Table 4.5. DECON Variables in CCDF.DAT

Item	Description	Applies to
1	Cleanup Level	DZ
2	Decontamination Costs	DZ, RP, BO, UD
3	Total Surface Area Decontaminated	DZ, RP, BO
4	Surface Area Requiring No Decontamination	SA, RP
5	Surface Area Not Able to Decontaminate	DZ, RP
6	Real Property Value Pre-Accident	SA, RP, UD
7	Net Present Value of Real Property	SA, RP, FD, NPV
8	Value of All Property, Pre-Accident	SA, AP, UD
9	Potential Savings from Property Buy-Out Compensation at Pre-Accident Values	DZ, RP, BO, NPV
10	Potential Savings from Property Buy-Out Compensation at Net Present Value	DZ, RP, BO, NPV
11	Net Present Value of Real Property	SA, RP, BO, NPV
12	Dose to Radworkers	DZ, BO
13	Dose to Population Not Relocated	DZ, BO
14	Size of Resident Population	SA
15	Total Surveying and Monitoring Costs	SA, RP, BO, NPV
16	Volume of Radiological Waste	DZ, BO
17	Size of Area	SA
18	Decontamination Costs, Automobiles	DZ, PP, BO, UD
19	Autos Requiring No Decontamination	SA, PP
20	Autos Unable to Decontaminate	DZ, PP
21	Building Contents Requiring No Decon	SA, PP
22	Building Contents Unable to Decontaminate	DZ, PP
23	Decontamination Costs, Building Contents	DZ, PP, BO, UD
24	Number Decontaminated, Building Contents	DZ, PP, BO, UD
25	Number Decontaminated, Automobiles	DZ, PP, BO
26	Latent Cancer Fatalities	SA, FD
27	Size of Resident Population	DZ
28	Size of Area	DZ
29	Real Property Value Pre-Accident	DZ, RP, UD
30	Real Property Value Post-Decontamination	DZ, RP, UD
31	Latent Cancer Fatalities	DZ, FD
32	Net Present Value of All Property	SA, AP, BO, NPV
33	Value of All Property, Pre-Accident	DZ, AP, UD
34	Fractional Loss in All Property Value	SA, AP, BO, NPV
35	Net Present Value Losses	SA, AP, FD, NPV
36	Costs for Burial of Radwaste	DZ, BO, UD
37	Net Present Value of Personal Property	SA, PP, BO, NPV
38	(not used)	
39	Net Present Value of All Property	SA, AP, FD, NPV
40	Net Present Value Losses, All Property	SA, AP, BO, NPV
41	Undiscounted Decontamination Costs	DZ, AP, FD, UD
42	Discounted Decontamination Costs	DZ, AP, FD, NPV
43	Undiscounted Decontamination Costs	DZ, AP, BO, UD
44	Discounted Decontamination Costs	DZ, AP, BO, NPV
45	Deterioration Losses, Real Property	DZ, RP, BO, NPV
46	Losses from Deferred Use, Real Property	DZ, RP, BO, NPV
47	Residual Contamination Losses Real Prop.	DZ, RP, BO, NPV
48	Surveying and Monitoring Costs	SA, RP, BO, NPV
49	Losses from Deferred Use, Personal Prop.	DZ, PP, BO, NPV
50	Value of Per. Prop. that Cannot Be Decon'd	DZ, PP, BO, NPV
51	Value of Real Prop. that Cannot Be Decon'd	DZ, RP, BO, NPV
52	Average Decon Cost per Bldg Content Unit	DZ, PP, FD, UD

Table 4.5. DECON Variables in CCDF.DAT (Continued)

Item	Description	Applies to
53	Average Decon Cost per Automobile	DZ, PP, FD, UD
54	Average Decon Cost per Square Meter	DZ, RP, FD, UD
55	(not used)	
56	(not used)	

NOTE: In the last column, several codes are used to further describe each variable. They have the following meanings:

- *DZ* means that the variable applies to the *decontamination zone.*
- *SA* means that it applies to the *stud area.*
- *RP* refers to *real propert* .
- *PP* refers to *personal propert* .
- *AP* refers to *all propert* , both real and personal.
- *FD* means that *full decontamination* occurs, irrespective of cost-effectiveness considerations.
- *BO* means that property is *bought out* if restoration is not cost-effective.
- *UD* means that the costs are *undiscounted.*
- *NPV* denotes that the figure is a *net present value.*

5.0 A CASE STUDY: THE INDIAN POINT REACTOR SITE

In this chapter we demonstrate the capabilities of the Reference Database and of DECON by analyzing several severe accident scenarios at the Indian Point reactor site in New York State. Thirteen accident scenarios are evaluated for their economic consequences based on three accident severity levels and six meteorological conditions. Following a comparison of the major results from these 13 scenarios, we then show how DECON can be used to evaluate alternative site restoration strategies.

A major effort was conducted to obtain accurate data for the area affected by the simulated accidents. The largest accident considered extends across 16 counties lying in three states: New York, New Jersey and Connecticut. These data are described in the following section, and the results are discussed in Section 5.3.

The Indian Point site is located 40 kilometers north of New York City. Because it is near one of the most densely populated areas in the United States, the reader is cautioned that the estimated accident consequences are at the extreme high end of the consequence scale; therefore, they should not be construed as representative.

5.1 DESCRIPTION OF PROCEDURE

Before discussing the data, it is useful to provide an overview of the process that we will be conducting, since several steps are involved for each accident scenario. The first step is to run CRAC2 to generate for each scenario a file containing: 1) ground concentrations at specified intervals along the plume centerline; and 2) the plume dispersion factor at each interval.

In the second step the ground concentrations are converted into equivalent dose levels, using the program DOSES described in Section E.1 of Appendix E. For this case study, doses are measured as a 70-year whole body dose commitment beginning 14 days after the radiological release.

In Step 3 a map of the accident area is needed. Using the output from CRAC2 described above and output from the DOSES program, the GRID program described in Section E.2 of Appendix E, generates a set of points for each desired isopleth. The points are then plotted on the site map and isopleths are constructed from them.

In the case of an actual radiological accident, these first three steps are replaced by the process of obtaining radiation measurements directly from aerial and ground surveys. These measurements are then plotted on the site map and isopleths are constructed from them. In the case of an aerial survey, the results may include a map with the isopleths already produced.

In Step 4 we divide the accident site into grid elements. We also evaluate the advantages and disadvantages of the various grid arrangements discussed in Section 3.3.

In the fifth step, the data are collected and assembled for each grid element. These data include

- exposure levels
- population data
- land use data
- land areas
- occupied and vacant housing units
- property value data
- employment data

The exposure levels are already known, as the isopleths are used in defining the grid elements. The other data are collected from published sources as well as directly from personnel at state and local government agencies.

Step 6 involves organizing the data into a form that can be used by DECON. For this case study, IR-GRID, described in Section E.3 of Appendix E, is used to process the data.

IR-GRID is run in Step 7. Besides producing the site data file that is used by DECON, IR-GRID also produces estimates of 1) evacuation costs, 2) temporary relocation costs, and 3) permanent relocation costs.

In Step 8 DECON is run for each accident scenario. A summary analysis is produced for each of the 13 scenarios so that the major results from each scenario can be compared. Then we select one scenario for an in-depth analysis. For this scenario we make several runs to evaluate alternative site restoration strategies.

In the final step, the results of the analysis are reported.

5.2 PREPARATION OF THE DATA

The first six steps described above involve preparing the data. Details regarding each of these steps are described in this section.

5.2.1 Step 1: Running CRAC2

The 13 scenarios are defined with respect to one of three accident severity levels and one of six meteorological conditions. The accident severity levels are defined by the Siting Source Terms (SST) SST1, SST2, and SST3 described in Table 5.1.

The six meteorological conditions are defined by the Pasquill A through F weather stabilities; these are used with respective wind speeds of 3, 3.5, 4, 4, 3 and 1.5 m/sec. In each scenario, a constant wind speed and direction are assumed for the duration of the release.

Thirteen CRAC2 runs--one for each scenario--provided two sets of files, one used by the program DOSES, and the other used by the program GRID. The data include 1) a set of dose conversion factors, 2) isotope decay rates, and 3) ground concentrations and dispersion factors (σ_y's) for the following downwind distances: 0.402, 0.805, 1.609, 2.414, 3.219, 4.023, 4.828, 5.633,

Table 5.1. Siting Source Term (SST) Descriptions

Group	Description
SST1	Severe core damage. Essentially involves loss of all installed safety features. Severe direct breach of containment.
SST2	Severe core damage. Containment fails to isolate. Systems to mitigate fission product release (e.g., sprays, suppression pool, fan coolers) operate to reduce release.
SST3	Severe core damage. Containment fails by basemat melt-through. All other release mitigation systems function as designed.

