost data.

TABLE IV

SUMMARY OF DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS)
ESTIMATES FOR POSTULATED ACCIDENTS AT THE IAAP

Land Use and Meteorological Conditions	120 kg Pu		30 kg Pu		0.625 kg Pu	
	Healy	EPA	Healy	EPA	Healy	EPA
Agricultural						
Median	160	700	41	260	2.6	16
Unfavorable	68	320	36	230	1.4	9.1
Suburban						
Median	11	31	2.7	11	0.11	0.65
Unfavorable	89	120	8.9	25	0.48	3.1
Commercial						
Median	4.3	11	0.98	3.8	0.038	0.23
Unfavorable	36	47	3.5	9.2	0.16	1.1

V. POTENTIAL ACCIDENT DECONTAMINATION AT HANFORD

The 0.625-kg-plutonium accident T was the only accident addressed for Hanford. Both typical and unfavorable meteorological cases travel in the same direction, 155°. The unfavorable case is depicted in Figs. A-13 and A-14. None of the four isopleths for the unfavorable case extend beyond the Hanford boundary; hence, there is no impact to the public from decontamination deposited PuO_2. Isopleth 4 from the median meteorological case may reach the east bank of the Columbia River, but concentrations of up to 0.4 $\mu Ci/m^2$ would be negligible and no cleanup would likely be required. Table A-XXVI summarizes the onsite decontamination costs from both meteorological cases.

VI. CONCLUSIONS

Table V summarizes the decontamination costs for Pantex Plant, IAAP, and Hanford Site. For the Pantex Plant the decontamination costs were higher when the cloud drifted over Amarillo because more residential and commercial areas were contaminated. The lower wind speed and more turbulent stability (D instead of E) resulted in smaller areas for the unfavorable case but higher concentrations in the first isopleth. Truncation of the DIFOUT code at 80 km also made comparisons of isopleths 3 and 4 less sensitive.

TABLE V

SUMMARY OF DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS)
ESTIMATES FOR POSTULATED ACCIDENTS AT THE IAAP

	Release and Assumed Level of Cleanup					
	120 kg Pu		30 kg Pu		0.625 kg Pu	
Site	Healy	EPA	Healy	EPA	Healy	EPA
Pantex Plant						
Median	170	740	81	510	2.9	18
Unfavorable	190	890	97	590	3.3	22
IAAP						
Median	180	740	45	270	2.7	17
Unfavorable	190	490	48	260	2.0	13
Hanford Site (on-site costs only)						
Median					3.2	21
Unfavorable					1.6	10

Cleanup costs estimated for the vicinity of IAAP were usually greater for the median case than for the unfavorable case. Wind speed was the major reason for greater areas of contamination in the median cases. Burlington was far enough away from the 30-kg release that it was not impacted by isopleth 1; only for the 120-kg-plutonium release did isopleth 1 go through Burlington.

The situation at Hanford was similar to that at IAAP. The median dispersion case also resulted in higher decontamination costs than the unfavorable case because, in the median case, greater areas were contaminated, but these were not suburban or commercial areas. The Hanford estimates reflect costs for onsite decontamination only, whereas costs for the Pantex Plant and IAAP include both onsite and offsite costs.

The cost increase due to lower decontamination limits is predominant at all source terms. Cost is increased 2.6 to 6.6 times when using the EPA instead of Healy limits for the three land use categories.

Initial cloud height and wind speed at the release point greatly influence the surface area contaminated. This is especially true for the lower isopleth concentrations.

Other potential costs, not addressed in this study, are litigation costs, onsite decontamination of buildings, and decontamination beyond 80 km. A more precise cost analysis would require further detailed investigation. Decontamination costs for suburban areas are the least precise; however, even large changes in those costs would probably not change the overall magnitude of total costs for the scenarios analyzed.

A summary of general conclusions follows.

1. Decontamination costs for a particular accident would probably be about the same for the Pantex Plant and IAAP. Costs would be less at the Hanford Site because of the greater distance between the plant and the site boundary.
2. Meteorological conditions (wind speed, wind direction, and stability) and source term conditions (cloud height and concentration) would determine the surface area contaminated. Decontamination costs are overwhelmingly influenced by the surface area contaminated and its land use category.
3. Very little ($\sim$0.4 μCi/m^2) deposited contamination above the limits extends beyond the boundary at the Hanford Site for the 0.625-kg-plutonium release accident.

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APPENDIX

DECONTAMINATION METHODS AND COSTS

TABLE A-I

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR AGRICULTURAL AREAS
USING THE PROPOSED HEALY SOIL LIMIT

Initial Condition ($\mu Ci/m^2$)	Decontamination Method and Description	Cost/Acre Low	Cost/Acre High
>750	Precleanup radiation survey	480	480
	Crop purchase	300	500
	Manual removal of vegetation and 2 in. of soil	1 900	3 200
	Preparation of remote disposal site	500	500
	Package and transport retrievable waste 1000 mi	27 000	41 800
	Restore and replant decontaminated area	1 200	1 200
	Final radiation survey	480	480
	TOTAL	31 860	48 160
	Home and building decontamination population/4	1 600/home	15 700/home
75-750	Precleanup radiation survey	480	480
	Crop purchase	300	500
	Removal of vegetation with farm equipment	780	1 600
	Removal of 4 in. of soil with road equipment	260	480
	Preparation of remote disposal site	500	500
	Transport nonretrievable waste 2000 ft	400	400
	Restore and replant decontaminated area	1150	1 150
	Final radiation survey	240	240
	TOTAL	4 110	5 350
	Home and building decontamination population/4	800/home	7 900/home
7.5-75	Normal plowing, 12 in. deep	120	240
	Precleanup and final radiation survey	480	480
	TOTAL	600	720
DL-7.5*	Radiation survey only	480	480

*DL is detection limit of survey instruments.

TABLE A-II

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR AGRICULTURAL AREAS USING THE PROPOSED EPA CRITERIA AS DECONTAMINATION LIMIT

Initial Condition ($\mu ci/m^2$)	Decontamination Method and Description	Cost/Acre Low	Cost/Acre High
>750	Precleanup radiation survey	480	480
	Crop purchase	300	500
	Manual removal of vegetation and 2 in. of soil	1 900	3 200
	Preparation of remote disposal site	500	500
	Package and transport retrievable waste 1000 mi	27 500	41 800
	Deep plow 30 in.	180	360
	Restore and replant decontaminated area	1 200	1 200
	Final radiation survey	480	480
	TOTAL	32 540	38 520
	Home and building decontamination population/4	1 600/home	15 700/home
75-750	Precleanup radiation survey	480	480
	Crop purchase	300	500
	Removal of vegetation with farm equipment	780	1 600
	Removal of 4 in. soil with road equipment	260	480
	Preparation of remote disposal site	500	500
	Transport nonretrievable waste 2000 ft	400	400
	Normal plowing 12 in. deep	120	240
	Restore and replant decontaminated area	1 200	1 200
	Final radiation survey	240	240
	TOTAL	4 280	5 640
	Home and building decontamination population/4	800	7 900
7.5-75	Precleanup and final radiation survey	730	730
	Crop purchase	300	500
	Removal of vegetation with farm equipment	780	1 600
	Removal of 4 in. soil with road equipment	260	480
	Preparation of remote disposal site	500	500
	Transport nonretrievable waste 2000 ft	400	400
	Restore and replant decontaminated area	1 200	1 200
	TOTAL	4 170	5 410
	Add home and building decontamination population/4	400/home	4 000/home
0.2-7.5	Precleanup and final radiation survey	730	730
	Crop purchase	300	500
	Removal of vegetation with farm equipment	780	1 600
	Normal plowing 12 in. deep	120	240
	TOTAL	1 930	3 070

TABLE A-III

DECONTAMINATION FACTORS FOR AGRICULTURAL AREA
DECONTAMINATION OF PuO_2

General Description of Method	Decontamination Factor
Manual removal of vegetation	2
Manual removal of 2 in. of soil	100
Removal of vegetation with farm equipment	2
Removal of 4 in. of soil (two passes) with road equipment	300
Manual decontamination (detergents) of buildings	100
	Dilution Factor
Plowing 30 in. deep	76
Plowing 12 in. deep	31

TABLE A-IV

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR SUBURBAN AREAS USING THE PROPOSED HEALY SOIL LIMIT

Initial Condition ($\mu Ci/m^2$)	Decontamination Method and Description	Cost/Acre Low	Cost/Acre High
>750	Precleanup and final radiation surveys	1 200	1 200
	Manual removal of vegetation, sod, and 2 in. of soil	1 900	3 200
	Firehose roofs and walls twice - collect water	2 100	2 100
	Firehose streets, sidewalks, and pavements twice	2 100	2 100
	Treat collected water as LLLW	3 900	3 900
	Preparation of remote disposal site	500	500
	Package and transport retrievable waste (1000 mi)	27 500	41 800
	Restore and replant landscaping	2 800	2 800
	Single family home decontamination, 0.3 home/acre	480	4 700
	<6 floor building decontamination, 0.1 building/acre	480	4 800
	>6 floor building decontamination, 0.05 building/acre	240	2 400
	Commercial and public building decontamination, 0.15 building/acre	900	7 200
	TOTAL	44 100	76 700
75-750	Precleanup and final radiation surveys	1 200	1 200
	Manual removal of vegetation, sod, and 2 in. soil	1 900	3 200
	Firehose roofs and walls once	1 100	1 100
	Firehose streets, sidewalks, pavement once	1 100	1 100
	Preparation of remote disposal site	500	500
	Disposal at 50 mi (nonretrievable)	1 500	2 240
	Restore and replant landscaping	2 800	2 800
	Single family home decontamination	240	2 360
	<6 floor building decontamination	240	2 400
	>6 floor building decontamination	120	1 200
	Commercial and public building decontamination	410	4 100
	TOTAL	11 110	22 200
7.5-75	Precleanup and final radiation surveys	1 200	1 200
	Firehose streets, sidewalks, and pavement once	1 100	1 100
	Firehose roofs and walls once	1 100	1 100
	Irrigate and heavily water soil and vegetation	1 100	1 100
	TOTAL	4 500	4 500
0.2-7.5	Initial radiation survey only	480	480