Source: USNRC 1981

6.437, 7.242, 8.047, 9.656, 11.270, 13.680, 16.09, 20.12, 24.14, 28.16, 32.19, 40.23, 48.28, 56.33, 64.37, 72.42, 80.47, 88.51, 96.56, 112.7, 136.8, 160.9, 241.4, 321.9, 563.3 and 804.7 km.

5.2.2 Step 2: Running DOSES

The program DOSES reads the files produced by CRAC2. This program converts the ground concentrations shown in Table 5.2 to 70-year whole body dose commitments. The results incorporate the effects of decay and weathering. DOSES also passes through some information from the CRAC2 files to be used in GRID. This permits all of the information required by GRID--other than parameters specified by the user--to come from a single file.

5.2.3 Step 3: Running GRID

As just noted the DOSES program provides the input to the GRID program. To run GRID the analyst specifies the value of each isopleth to be produced, and GRID produces a file containing a set of points lying along that isopleth. The set consists of a point for each distance interval out to the point where the isopleth intersects the plume centerline. Each point lying off of the centerline is orthogonal to the centerline at the corresponding distance interval; in other words, a line connecting the isopleth point and the distance interval point is perpendicular to the centerline.

Table 5.2. Ground Concentrations at Time of Deposition

CO-58	8.36E-05	RH-105	6.31E-03	CS-137	3.30E-03
CO-60	5.04E-07	SB-127	1.26E-02	BA-140	9.35E-03
RB-86	2.42E-05	SB-129	2.54E-02	LA-140	2.96E-03
SR-89	5.37E-03	TE-127	1.26E-02	CE-141	2.56E-03
SR-90	2.90E-04	TE-127M	1.66E-03	CE-143	2.31E-03
SR-91	5.31E-03	TE-129	3.26E-02	CE-144	1.54E-03
Y-90	9.46E-05	TE-129M	1.12E-02	PR-143	2.45E-03
Y-91	1.97E-03	TE-131M	1.98E-02	ND-147	1.09E-03
ZR-95	2.50E-03	TE-132	2.07E-01	NP-239	2.98E-02
ZR-97	2.26E-03	I-131	1.46E-02	PU-238	1.97E-06
NB-95	2.37E-03	I-132	5.55E-02	PU-239	4.35E-07
MO-99	1.79E-02	I-133	2.74E-02	PU-240	4.87E-07
TC-99M	1.68E-02	I-134	1.87E-03	PU-241	9.12E-05
RU-103	1.39E-02	I-135	1.98E-02	AM-241	6.11E-08
RU-105	5.20E-03	CS-134	6.37E-03	CM-242	2.30E-05
RU-106	3.24E-03	CS-136	1.96E-03	CM-244	1.42E-06

5.2.4 Step 4: Defining the Grid Elements

The map and isopleths for an SST1 accident with Pasquill A stability are shown in Figure 5.1. Although this is a massive accident with enormous consequences, much of the radioactive deposition falls in the Atlantic Ocean, where consequences are assumed to be negligible.

Since almost all of the data that we have gathered for this case study are based on counties, it is reasonable that we take advantage of this fact by defining the grid elements in terms of political boundaries. This minimizes the problems associated with imputing data values to geographical areas based on other criteria. In fact, because in many of the accident scenarios several isopleths traverse a single county, we have selected the grid arrangement based on both county boundaries and the radiological isopleths. For example, all of the isopleths cross Westchester county, and these divide Westchester into eight grid elements.

To simplify the data collection effort, we assume that, except for the exposure level and area, all of the other characteristics of the counties are evenly distributed throughout the county. Thus, different grid elements within the same county are assumed to have the same population density, the same mix of land uses and the same level of property values.

5.2.5 Steps 5 and 6: Collecting and Organizing the Data

This step is by far the most time-consuming and onerous part of the process. A large number of published materials were obtained, and numerous individuals, primarily affiliated with government agencies, were directly contacted. A significant amount of data could not be used in the form in which it was obtained and had to be further processed. For example, many of the counties did not have the required type of land use information, so this information had to be picked off of detailed land use maps. A random sampling technique was used in these cases. In some cases where data were simply not available for a county, we assumed the characteristics of a neighboring county. A detailed description of the data and data sources is provided in Appendix D. These data were then organized into a specific format so that they could be read into IR-GRID. This format is similar to the one in which the data are presented in Tables 5.3 and 5.4.

5.2.6 Step 7: Running IR-GRID

Once the data were organized in Step 6, running IR-GRID was a simple process. The user needs to specify the radiation limit with respect to evacuation and with respect to site restoration. These radiation limits determine the dose avoided through evacuation, and through temporary and permanent

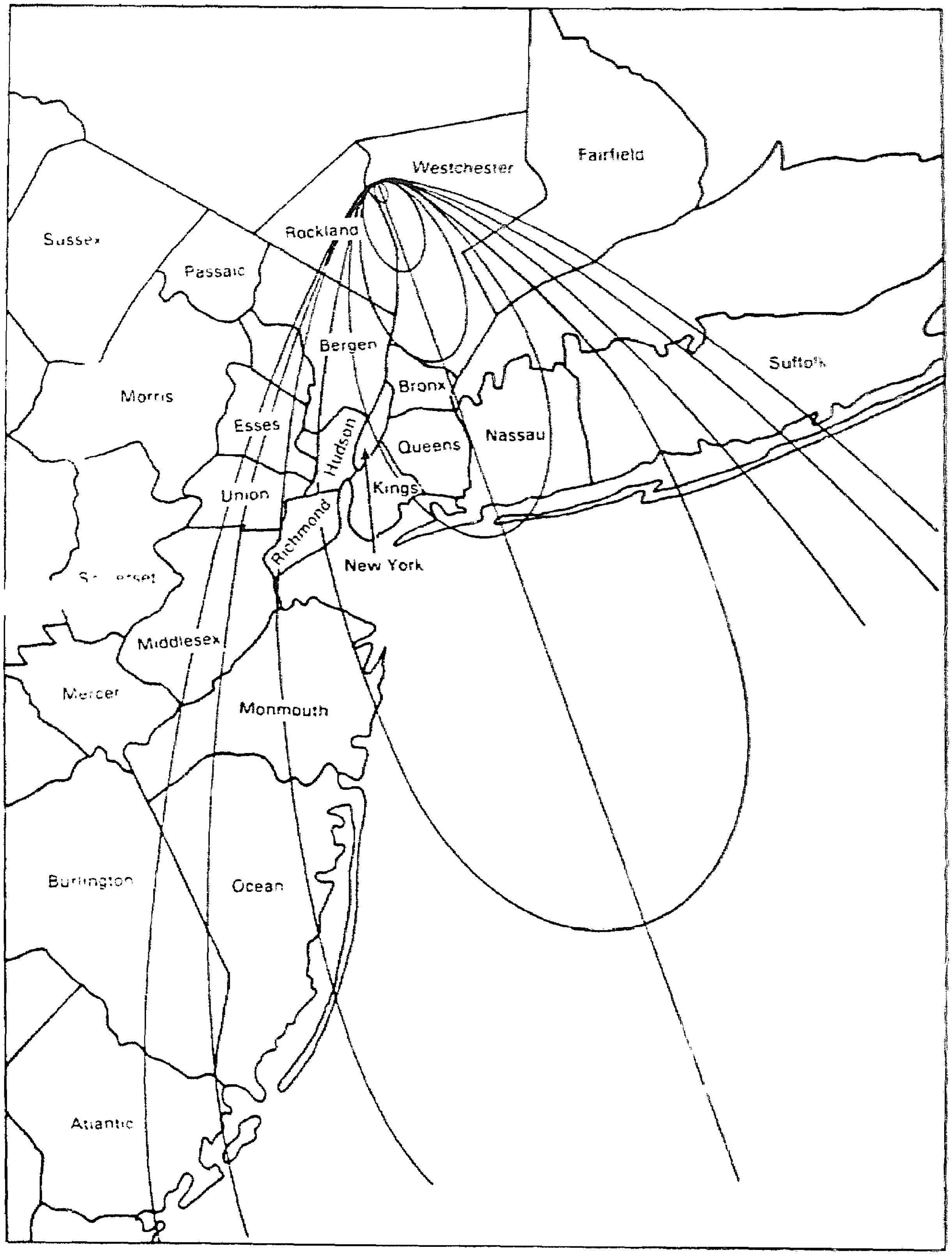

Figure 5.1. Accident Site with Isopleths: SST1/Pasquill A Scenario

GRID #	COUNTIES	EMPLOYMENT: DURABLE MAN	NONDURABLE MAN.	SERVICES	WHOLESALE TRADE	RETAIL TRADE	FINANCE, INS , AND REAL EST	TRANS AND UTIL	CONSTR'N	LOCAL GOVNMT	STATE GOVNMT	ASSESSED VALUE ALL TAXABLE PROP	MKT VALUE MEDIAN HOUSE
1	WESTCHESTER	36000	32000	107300	27000	66600	74000	20500	22000	33727		6 38E-09	100956
2	ROCKLAND	6100	9700	22900	5100	18600	3500	4000	3900	9157		3 27E-09	97725
3	BRONX	10200	11972	82050	17150	28770	10450	8702	14756	26718	3477	7 75E-09	57490
4	NASSAU	88310	26712	140591	42740	116509	35338	24691	28493	65113	15869	3 75E-09	103713
5	QUEENS	33048	40880	122528	41405	89459	23012	69158	35343	62634	8151	1 25E-10	62749
6	BERGEN	93216	7727	86028	54658	75992	22285	23077	16504	27122		2 00E-10	91434
7	FAIRFIELD	10500	31900	106800	24800	83700	25800	18300	18200	24754		1 55E-10	182303
8	SUFFOLK	84484	25488	136709	41560	113291	34362	24009	27707	64287	15431	6 26E-09	60221
9	NEW YORK	34236	187172	730792	142100	238380	463378	122057	42840	284700	37050	9 47E-09	111155
10	KINGS	29700	49840	135656	36995	62061	22489	24503	20825	65188	7182	1 48E-10	61075
11	PASSAIC	58301	4577	36292	13022	29637	9830	7529	8796	16477	3398	4 78E-09	80881
12	ESSEX	82107	4467	92915	24770	51697	30194	34528	10524	1506		8 09E-09	80318
13	HUDSON	40929	5443	34613	21076	30809	8885	52382	5398	22577		3 63E-09	34840
14	UNION	72202	3102	55864	22888	32490	14822	22219	11359	17003		7 84E-09	43442
15	RICHMOND	768	2336	22974	7350	12330	3661	4580	5236	8760	1140	2 33E-09	73745
16	MIDDLESEX	76825	3803	55146	28169	52186	15958	22214	11566	21928		9 19E-09	74931
17	MONMOUTH	23234	1169	47125	7897	42202	9015	9581	9393	17169		7 00E-09	78287
18	OCEAN	6941	180	23057	2424	26316	5236	4092	6459	10751		6 98E-09	48341
19	BURLINGTON	24178	782	25323	7060	27289	5747	5901	5919	12135		5 07E-09	57609
20	ATLANTIC	6629	666	55613	2543	19868	5244	4558	5063	8715		4 23E-09	62988

GRID #	COUNTIES:	AVE MKT. VALUE PER ACRE CROPLAND	TOTAL ACRES OF: RES. PROP.	COMM./IND. PROP	AGRI. PROP.	ALL OTHER PROP.	FRACTION OF ASSESSED VALUE IN: RES. PROP.	COMM. IND. PROP.	AGRI. PROP.	TOTAL NUMBER HOUSING UNITS	MEDIAN VALUE OF HOUSING UNITS	MEDIAN RATIO ASSESSED VALUE TO SALES VALUE: ALL TAX PROP	TAX RES PROP.
1	WESTCHESTER	6634	103718	43460	10934	122218	0.695	0.272	0 005	315468	100956	0 242	0.177
2	ROCKLAND	9368	29156	6719	1092	89800	0.762	0.190	0.004	80045	97725	0 521	0.521
3	BRONX	0	7666	3044	0	15348	0.431	0.553	0 000	450910	57490	0 243	0.122
4	NASSAU	20206	97368	33066	2226	50020	0.788	0.196	0.001	431944	103713	0 082	0 062
5	QUEENS	55164	27764	8790	0	33206	0.431	0.553	0.000	736502	62749	0 243	0.122
6	BERGEN	21857	62091	22933	3024	64736	0.648	0 316	0.009	306564	91434	0.503	0.467
7	FAIRFIELD	8917	103547	42876	18318	239740	0.731	0 245	0 014	293194	182303	0 376	0 386
8	SUFFOLK	5645	140484	104230	50907	270846	0.705	0.194	0.018	[illegible]	60221	0 196	0 179
9	NEW YORK	0	3745	5632	0	4703	0.431	0.553	0 000	753756	111155	0 243	0 122
10	KINGS	62400	16934	7302	0	20563	0.431	0.553	0 000	880840	61075	0 243	0 122
11	PASSAIC	7672	19947	11569	486	7892	0.667	0.323	0 005	105405	80881	0 606	0 451
12	ESSEX	10763	40640	17719	1204	21717	0.425	0.556	0.008	317164	80318	0 281	0 240
13	HUDSON	0	5417	11664	0	12359	0.558	0.401	0 004	221211	34843	0 387	0 327
14	UNION	22226	36256	17271	579	11814	0.576	0.386	0 001	182782	43442	0 647	0 667
15	RICHMOND	0	10837	4984	0	21939	0 431	0.553	0.000	110829	73745	0 243	0 122
16	MIDDLESEX	4492	69773	62492	32951	37024	0.632	0.326	0.032	203395	74931	0.443	0 433
17	MONMOUTH	3868	105728	33229	89302	93821	0.885	0 076	0.014	180885	78287	0.503	0 457
18	OCEAN	3624	41024	89432	10019	269765	0 803	0.144	0.002	140642	48341	0 655	0.623
19	BURLINGTON	2396	38784	60161	114176	313997	0.648	0 316	0.009	120894	57609	0 503	0.457
20	ATLANTIC	2781	35862	10505	30200	285873	0.648	0.316	0.009	87601	62988	0.503	0.467

Table 5.3. Data for the Indian Point Site: Employment and Property Values

GRID #	COUNTIES	# OF HSEHLDS (OCC)	# OF VACANT HSEHLDS	MEDIAN # OF PERSONS/ HSEHLD	MEDIAN VALUE OF RES.UNIT	COUNTY TO WHICH TWNSHP BELONGS	TOTAL ACRES OF: TWNSHP	SINGLE FAM RES.	COMM	INDUST.	STREETS AND ROADS	WOOD LAND	AGRI	ORCHARD	VACANT LAND	MULTI-FAMILY RES	WATER BODIES
1	WESTCHESTER	307460	8018	2.39	100956	1	280320	102317	14016	29434	9811	44851	10423	511	50736	1402	16819
2	ROCKLAND	77906	2140	3.06	97726	2	120767	26621	5451	1260	3803	20203	933	159	65714	2535	0
3	BRONX	429267	21053	2.29	57490	3	26880	2957	2967	887	4731	0	0	0	10618	4731	0
4	NASSAU	423401	8543	2.84	103713	4	182680	32882	20277	12788	12422	13016	1897	329	24582	84486	0
5	QUEENS	711940	24562	2.26	62749	5	69760	17161	6209	2581	16463	0	0	0	18742	10604	0
6	BERGEN	300410	6154	3.00	91434	6	152784	61114	11000	11932	13094	15276	2728	296	32621	978	3743
7	FAIRFIELD	280597	12597	2.83	102303	7	404480	101624	13752	29123	9162	182016	17845	473	48543	2022	0
8	SUFFOLK	386719	10929	3.09	60221	8	566466	117825	48716	65514	20959	136745	49898	1009	110876	22659	2266
9	NEW YORK	704602	49264	1.61	111165	9	14080	310	3769	1873	2506	0	0	0	2196	3436	0
10	KINGS	820267	52583	2.27	61075	10	44800	5646	3987	3316	11917	0	0	0	8646	11290	0
11	PASSAIC	102290	3107	3.41	60081	11	39893	19540	6383	5186	1197	4907	479	7	990	399	798
12	ESSEX	300303	16861	3.27	60310	12	81280	39827	10892	6878	2438	5039	1204	0	13426	813	813
13	HUDSON	207067	13354	2.95	34840	13	29440	4367	2449	9215	3297	0	0	0	9862	1060	0
14	UNION	177973	4009	3.19	43442	14	65920	35597	12067	4614	1978	0	579	0	3904	659	5933
15	RICHMOND	114674	4255	2.76	73745	15	37760	8798	2341	2643	5551	0	0	0	16188	2039	0
16	MIDDLESEX	190700	8687	3.47	74931	16	202240	35392	24067	30426	6087	30957	32438	513	0	34381	0
17	MONMOUTH	170130	10755	3.27	78207	17	302080	92134	25677	7552	9062	77207	68275	1027	0	13594	7552
18	OCEAN	170304	12330	3.20	40341	18	410240	41024	30101	53331	12307	246144	9960	69	11313	0	0
19	BURLINGTON	114090	6804	3.29	57609	19	617120	38784	22753	27407	16514	274074	112689	1489	24410	0	0
20	ATLANTIC	71000	15795	3.56	62980	20	362240	35862	6863	3622	10867	260451	27504	2696	14356	0	0