TABLE A-V

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR SUBURBAN AREAS USING THE PROPOSED EPA CRITERIA AS DECONTAMINATION LIMIT

Initial Conditions ($\mu Ci/m^2$)	Decontamination Methods and Description	Cost/Acre Low	Cost/Acre High
>750	Same as Healy Limits	44 100	76 700
	Add: Two more roof and wall firehosings	2 100	2 100
	Two more street, sidewalk, and pavement firehosings	2 100	2 100
	Treat water as LLLW	3 900	3 900
	Final irrigation and heavily watered vegetation and soil	1 200	1 200
	TOTAL	53 400	86 000
75-750	Same as Healy Limits	11 100	22 200
	Add: One more roof and wall firehosing	1 100	1 100
	One more street, sidewalk, and pavement firehosing	1 100	1 100
	Final irrigation and heavily watered vegetation and soil	1 200	1 200
	TOTAL	14 500	25 600
7.5-75	Same as Healy Limits	4 500	4 500
	Add: Final irrigation and heavily watered vegetation and soil	1 200	1 200
	TOTAL	5 700	5 700
0.2-7.5	Same as Healy Limits	480	480
	Add: Final irrigation and heavily watered vegetation and soil	1 100	1 100
	Hose down building surface	1 100	1 100
	Final radiation survey	480	480
	TOTAL	3 160	3 160

TABLE A-VI

DECONTAMINATION FACTORS FOR
SUBURBAN AREA DECONTAMINATION OF PuO_2

General Description of Method	Decontamination Factor
Firehosing hard surfaces once	30
Firehosing hard surfaces twice	50
Manual decontamination with detergents of interior of buildings	100
Manual water hosing of vegetation.	10

TABLE A-VII

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR COMMERCIAL AREAS USING THE PROPOSED HEALY SOIL LIMIT

Initial Conditions ($\mu Ci/m^2$)	Decontamination Methods and Description	Cost/Acre Low	Cost/Acre High
>750	Precleanup and final radiation surveys	1 200	1 200
	Manual removal of vegetation and 2 in. soil	1 200	1 200
	Firehose roofs and walls twice - collect water	2 400	2 400
	Firehose streets, sidewalks, pavement twice	2 400	2 400
	Firehose building surface and ledges	2 400	2 400
	Treat decontaminated water as LLLW	6 700	6 700
	Package and transport retrievable waste (1000 mi)	27 500	41 800
	Preparation of remote disposal site	500	500
	Restore and replant landscaping	2 800	2 800
	Single family home decontamination, 0.2 home/acre	320	3 200
	<6 floor building decontamination, 0.1 building/acre	480	4 800
	>6 floor building decontamination, 0.1 building/acre	480	4 800
	Commercial and public building decontamination 0.4 building/acre	1 900	19 000
	TOTAL	50 280	93 200
75-750	Precleanup and final radiation surveys	1 200	1 200
	Manual removal of vegetation and 2 in. soil	1 200	1 200
	Firehose roofs and walls once	1 100	1 100
	Firehose building surface and ledges once	1 100	1 100
	Firehose streets, sidewalks, pavement once	1 100	1 100
	Preparation of remote disposal site	500	500
	Transport waste 50 mi (nonretrievable)	1 500	2 240
	Restore and replant landscaping	2 800	2 800
	Single family home decontamination	160	1 600
	<6 Floor building decontamination	240	2 400
	>6 Floor building decontamination	240	2 400
	Commercial and public decontamination	960	9 600
	TOTAL	12 100	27 240
7.5-75	Precleanup and final radiation surveys	1 200	1 200
	Firehose roofs and walls once	1 100	1 100
	Firehose streets, sidewalks, pavement once	1 100	1 100
	Firehose ledges and surfaces of buildings	1 100	1 100
	Irrigation and heavily water vegetation and soil	1 100	1 100
	TOTAL	5 600	5 600
0.2-7.5	Radiation survey only	480	480

TABLE A-VIII

DECONTAMINATION METHODS AND COSTS (1981 DOLLARS) FOR COMMERCIAL AREAS USING THE PROPOSED EPA CRITERIA AS DECONTAMINATION LIMIT

Initial Conditions ($\mu Ci/m^2$)	Decontamination Methods and Description	Cost/Acre Low	Cost/Acre High
>750	Same as Healy Limits	50 280	93 200
	Add: Firehose roofs and wall twice - collect water	2 400	2 400
	Firehose streets, sidewalks, pavement twice	2 400	2 400
	Firehose building, ledges, and surface twice	2 400	2 400
	Treat decontaminated water as LLLW	6 700	6 700
	Irrigate and hose down vegetation and soil	1 200	1 200
		65 380	108 300
75-750	Same as Healy Limits	12 100	27 240
	Add: Firehose roofs and walls once	1 100	1 100
	Firehose streets, sidewalks, pavement once	1 100	1 100
	Firehose ledges and surface buildings once	1 100	1 100
	Irrigate and hose down vegetation and soil	1 100	1 100
		16 500	31 640
7.5-75	Same as Healy Limits	5 600	5 600
	Add: Irrigate and hose down vegetation and soil	1 100	1 100
		6 700	6 700
0.2-7.5	Precleanup and final radiation survey	1 200	1 200
	Irrigate and hose down vegetation and soil	1 100	1 100
	Hose down building surface	1 100	1 100
		3 400	3 400

TABLE A-IX

PANTEX POPULATION (1990) ESTIMATES FOR 120-kg-PLUTONIUM RELEASE ACCIDENT I DIFOUT ISOPLETHS

Annulus Distance (km)	Population Average in Two annuli	Isopleth 1	Isopleth 2	Isopleth 3	Isopleth 4
Median Case					
4	0	0	0	0	0
8	6	1	3	1	1
16	25	6	13	4	4
25	51		17	5	5
32	47		12	6	6
50	9 514		95	3 171	1 586
64	2 208			736	736
80	1 327			332	221
Σ	13 178	7	140	4 255	2 559
Unfavorable Case					
4	0	0	0	0	0
8	9	2	3	2	2
16	3 050	153	1 017	508	508
25	16 794		5 598	4 199	2 099
32	41 851		10 463	10 463	5 231
50	26 937		3 367	12 312	3 367
64	3 967			992	496
80	1 269			254	159
Σ	93 877	155	20 448	28 730	11 862

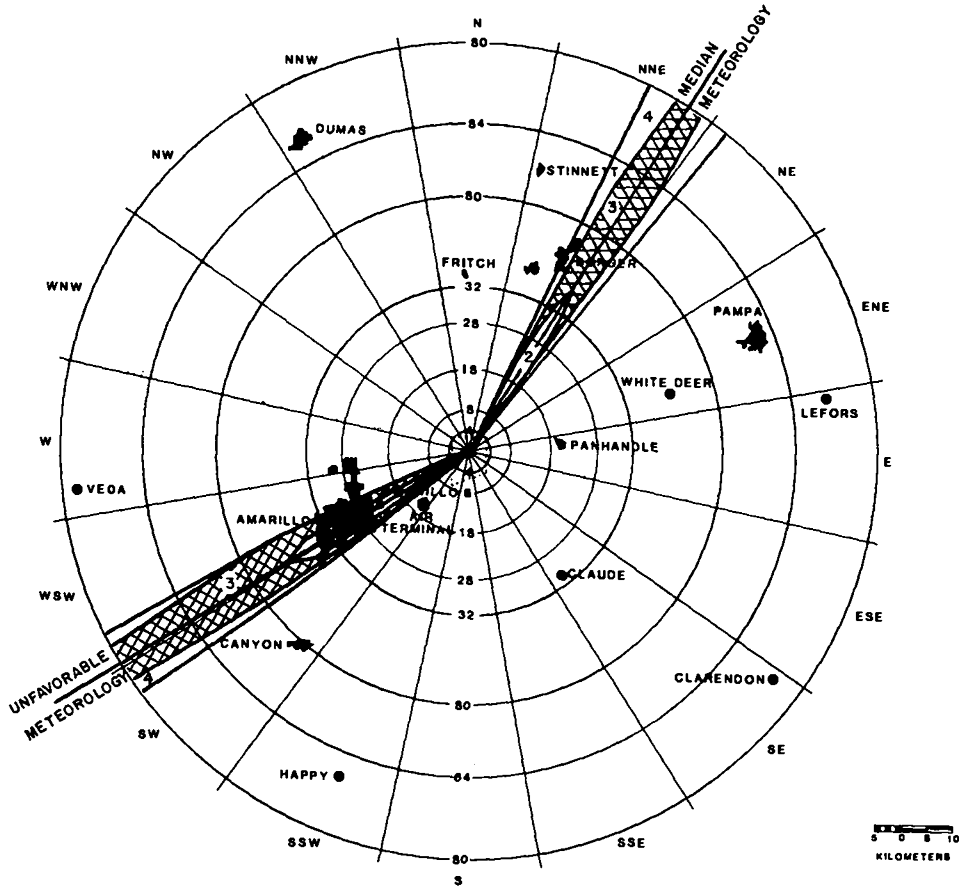

Fig. A-1. Pantex 120-kg-Pu postulated release I, 80-km map.