Table 5.4. Data for the Indian Point Site: Population and Land Use

relocation prior to the site being restored. The radiation limit for evacuation and temporary relocation is a 70-year effective dose to an individual from the plume plus inhalation plus four days of deposition. For permanent relocation, the radiation limit is measured as the 70-year dose-commitment beginning 14 days after release.

If households and businesses are not permitted to return to their original locations until after decontamination has been completed, they are assumed to incur relocation costs. Relocation costs include moving costs and loss of income or earnings over some specified period--three months for households and six months for businesses are assumed in this analysis.

According to recent research conducted at PNL, estimated relocation costs per household are $1,800 for moving costs and $6,300 in foregone income; earnings losses for businesses are estimated at $7,900 per employee, while moving costs amount to $2,100 per employee for commercial enterprises and $3,000 per employee for industrial enterprises. Costs are measured in 1986 dollars.

Figures 5.2, 5.3 and 5.4 show evacuation costs as a function of the early dose limit for SST1, SST2 and SST3 accidents, respectively. Each figure shows the relationship between the early dose limit and evacuation costs for each of the six Pasquill stability classes. In Figure 5.2, we see that evacuation costs range from nearly $5 billion for the Pasquill A meteorology and a 0.02 Sv (2 rem) radiation limit to about $600 million for the Pasquill F meteorology and a 0.10 Sv (10 rem) dose limit. For the SST2 accident shown in Figure 5.3, the Pasquill E evacuation costs are significantly higher than for the other meteorologies, especially at the more stringent dose limits.

Figures 5.5 through 5.7 illustrate the temporary relocation costs as a function of early dose limits for SST1, SST2 and SST3 accidents, respectively. The relationships shown for the six Pasquill stability classes are very similar to those for evacuation costs, except that the temporary relocation costs are about an order of magnitude higher.

Comparable relationships are shown for permanent relocation costs in Figures 5.8 through 5.10. For the SST1 accident scenarios shown in Figure 5.8, the relationship among the six meteorologies is about the same as for the temporary relocation costs shown in Figure 5.5, at least out to a dose limit of 2.0 Sv (200 rem). Permanent relocation costs appear to run about twice as high as the temporary relocation costs. Figure 5.9 also shows that the costs for the SST2/Pasquill E scenario are significantly higher than the costs for the other meteorologies, especially at dose limits below 1.0 Sv (100 rem).

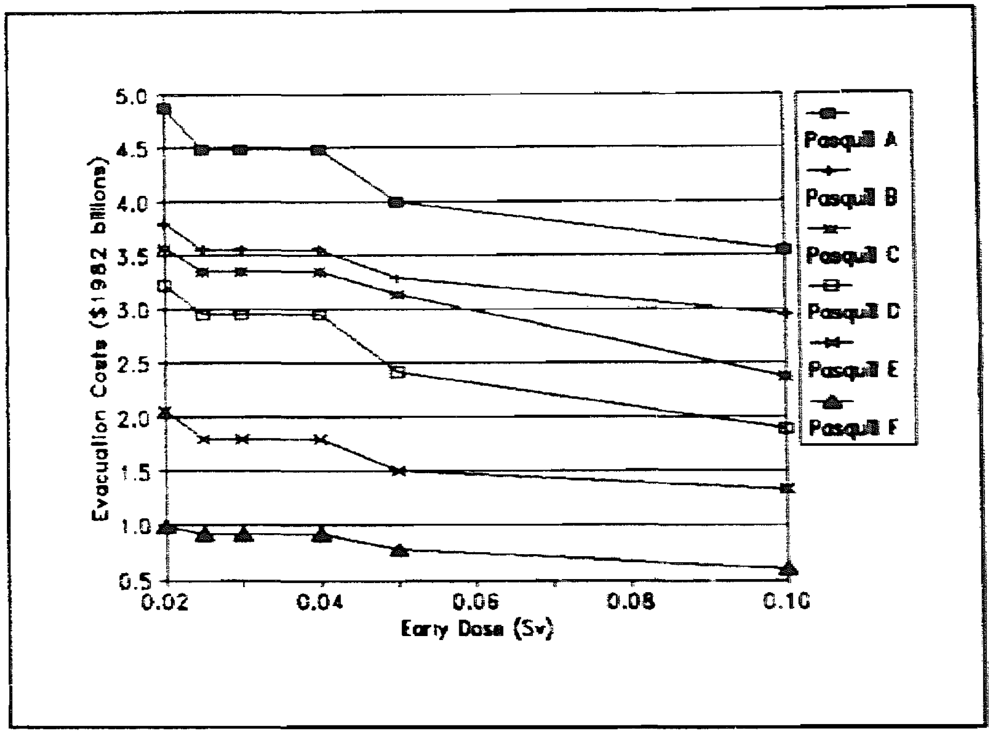

Figure 5.2. Evacuation Costs vs. Early Dose Limit: SST1

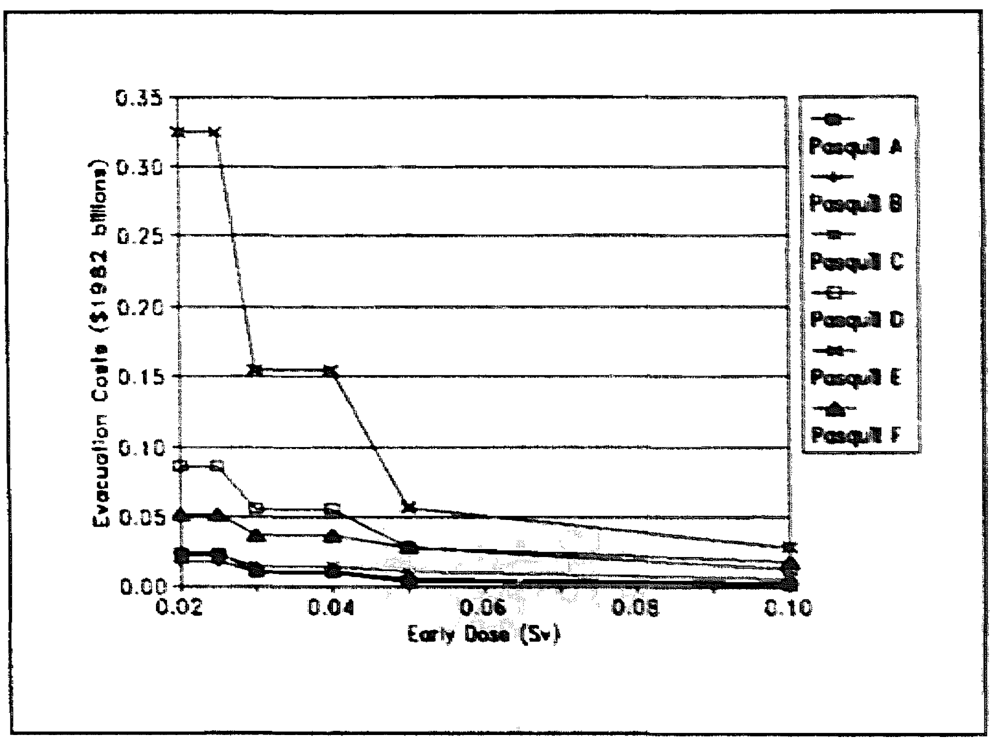

Figure 5.3. Evacuation Costs vs. Early Dose Limit: SST2

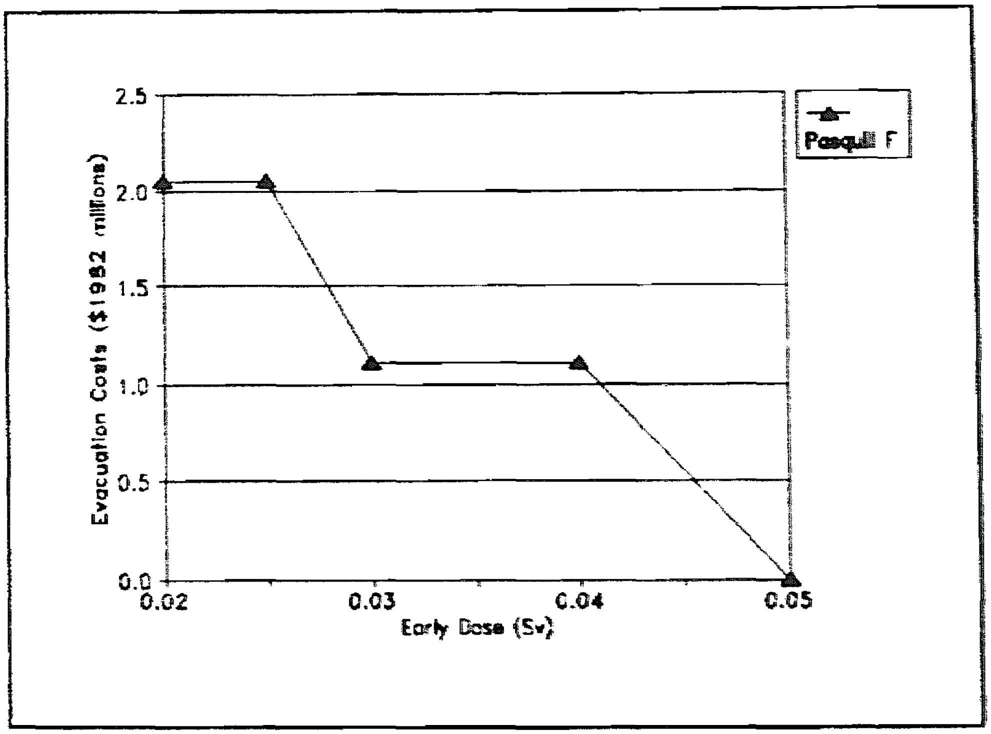

Figure 5.4. Evacuation Costs vs. Early Dose Limit: SST2

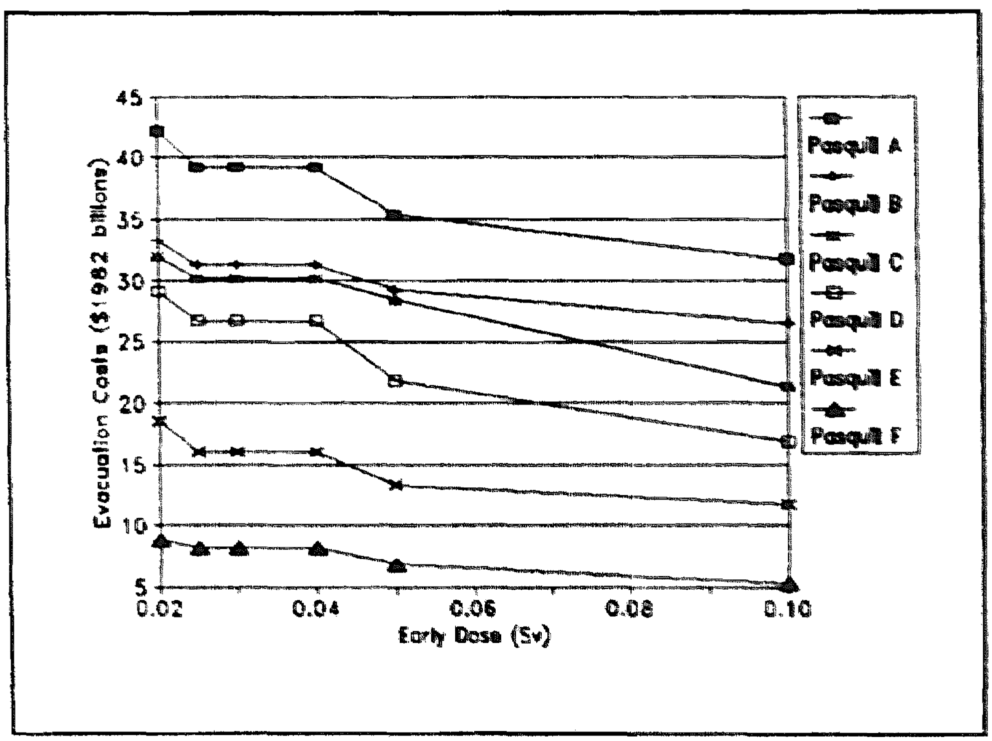

Figure 5.5. Temporary Relocation Costs vs. Dose Limit: SST1

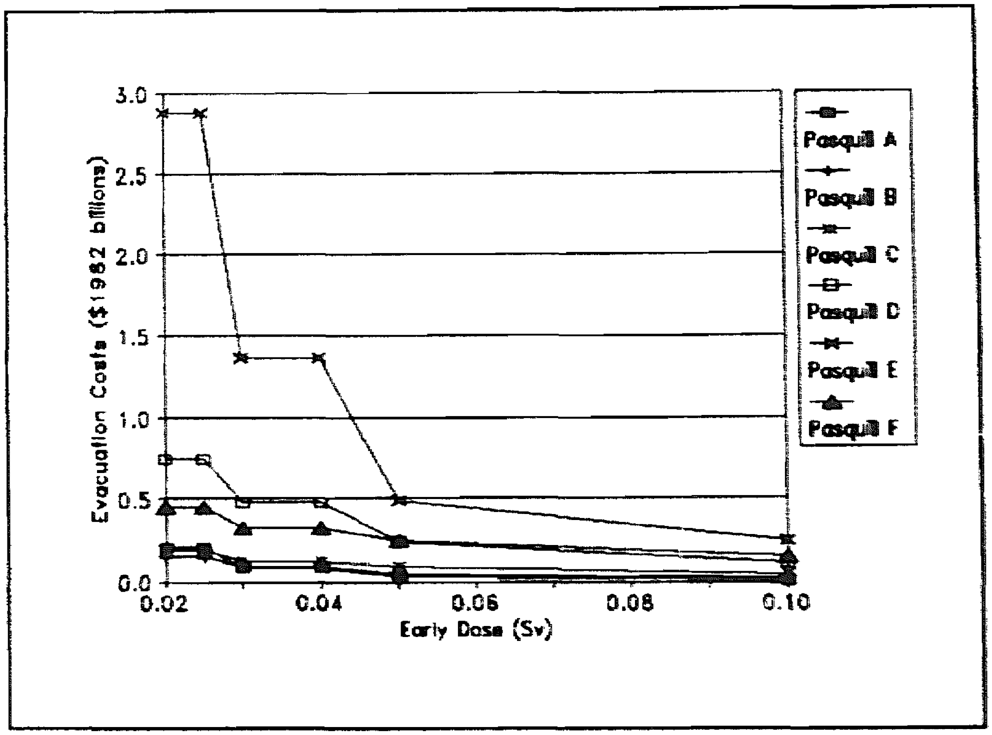

Figure 5.6. Temporary Relocation Costs vs. Dose Limit: SST2

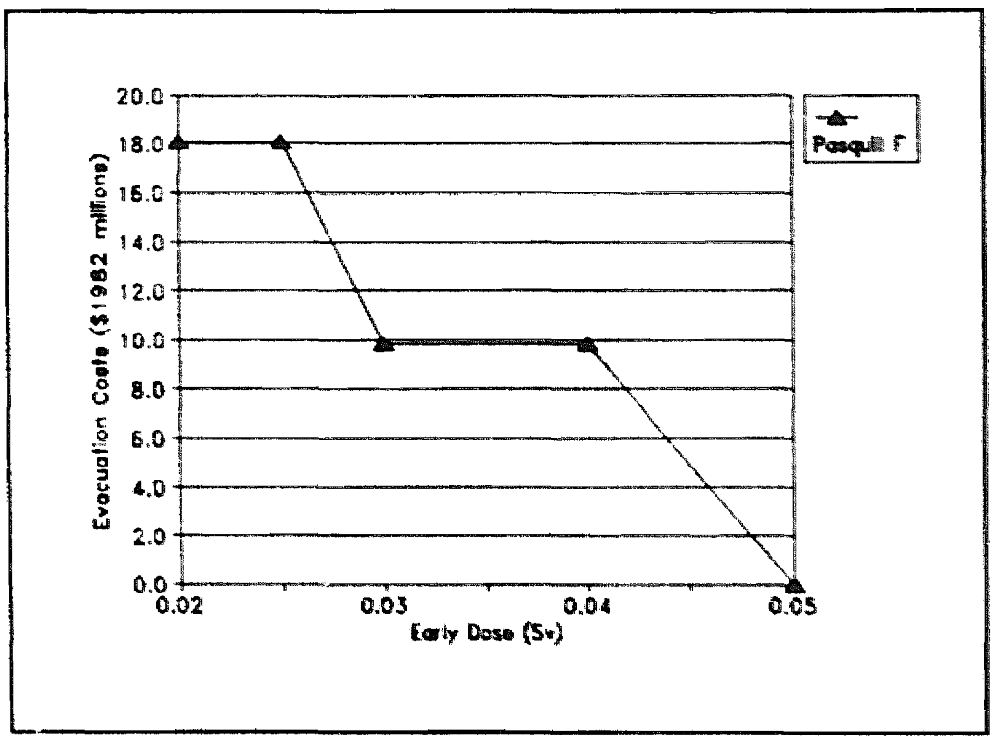

Figure 5.7. Temporary Relocation Costs vs. Dose Limit: SST3

Costs under the SST1 scenarios decrease as the weather stabilities progress from Pasquill A through Pasquill F; i.e, as the weather becomes more stable. However, for the SST2 scenarios, just the opposite effect is observed. The reason for this anomaly is that for an SST1 release less stable weather results in greater fallout over the Atlantic Ocean. This distorts the results, since no costs are incurred over the ocean area. SST2 releases do not extend over the Atlantic, and therefore they provide a more accurate picture of the relative costs under the different stabilities.

Costs in the SST3 accident (only the Pasquill F scenario produces off-site effects) are, as expected, at least an order of magnitude lower than the corresponding costs in the SST2 scenario.

5.2.7 Steps 8 and 9: Running DECON and Reporting Results