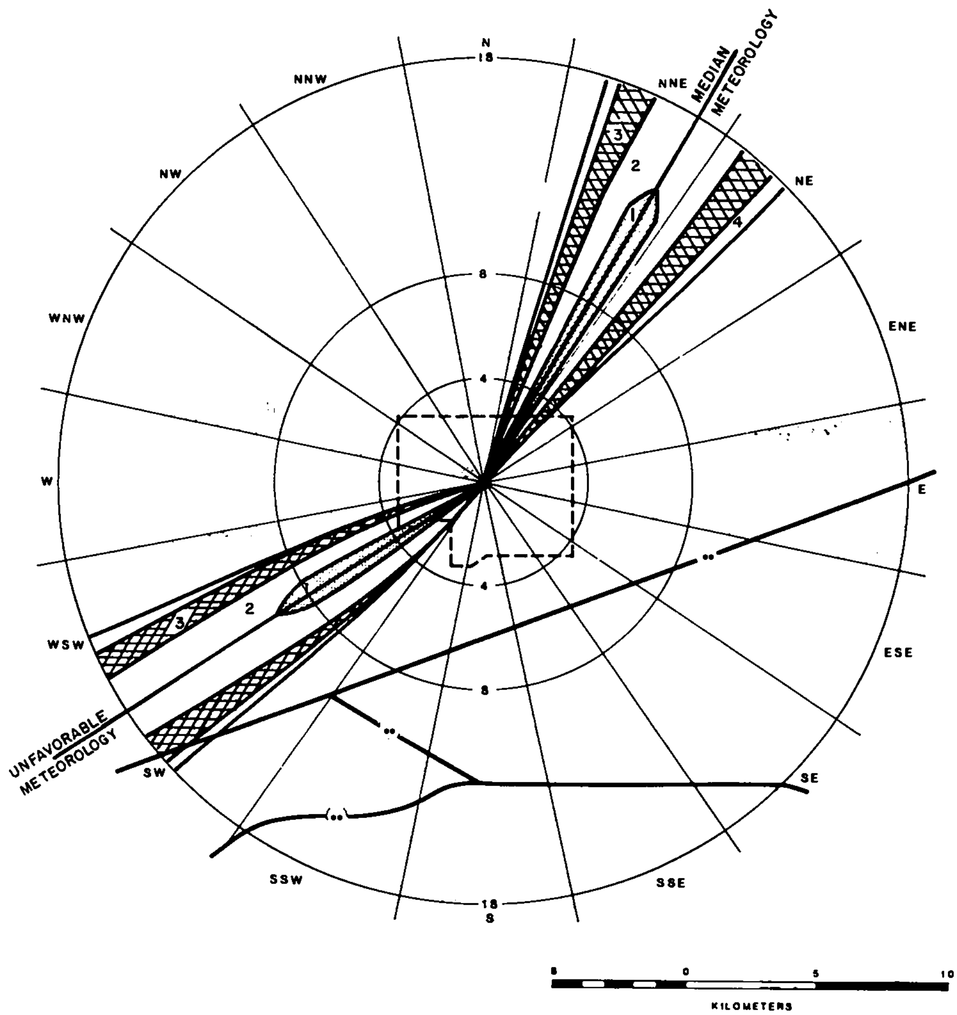

Fig. A-2. Pantex 120-kg-Pu postulated release I, 16-km map.

TABLE A-X

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 120-kg-PLUTONIUM ACCIDENT I FOR MEDIAN METEOROLOGY AT PANTEX PLANT
(6.8 m/s, SSW wind, D stability, 344-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural				
1	1 144	786	55	56
1	1 144	400	6.1	6.5
2	18 654	40	13	110
3	>89 609	4	43	280
4	>87 561	0.4	42	270
			Σ 160	720
Suburban				
1	9	786	0.69	0.77
1	9	400	0.20	0.23
2	141	40	0.63	0.80
3	679	4	0.33	2.2
4	3 456	0.4	1.7	11
			Σ 3.6	15
Commercial				
1	3	786	0.28	0.32
1	3	400	0.082	0.095
2	47	40	0.26	0.31
3	226	4	0.11	0.77
4	1 152	0.4	0.59	3.9
			Σ 1.3	5.4
			ΣΣ 170	740

TABLE A-XI

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 120-kg-PLUTONIUM ACCIDENT I FOR UNFAVORABLE METEOROLOGY AT PANTEX PLANT (4.3 m/s, NE wind, E stability, 344-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural				
1	403	1101	20	20
1	403	400	2.5	2.6
2	15 409	40	11	83
3	>90 707	4	44	280
4	>93 488	0.4	45	290
			Σ 120	680
Suburban				
1	21	1101	1.6	1.8
1	21	400	0.47	0.54
2	7 587	40	34	43
3	18 142	4	8.7	57
4	18 698	0.4	9	59
			Σ 54	160
Commercial				
1	5	1101	0.19	0.54
1	5	400	0.14	0.16
2	1 897	40	11	13
3	4 536	4	2.2	15
4	4 675	0.4	2.2	16
			Σ 16	45
			ΣΣ 190	890

TABLE A-XII

PANTEX POPULATION (1990) ESTIMATES FOR 30-kg-PLUTONIUM RELEASE ACCIDENT H DIFOUT ISOPLETHS

Annulus Distance (km)	Population Average in Two Annuli	Isopleth 1	Isopleth 2	Isopleth 3	Isopleth 4
Median Case					
4	0	0	0	0	0
8	6		4	1	1
16	25		9	8	4
25	51		9	17	10
32	47			16	12
50	9 514			2 379	3 140
64	2 208			375	729
80	1 327			62	438
Σ	13 178	0	22	2 858	4 334
Unfavorable Case					
4	0	0	0	0	0
8	9	1	3	5	2
16	3 050		1 007	1 525	519
25	16 794		4 199	8 397	3 359
32	41 851		5 859	2 511	8 370
50	26 937			16 162	5 387
64	3 967			1 190	1 190
80	1 269			317	508
Σ	93 877	1	11 068	30 107	19 335

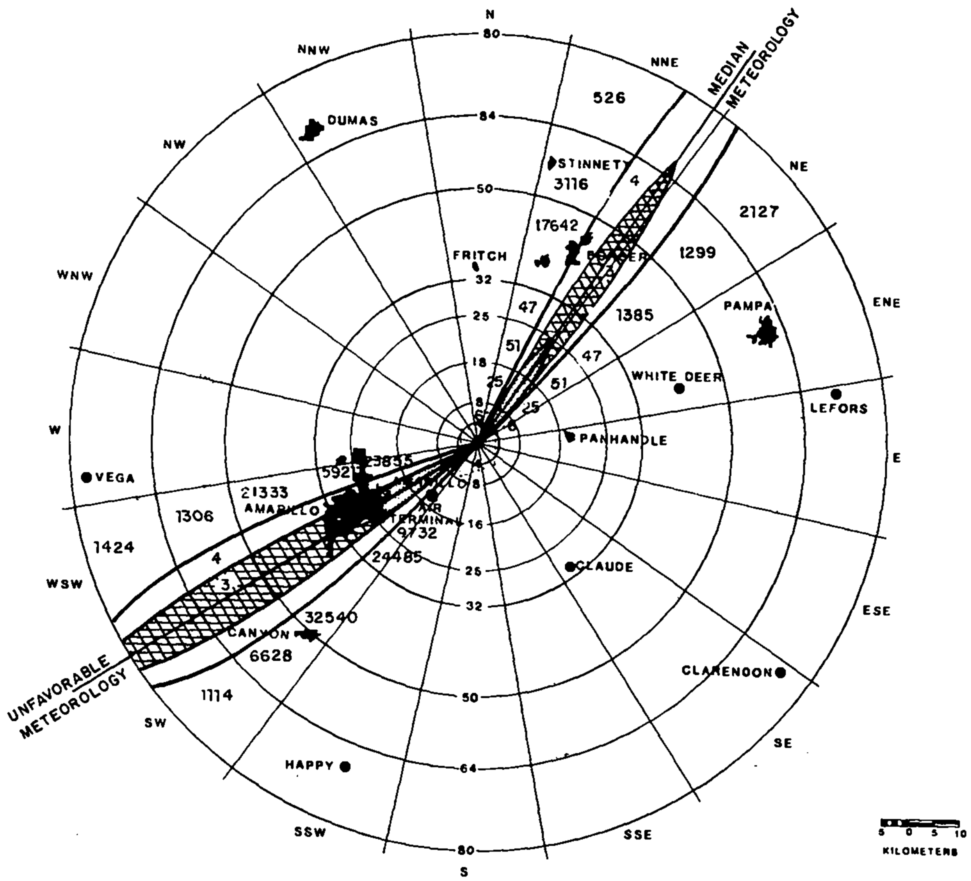

Fig. A-3. Pantex 30-kg-Pu postulated release H, 80-km map.

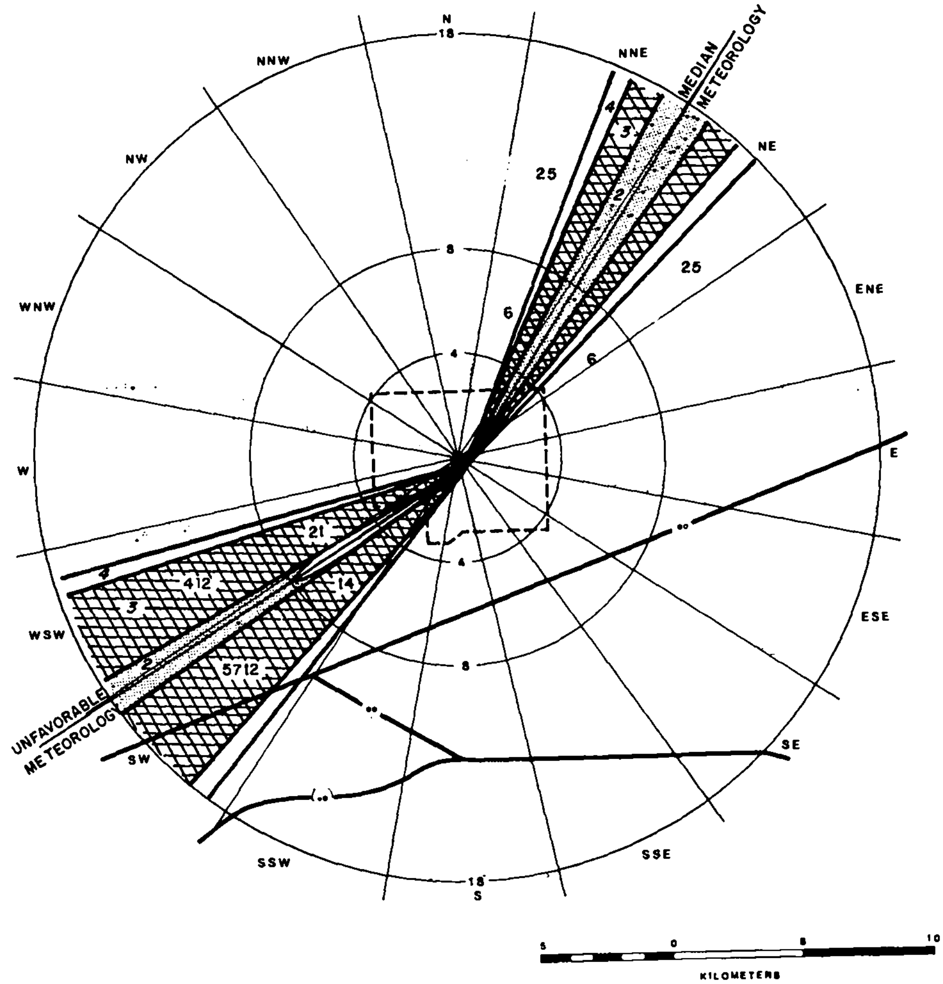

Fig. A-4. Pantex 30-kg-Pu postulated release H, 16-km map.

TABLE A-XIII

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 30-kg-PLUTONIUM ACCIDENT H FOR MEDIAN METEOROLOGY AT PANTEX PLANT
(6.8 m/s, SSW wind, D stability, 508-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)		Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural					
1	9	150		0.048	0.051
1	9	400		0.048	0.051
2	6 246	40		4.5	34
3	45 257	4		22	140
4	>103 758	0.4		50	319
			Σ	77	490
Suburban					
1	0	150			
1	0	400			
2	47	40		0.21	0.27
3	343	4		0.16	1.1
4	4 096	0.4		2	13
			Σ	2.4	14
Commercial					
1	0	150			
1	0	400			
2	16	40		0.9	0.11
3	114	4		0.055	0.39
4	1 365	0.4		0.66	4.6
			Σ	1.6	5.1
			ΣΣ	81	510

TABLE A-XIV

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 30-kg-PLUTONIUM ACCIDENT H FOR UNFAVORABLE METEOROLOGY AT PANTEX PLANT
(4.3 m/s, NE wind, E stability, 508-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural				
1	35	166	0.2	0.2
1	35	400	0.2	0.2
2	2 892	40	2.1	16
3	46 257	4	22	142
4	>105 183	0.4	50	323
			Σ 75	480
Suburban				
1	2	166	0.044	0.051
1	2	400	0.044	0.051
2	1 069	40	4.8	6.1
3	6 938	4	3.3	22
4	15 778	0.4	7.6	50
			Σ 16	78
Commercial				
1	0	166		
1	0	400		
2	356	40	2.0	2.4
3	2 313	4	1.1	7.9
4	5 259	0.4	2.5	18
			Σ 5.6	28
			ΣΣ 97	590

TABLE A-XV

PANTEX POPULATION (1990) ESTIMATES FOR 0.625-kg-PLUTONIUM RELEASE ACCIDENT K DIFOUT ISOPLETHS

Annulus Distance (km)		Population Average in Two Annuli	Isopleth 1	Isopleth 2	Isopleth 3	Isopleth 4
Median Case						
4		0	0	0	0	0
8		6			2	1
16		25			3	6
25		51				5
	Σ	82	0	0	5	12
Unfavorable Case						
4		0	0	0	0	0
8		9			1	1
16		3 050			153	610
25		16 794				3 359
	Σ	19 853	0	0	154	3 970

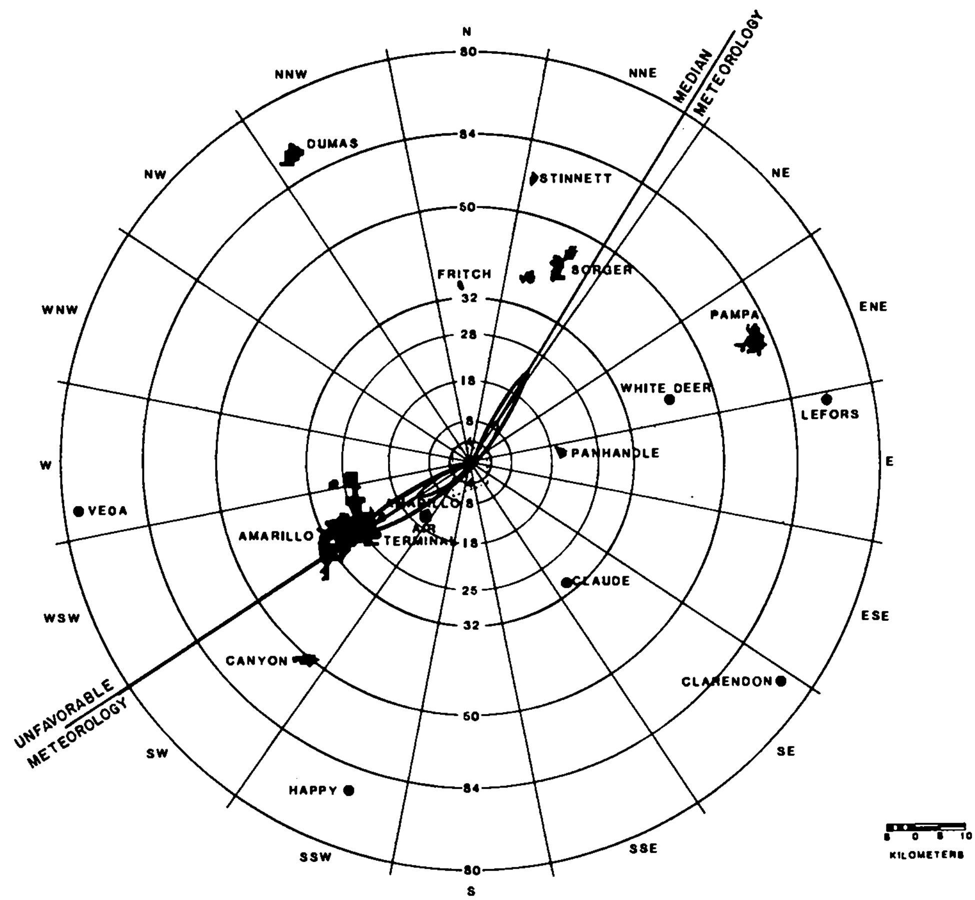

Fig. A-5. Pantex 0.625-kg-Pu postulated release K, 80-km map.

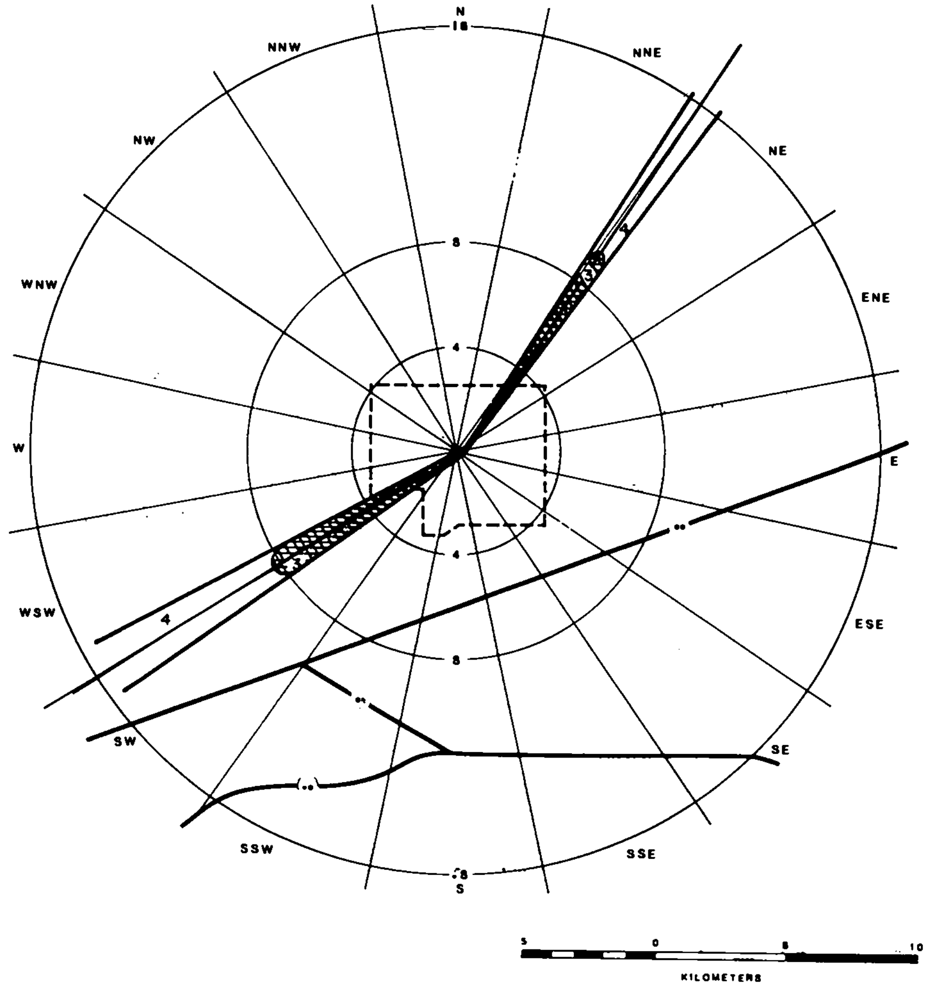

Fig. A-6. Pantex 0.625-kg-Pu postulated release K, 16-km map.