Relatively little effort is involved in running DECON, once the site data file has been produced by IR-GRID. We begin by obtaining a summary result for each of the 13 scenarios; major results for these scenarios are presented in the next section.

5.3 A COMPARISON OF MAJOR RESULTS FOR 13 ACCIDENT SCENARIOS

All of the scenarios were run with the assumptions indicated in Figure 4.2, except that a cleanup level of 0.25 Sv (instead of 0.20 Sv) was used for all scenarios and no restrictions or requirements were applied. Selected consequences of these runs are shown in Table 5.5.

The upper left panel of this table shows the size of the decontamination zone. This zone includes all of the grid elements with exterior, horizontal surfaces that have been contaminated to an exposure level above 0.25 Sv. These numbers display a pattern that is consistent with the costs for evacuation and relocation shown in Figures 5.2 through 5.10.

Decontamination costs are shown in the upper right panel of Table 5.5. A review of the summary reports (not shown) reveals that building contents--especially those pertaining to hard- and soft-surface furnishings--account for a significant portion of the decontamination costs. For example, for the SST2/Pasquill A scenario, restoring building contents is about half as costly as restoring real property, while for an SST2/Pasquill F scenario, restoring building contents is twice as costly.

Because the Pasquill F condition causes the contaminants to be confined to a smaller area, they are more concentrated and therefore more costly to remove. But a more important reason in this case is that a much larger area