TABLE A-XVI

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 0.625-kg-PLUTONIUM ACCIDENT K FOR MEDIAN METEOROLOGY AT PANTEX PLANT (6.8 m/s, SSW wind, D stability, 135-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)		Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural					
1	0	400			
2	99	40		0.071	0.54
3	913	4		0.44	2.8
4	4 913	0.4		2.4	15
			Σ	2.9	18
Suburban					
1	0	400			
2	1	40		0.0045	0.0057
3	9	4		0.0043	0.028
4	49	0.4		0.024	0.15
			Σ	0.033	0.18
Commercial					
1	0	400			
2	0	40			
3	2	4		0.00096	0.0068
4	12	0.4		0.0058	0.041
			Σ	0.0068	0.048
			ΣΣ	2.9	18

TABLE A-XVII

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 0.625-kg-PLUTONIUM ACCIDENT K FOR UNFAVORABLE METEOROLOGY AT PANTEX PLANT (4.3 m/s, NE wind, E stability, 135-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural				
1	0	400		
2	0	40		
3	678	4	0.33	2.1
4	4 088	0.4	2	13
			Σ 2.3	15
Suburban				
1	0	400		
2	0	40		
3	27	4	0.013	0.085
4	1 510	0.4	0.72	4.8
			Σ 0.73	4.9
Commercial				
1	0	400		
2	0	40		
3	9	4	0.0043	0.031
4	503	0.4	0.24	1.7
			Σ 0.24	1.7
			ΣΣ 3.3	22

TABLE A-XVIII

IAAP POPULATION (1990) ESTIMATES FOR 120-kg-PLUTONIUM RELEASE ACCIDENT H DIFOUT ISOPLETHS

Annulus Distance (km)	Population Average in Two Annuli	Isopleth 1	Isopleth 2	Isopleth 3	Isopleth 4
Median Case					
4	12	4	3	2	2
8	614	154	123	123	102
16	618	88	155	124	103
25	1 356		339	271	194
32	295		74	74	49
50	1 816		227	605	303
64	2 539			635	508
80	12 062			2 412	3 016
Σ	19 312	246	921	4 246	4 277
Unfavorable Case					
4	0	0	0	0	0
8	1 530	383	765	306	255
16	28 720		7 180	5 744	4 787
25	494		99	99	71
32	302		15	101	50
50	3 758			940	626
64	1 626			325	325
80	10 271			1 712	2 054
Σ	46 701	383	8 059	9 227	8 168

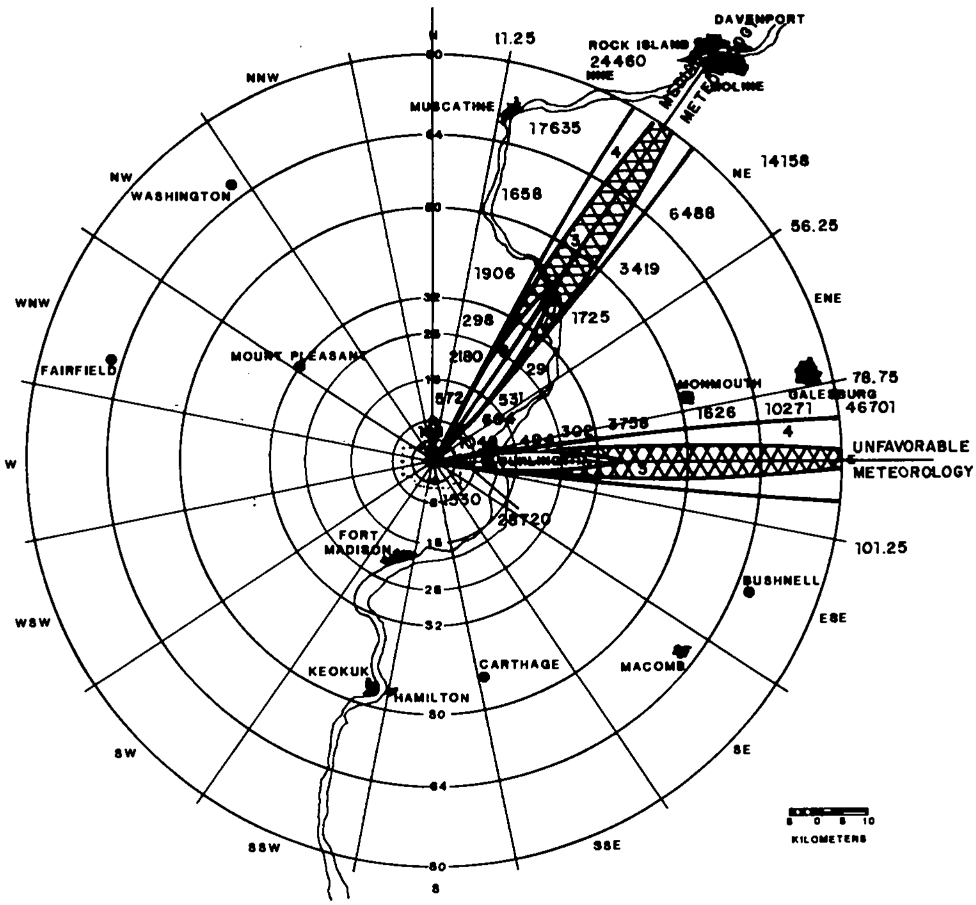

Fig. A-7. IAAP 120-kg-Pu postulated release R, 80-km map.

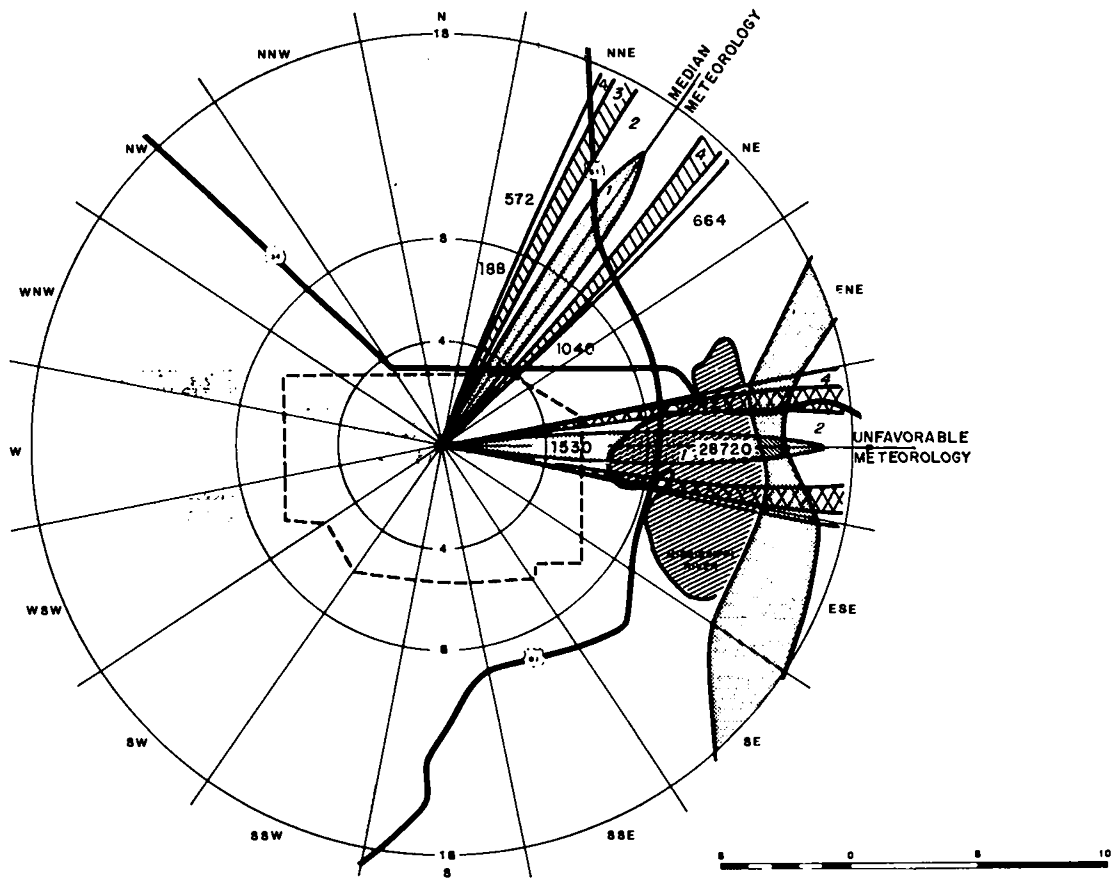

Fig. A-8. IAAP 120-kg-Pu postulated release R, 16-km map.