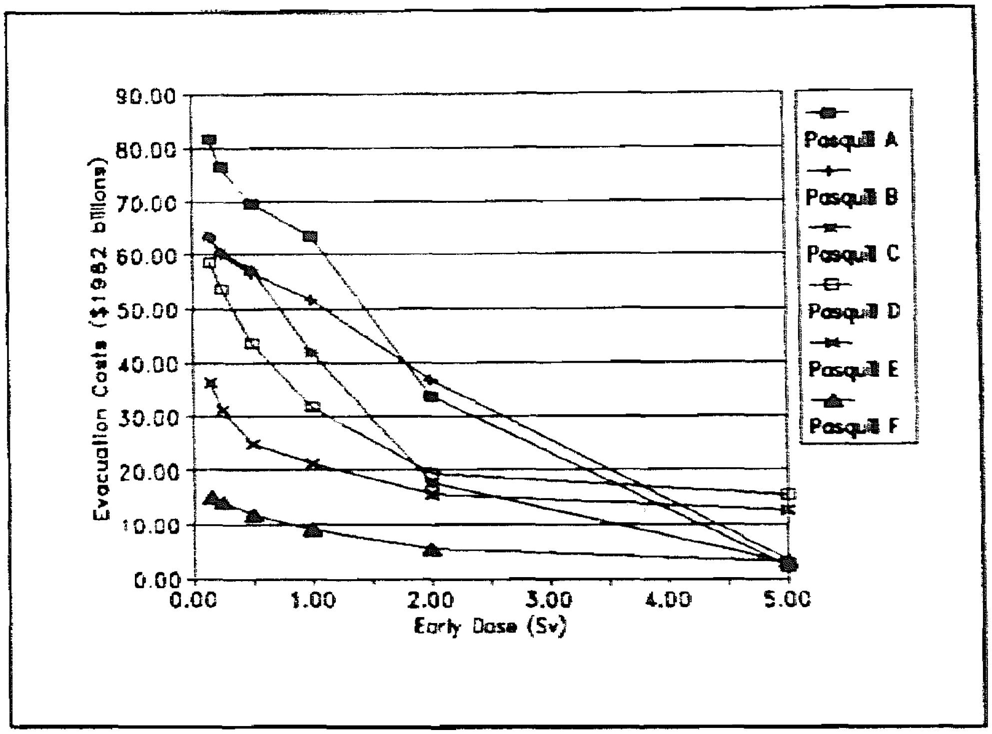

Figure 5.8. Permanent Relocation Costs vs. Dose Limit: SST1

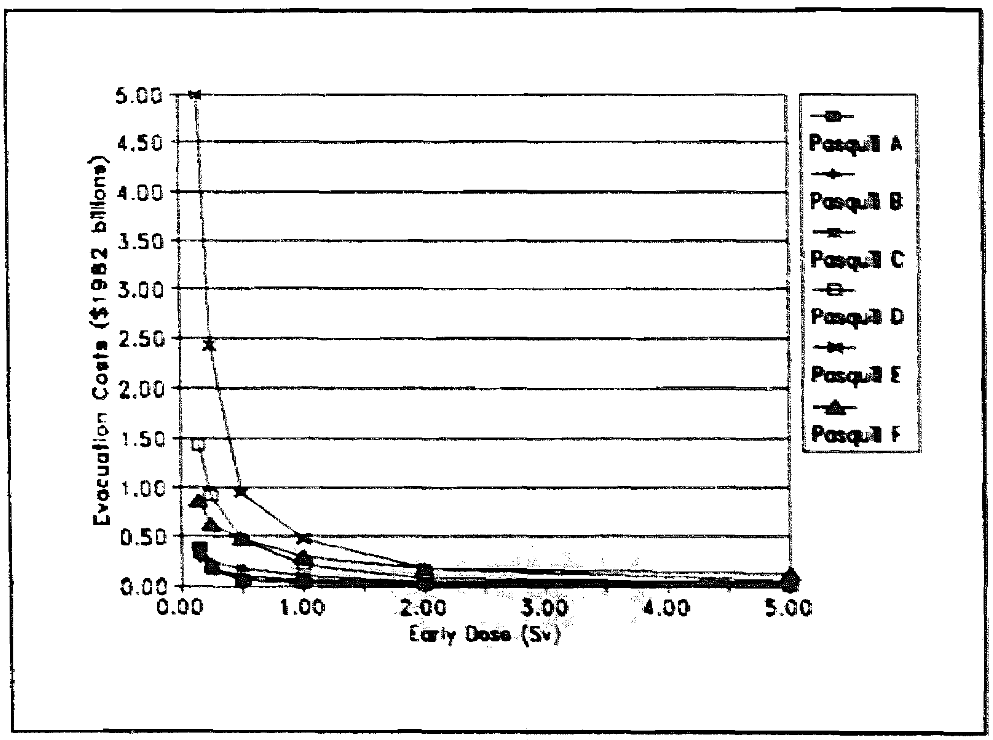

Figure 5.9. Permanent Relocation Costs vs. Dose Limit: SST2

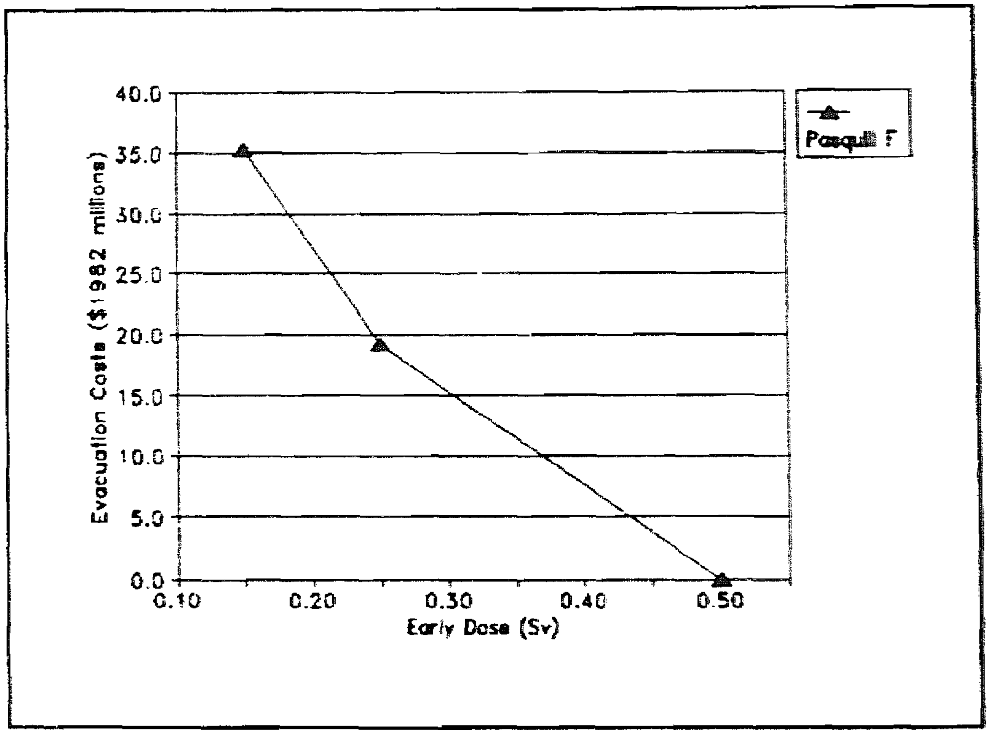

Figure 5.10. Permanent Relocation Costs vs. Dose Limit: SST3

Table 5.5. INDIAN POINT: SELECTED ACCIDENT CONSEQUENCES

SIZE OF DECONTAMINATION ZONE (hectares)

SST	Pasquill A	B	C	D	E	F
1	7e5	4e5	3e5	2e5	2e5	1e5
2	4e3	4e3	6e3	2e4	4e4	1e4
3	-	-	-	-	-	4e2

TOTAL DECONTAMINATION COSTS ($1986)

SST	Pasquill A	B	C	D	E	F
1	8e10	6e10	5e10	3e10	3e10	1e10
2	1e8	2e8	3e8	1e9	2e9	1e9
3	-	-	-	-	-	9e6

LATENT CANCER FATALITIES (persons)

SST	Pasquill A	B	C	D	E	F
1	6e4	5e4	4e4	4e4	3e4	1e4
2	4e2	3e2	4e2	2e3	6e3	7e2
3	-	-	-	-	-	3e1

NET PRESENT VALUE PROPERTY REDUCTION ($1986)

SST	Pasquill A	B	C	D	E	F
1	3e11	2e11	2e11	2e11	1e11	7e10
2	5e8	7e8	1e9	3e9	9e9	3e9
3	-	-	-	-	-	5e7

could not be decontaminated in the Pasquill E and F accidents, as compared with the others. Decontamination costs for the SST2 scenarios show approximately the same pattern, although the costs are about two orders of magnitude lower. For a cleanup level of 1.0 Sv, no decontamination is necessary for an STT3 accident.

Latent cancer fatalities are presented in the lower left panel of Table 5.5. In an SST1 accident, cancer deaths range from 60,200 in the Pasquill A scenario to 13,900 deaths in the Pasquill F. Cancer deaths in an SST2 accident are about one to two orders of magnitude lower than in the corresponding SST1 accident. Only 31 deaths are estimated for the SST3/Pasquill F scenario.

Finally, the lower right panel reports the net present value of the property value reduction caused by the accident. The pattern shown in all scenarios is similar to the pattern for total decontamination costs.

5.4 USING COST/RISK RELATIONSHIPS TO SELECT A BASE CASE CLEANUP LEVEL

In this section we use a feature of DECON to conduct a cost/risk analysis over a range of cleanup levels. Normally, if we reduce the health risk by employing a more stringent cleanup level, we can expect the property losses to increase. This conclusion should be qualified, however. In the DECON runs that employ the cost/risk analysis option, the residual contamination factors were not changed when different cleanup levels were applied. However, using more stringent cleanup levels should cause less property loss because of fewer residual contaminants. Although more stringent cleanup levels should still cause the property losses to increase, the economic losses from more stringent cleanup levels are therefore somewhat overstated in our analysis.

A second qualification is that the cost/risk analyses do not include the effect of permanent relocation costs, which are affected by the cleanup level. The reason for the exclusion is that this cost is calculated in another program (IR-GRID) and currently it is not passed through to DECON. The effect of omitting the permanent relocation costs is likely to somewhat understate the economic losses from more stringent cleanup levels.

The last qualification concerns property that could not be decontaminated with the methods in the Reference Database. Had more powerful--and more costly--methods been available to decontaminate the property, then those methods would have been selected if using them would have reduced property losses. The effect of not having such methods in the Reference Database likely causes the economic losses from more stringent cleanup levels to be somewhat overstated.

Figures 5.11 through 5.13 show the incremental cost per fatality avoided as a function of the cleanup level for scenarios SST1/Pasquill D, SST2/Pasquill D, and SST2/Pasquill F, respectively. Since the estimated values do not follow a smooth progression, we have fitted a least-squares regression line through the data in each of the figures. Based on the estimated regression for the SST1 scenario, the incremental cost per fatality avoided ranges from $433,000, when the cleanup level is reduced from 3 Sv to 2.5 Sv, to $4.25 million, when the cleanup level is reduced from 0.1 Sv to 0.05 Sv.

Studies conducted by economists and others show a wide variance in estimates of the value placed on a statistical life by society (Jones-Lee 1976). While there is certainly no consensus on any particular value, amounts that our society appears willing to spend on highway safety and public health programs suggest a value somewhere in the range of $500,000 to $5 million. For this range, cleanup levels in the following respective ranges are indicated for the SST1/Pasquill D, SST2/Pasquill D, and SST2/Pasquill F accidents: 0.04 Sv to 0.8 Sv; 0.08 Sv to 2 Sv (or more); and 0.11 Sv to 2 Sv (or more)[1].

The incremental cost per fatality avoided for the SST3/Pasquill F scenario ranged from over $25 million to nearly $250 million. On economic grounds, it would be difficult to justify any cleanup from this accident, except perhaps at isolated spots.

If the cleanup level is to be tied to a specific value of the incremental cost per fatality avoided, then a different cleanup level will be indicated for different accidents and for different sites. For example, in less densely populated areas, a less stringent cleanup level will usually be appropriate. For example, in another case study, the incremental cost per fatality avoided was estimated at $1.8 million for a cleanup level of 0.75 Sv (Tawil and Strenge 1987). By way of comparison, the SST1/Pasquill D, SST2/Pasquill D, and SST2/Pasquill F accidents have indicated cleanup levels of 0.13, 0.43 and 0.38 Sv, respectively, based on the regression estimates and a value of $1.8 million to avoid an additional cancer fatality.

Readers and decision makers are likely to have their own views on society's willingness to pay to avoid a future statistical death. The cleanup levels discussed above are not meant to preempt them in this regard. Indeed, they are encouraged to conduct their own cost/risk analyses to arrive at a cleanup level they feel is appropriate.

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[1]For the latter two accidents, the regression line does not reach the lower limit of $500,000 in the range of cleanup values considered.