TABLE A-XIX

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 120-kg-PLUTONIUM ACCIDENT H FOR MEDIAN METEOROLOGY AT IAAP
(4.3 m/s, SSW wind, D stability, 344-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)		Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural					
1	1 167	1 739		57	58
1	1 167	400		6.7	7.1
2	19 592	40		14	107
3	>83 384	4		40	256
4	>88 530	0.4		42	272
			Σ	160	700
Suburban					
1	46	1 739		3.5	4
1	46	400		1	1.2
2	773	40		3.5	4.4
3	3 272	4		1.6	10
4	3 495	0.4		1.7	11
				11	31
Commercial					
1	15	1 739		1.4	1.6
2	15	400		0.41	0.47
3	258	40		1.4	1.7
4	1 097	4		0.53	3.7
	1 165	0.4		0.56	4
			Σ	4.3	11
			ΣΣ	180	740

TABLE A-XX

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 120-kg-PLUTONIUM ACCIDENT H FOR UNFAVORABLE METEOROLOGY AT IAAP
(2.5 m/s, W wind, D stability, 344-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)		Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural					
1	485	4 197		25	25
1	485	400		3.4	3.5
2	11 899	40		8.6	97
3	>39 104	4		19	120
4	>24 846	0.4		12	76
			Σ	68	320
Suburban					
1	738	4 197		57	63
1	738	400		16	19
2	2 975	40		13	17
3	3 259	4		1.6	10
4	2 071	0.4		0.99	6.5
				89	120
Commercial					
1	246	4 197		23	27
1	246	400		6.7	7.8
2	992	40		5.6	6.6
3	1 086	4		0.52	3.7
4	690	0.4		0.33	2.3
			Σ	36	47
			ΣΣ	190	490

TABLE A-XXI

IAAP POPULATION (1990) ESTIMATES FOR 30-kg-PLUTONIUM RELEASE ACCIDENT Q DIFOUT ISOPLETHS

Annulus Distance (km)	Population Average in Two Annuli	Isopleth 1	Isopleth 2	Isopleth 3	Isopleth 4
Median Case					
4	12	3	2	2	2
8	614	31	102	88	77
16	618		103	88	77
25	1 356		226	194	170
32	295		49	42	49
50	1 816			259	303
64	2 539			254	508
80	12 062				2 412
Σ	19 312	34	482	927	3 598
Unfavorable Case					
4	0	0	0	0	0
8	1 530	153	306	255	191
16	28 720		5 744	5 744	3 590
25	494		124	99	62
32	302		76	60	38
50	3 758			940	626
64	1 626			163	542
80	10 271				2 324
Σ	46 701	153	6 250	7 261	7 373

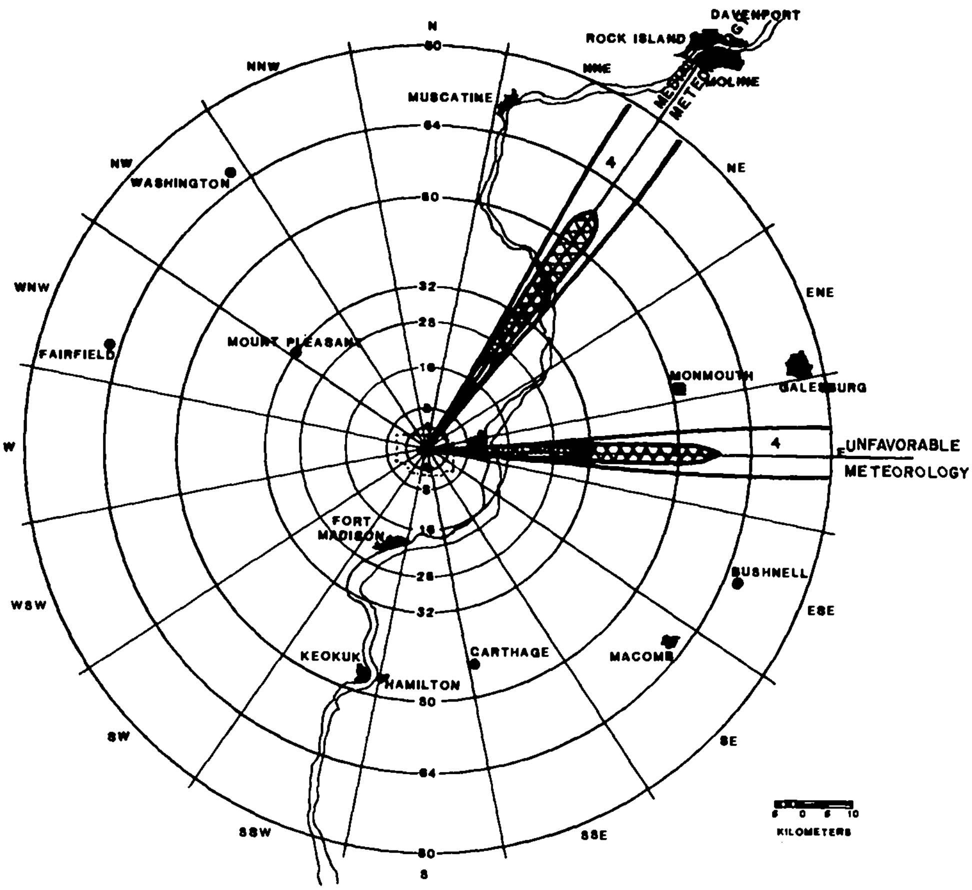

Fig. A-9. IAAP 30-kg-Pu postulated release Q, 80-km map.

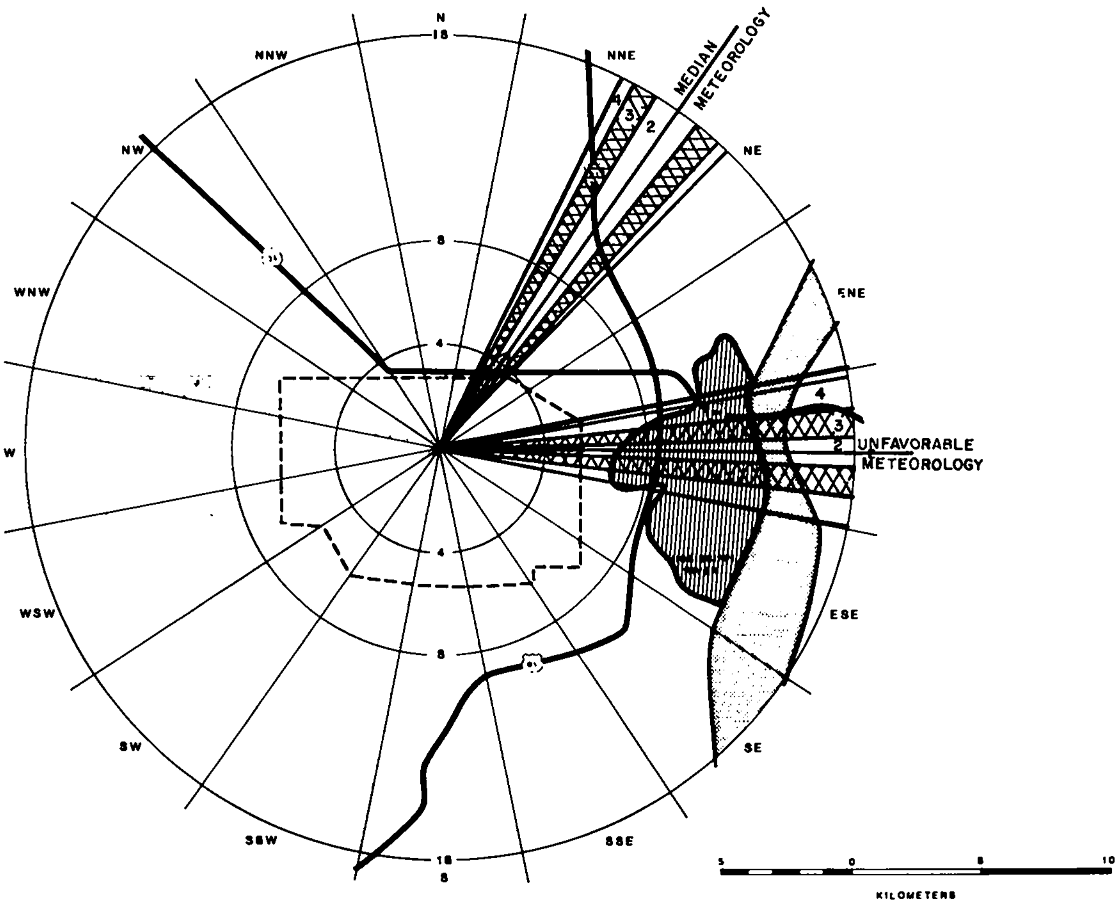

Fig. A-10. IAAP 30-kg-Pu postulated release Q, 16-km map.

TABLE A-XXII

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 30-kg-PLUTONIUM ACCIDENT Q FOR MEDIAN METEOROLOGY AT IAAP
(4.3 m/s, SSW wind, D stability, 508-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural				
1	75	232	0.47	0.49
1	75	400	0.47	0.49
2	6 545	40	4.7	36
3	34 782	4	17	110
4	36 849	0.4	18	110
			Σ 41	260
Suburban				
1	3	232	0.067	0.077
1	3	400	0.067	0.077
2	258	40	1.2	1.5
3	1 373	4	0.66	4.3
4	1 454	0.4	0.7	4.6
			Σ 2.7	11
Commercial				
1	1	232	0.027	0.032
1	1	400	0.027	0.032
2	86	40	0.48	0.58
3	458	4	0.22	1.6
4	485	0.4	0.23	1.6
			Σ 0.98	3.8
			ΣΣ 45	270

TABLE A-XXIII

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 30-kg-PLUTONIUM ACCIDENT Q FOR UNFAVORABLE METEOROLOGY AT IAAP (2.5 m/s, SSW wind, D stability, 508-m cloud)

Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)		Healy Limits (Cost x 10^6) Decontamination	EPA Limits (Cost x 10^6) Decontamination
Agricultural					
1	143	682		0.77	0.81
1	143	400		0.77	0.81
2	5 375	40		3.9	29
3	30 043	4		14	92
4	34 716	0.4		17	110
			Σ	36	230
Suburban					
1	6	682		0.13	0.15
1	6	400		0.13	0.15
2	1 344	40		6	7.7
3	2 503	4		1.2	7.9
4	2 893	0.4		1.4	9.1
			Σ	8.9	25
Commercial					
1	2	682		0.054	0.063
1	2	400		0.054	0.063
2	448	40		2.5	3.0
3	835	4		0.4	2.8
4	964	0.4		0.46	3.3
			Σ	3.5	9.2
			ΣΣ	48	260