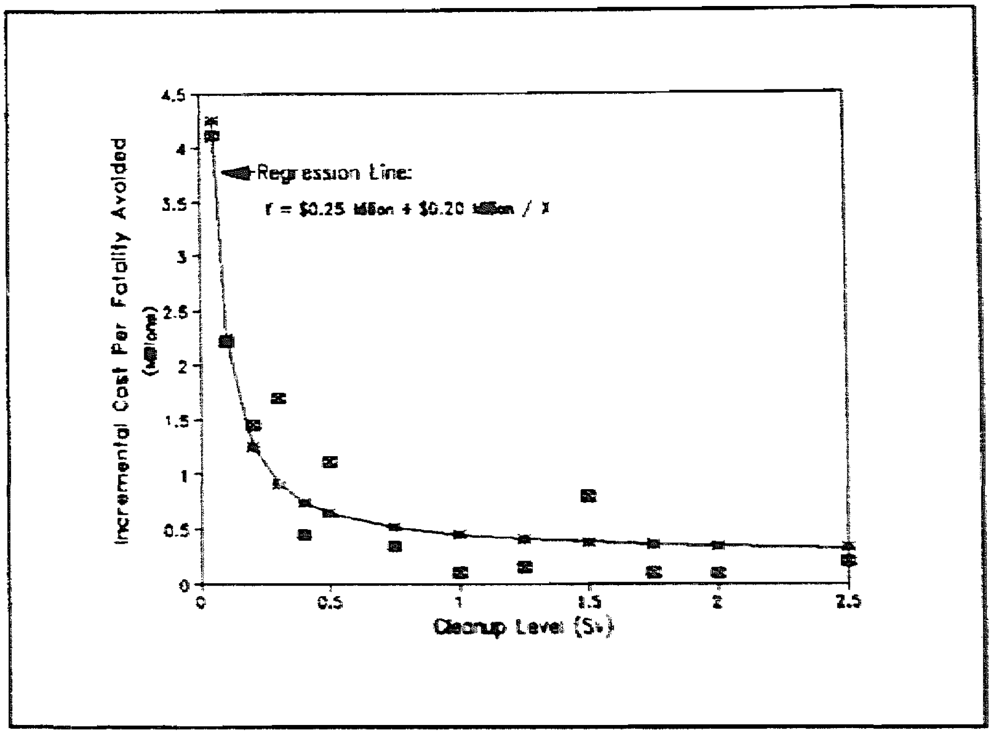

Figure 5.11. Incremental Cost per Fatality Avoided: SST1/Pasquill D

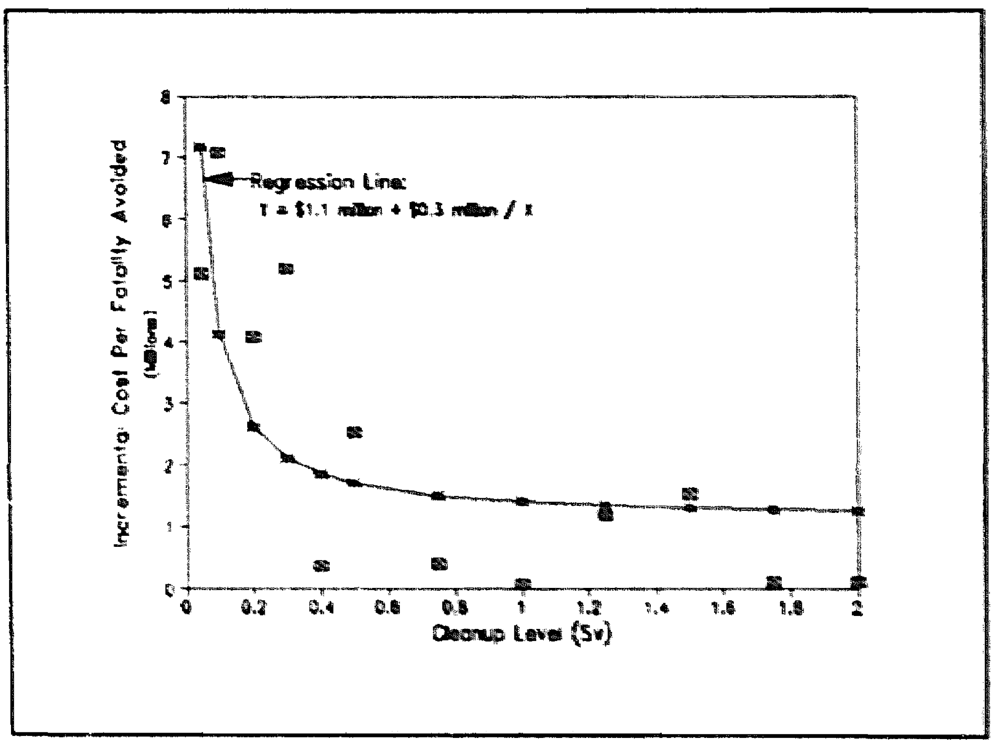

Figure 5.12. Incremental Cost per Fatality Avoided: SST2/Pasquill D

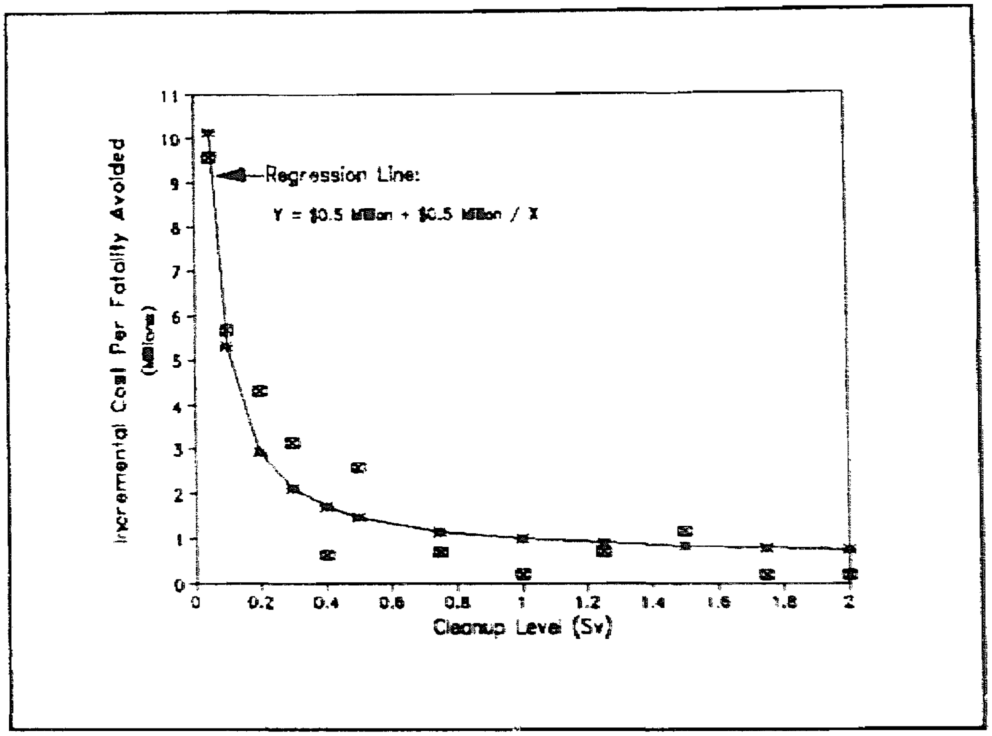

Figure 5.13. Incremental Cost per Fatality Avoided: SST2/Pasquill F

In the remainder of this chapter, we will look at alternative strategies for restoring the accident site based on the SST2/Pasquill D scenario. These strategies are compared with the base case cleanup discussed below. The cleanup level for the base case analysis is 0.25 Sv.

5.5 BASE CASE RESULTS FOR THE SST2/PASQUILL D SCENARIO

Summary results for the base case are shown in Figure 5.14. In this figure, the fourth entry from the bottom shows that the net present value of the property losses from this accident are $3.42 billion. Within the 16 grid elements in the study area, 2,110 cancer deaths are estimated. For the base case cleanup level, nine grid elements are within the decontamination zone. The optimal year to decontaminate all of these grid elements, except for Grid Element #8, is during the first year following the accident. Grid Element #8 was the most heavily contaminated grid element and could not be fully decontaminated with the methods in the Reference Database until the eighth year after the accident. The optimal year to decontaminate it is reported as year 30. Since the DECON analysis ends at year 30, it seems likely that waiting even longer would prove cost-effective.