TABLE A-XXIV

IAAP POPULATION (1990) ESTIMATES FOR 0.625-kg-PLUTONIUM RELEASE ACCIDENT S

Annulus Distance	Population Average of Two Annuli	Isopleth 2	Isopleth 3
Median Case			
4	12	4	2
8	614	154	102
16	618	31	103
25	1 356		68
32	295		
50	1 816		
Σ	4 711	189	275
Unfavorable Case			
4	0	0	0
8	1 530	383	255
16	28 720	1 436	5 744
25	494		49
32	302		
50	3 758		
Σ	34 804	1 819	6 048

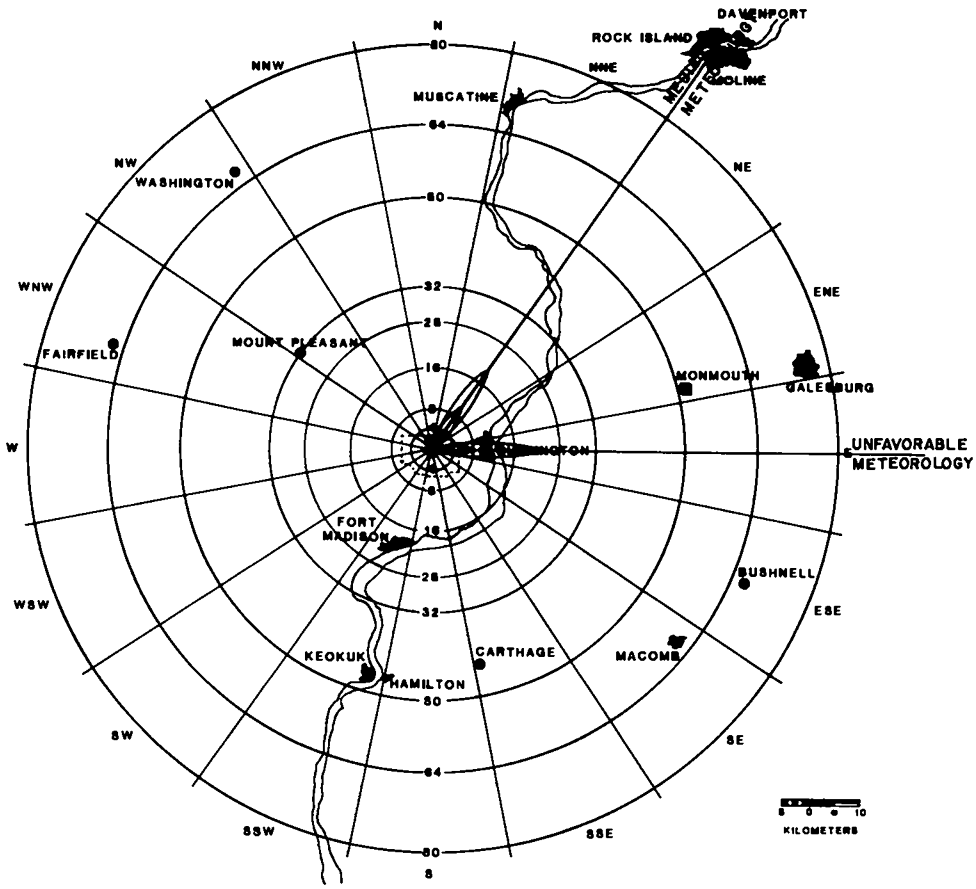

Fig. A-11. IAAP 0.625-kg-Pu postulated release S, 80-km map.

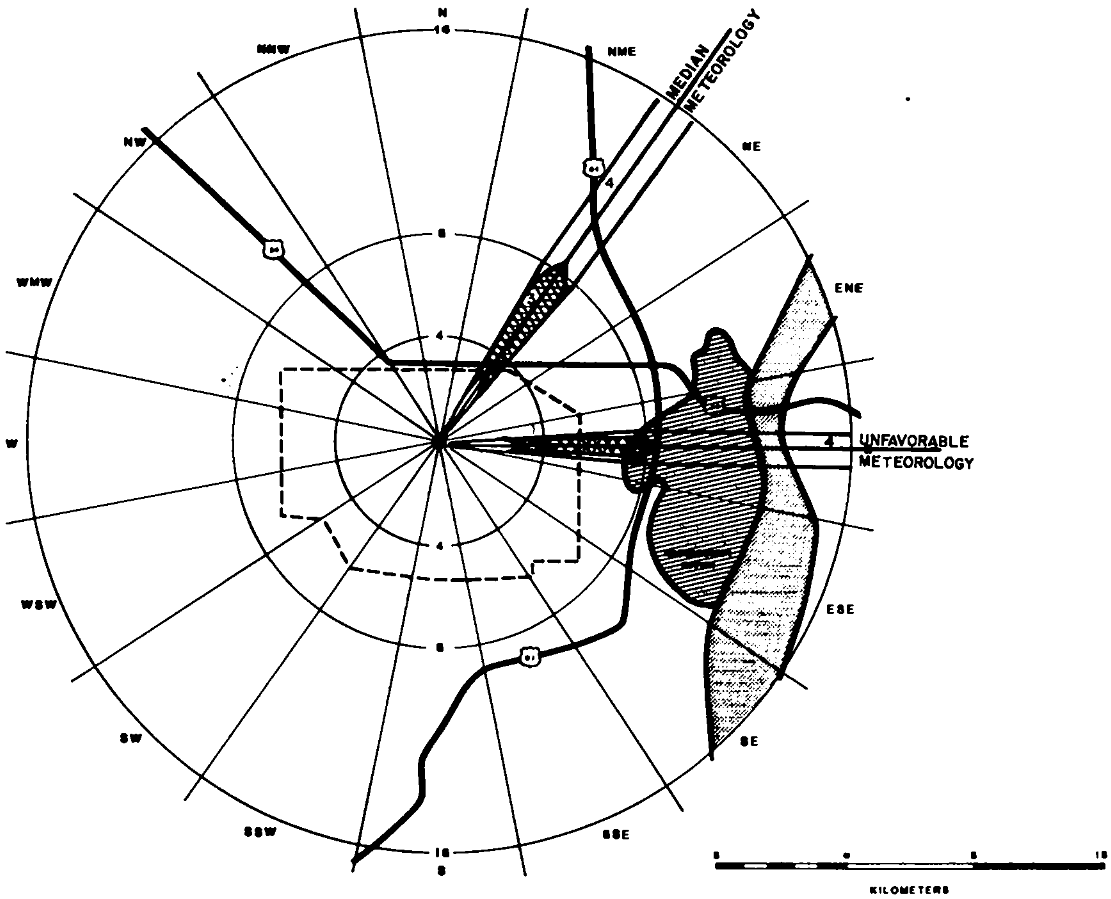

Fig. A-12. IAAP 0.625-kg-Pu postulated release S, 16-km map.

TABLE A-XXV

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 0.625-kg-PLUTONIUM ACCIDENT S FOR MEDIAN AND UNFAVORABLE METEOROLOGICAL CASES AT IAAP

Isopleth Number	Median Meteorology Case (4.3 m/s, SSW Wind, D Stability, 135-m cloud): Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limit Cost x 10^6	EPA Limit Cost x 10^6	Unfavorable Meteorology Case (2.5 m/s, W Wind, D Stability, 135-m cloud): Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limit Cost x 10^6	EPA Limit Cost x 10^6
Agricultural								
1	0.03	400	0.00016	0.00017	0	400	0	0
2	99	40	0.071	0.54	45	40	0.032	0.24
3	798	4	0.38	2.4	547	4	0.26	1.7
4	4 299	0.4	2.1	13	2 351	0.4	1.1	7.2
		Σ	2.6	16			1.4	9.1
Suburban								
1	0	400	0	0	0	400	0	0
2	4	40	0.018	0.023	2	40	0.009	0.011
3	31	4	0.015	0.098	103	4	0.049	0.33
4	169	0.4	0.081	0.53	881	0.4	0.42	2.8
		Σ	0.11	0.65			0.48	3.1
Commercial								
1	0	400	0	0	0	400	0	0
2	1	40	0.0056	0.0067	0	40	0	0
3	11	4	0.0053	0.037	34	4	0.016	0.12
4	57	0.4	0.027	0.19	294	0.4	0.14	1
		Σ	0.038	0.23			0.16	1.1
		ΣΣ	2.7	17		ΣΣ	2.0	13

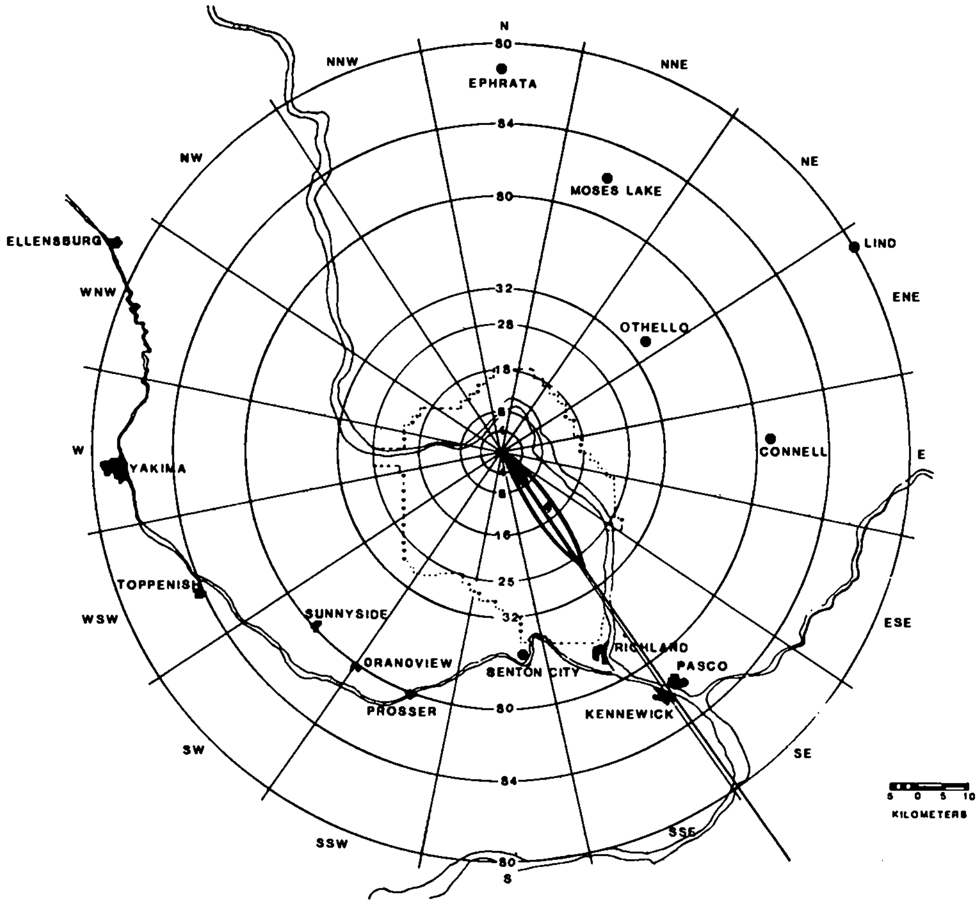

Fig. A-13. Hanford 0.625-kg-Pu postulated release T, unfavorable meteorology, 80-km map.

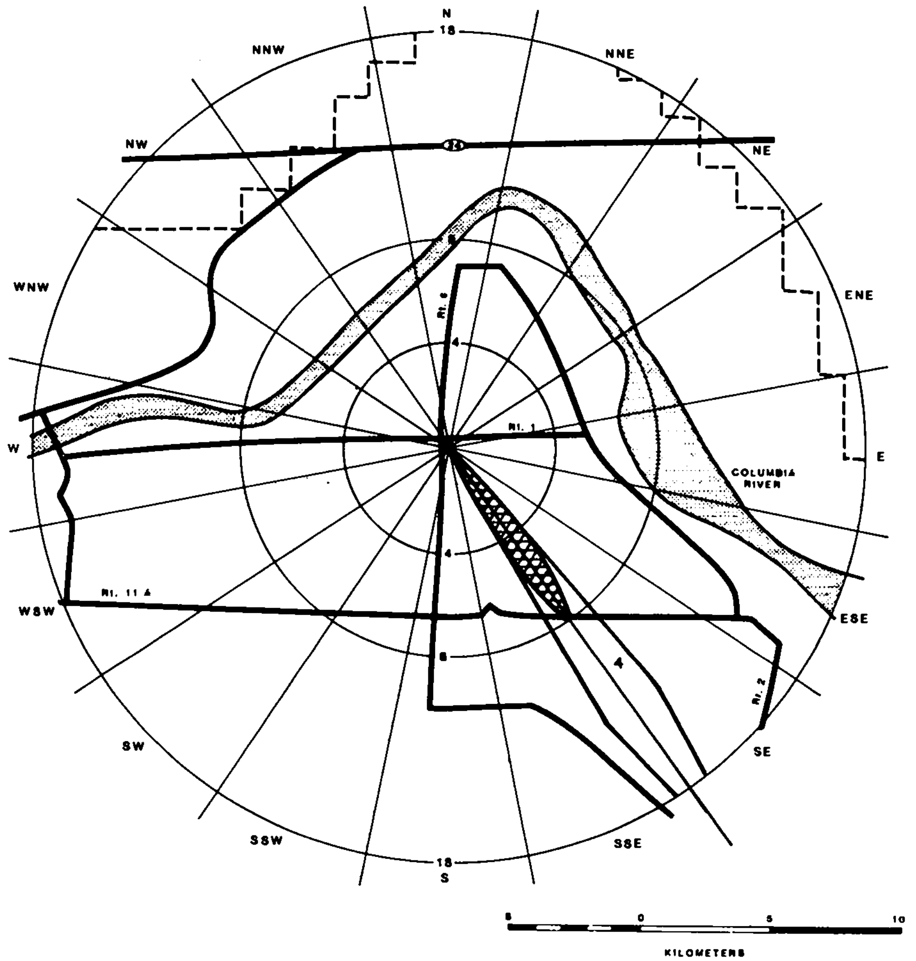

Fig. A-14. Hanford 0.625-kg-Pu postulated release T, unfavorable meteorology, 16-km map.

TABLE A-XXVI

DECONTAMINATION COST (MILLIONS OF 1981 DOLLARS) ESTIMATES FOR THE 0.625-kg-PLUTONIUM ACCIDENT T FOR MEDIAN AND UNFAVORABLE CASES AT HANFORD SITE

	Median Meteorology Case (5.4 m/s, NW Wind, E Stability, 135-m cloud)				Unfavorable Meteorology Case (0.6 m/s, NW Wind, E Stability, 135-m cloud)			
Isopleth Number	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limit Cost x 10^6	EPA Limit Cost x 10^6	Acres	Average Contamination Level ($\mu Ci/m^2$)	Healy Limit Cost x 10^6	EPA Limit Cost x 10^6
Agricultural								
1	5.6	400	0.03	0.032	12	400	0.064	0.068
2	90	40	0.065	0.49	45	40	0.032	0.24
3	735	4	0.35	2.3	510	4	0.24	1.6
4	5 866	0.4	2.8	18	2 660	0.4	1.3	8.2
			Σ 3.2	21			Σ 1.6	10
Residential								
1	0	400			0	400		
2	0	40			0	40		
3	0	4			0	4		
4	0	0.4			0	0.4		
Commercial								
1	0	400			0	400		
2	0	40			0	40		
3	0	4			0	4		
4	0	0.4			0	0.4		
			ΣΣ 3.2	21			ΣΣ 1.6	10

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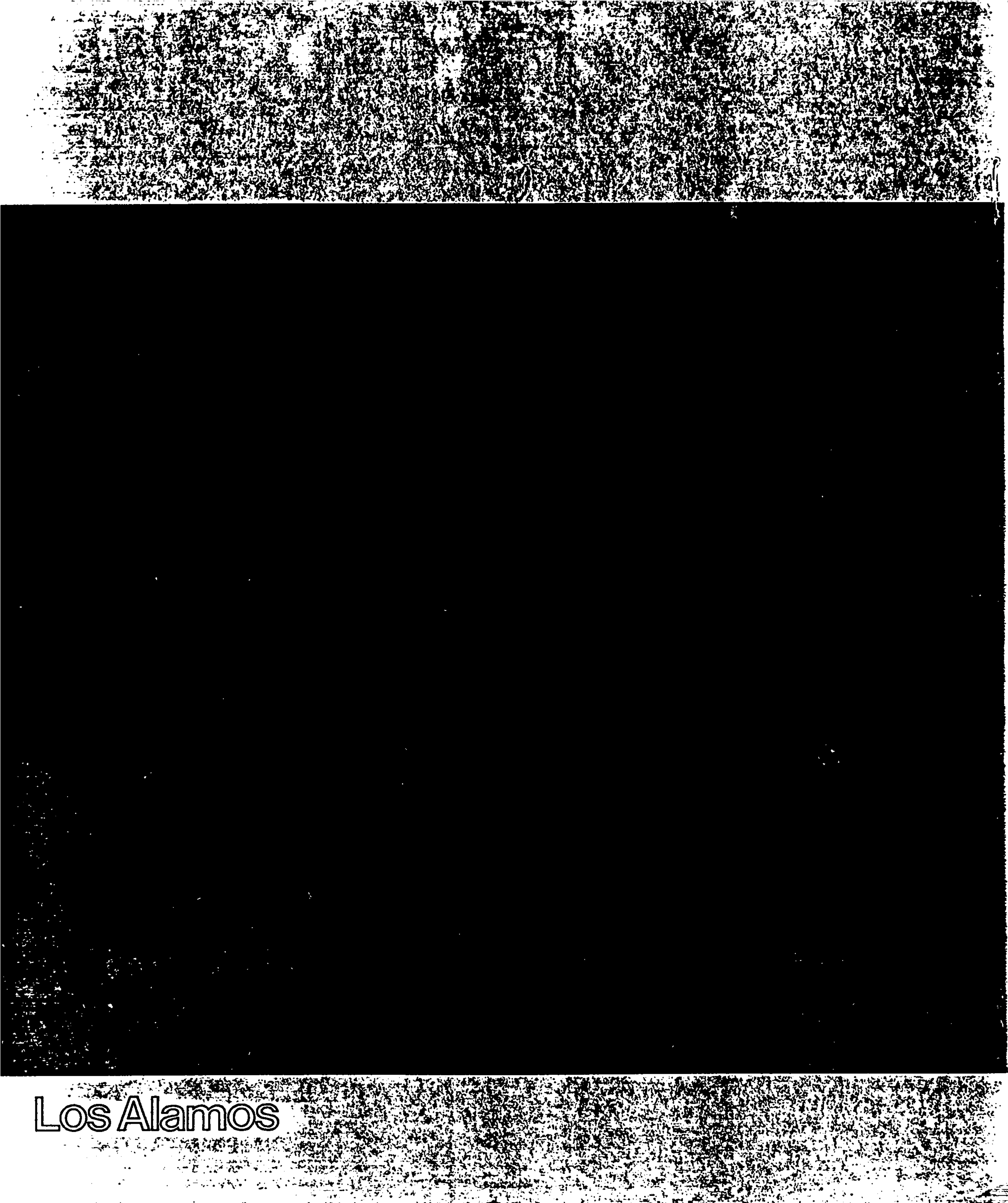

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