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MCNP Model for the Many KE-Basin Radiation Sources

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Abstract: This document presents a model for the location and strength of radiation sources in the accessible areas of KE-Basin which agrees well with data taken on a regular grid in September of 1996. This modelling work was requested to support dose rate reduction efforts in KE-Basin. Anticipated fuel removal activities require lower dose rates to minimize annual dose to workers. With this model, the effects of component cleanup or removal can be estimated in advance to evaluate their effectiveness. In addition, the sources contributing most to the radiation fields in a given location can be identified and dealt with.

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MCNP Model for the Many KE-Basin Radiation Sources

by Paul D. Rittmann PhD CHP May 7, 1997

The model presented in this document approximates the location and strength of radiation sources in the accessible areas of KE-Basin. This modelling work was requested to support dose rate reduction efforts in KE-Basin. Anticipated fuel removal activities require lower dose rates to minimize annual dose to workers. With this model, the effects of component cleanup or removal can be estimated in advance to evaluate their effectiveness. In addition, the sources contributing most to the radiation fields in a given location can be identified and dealt with.

The MCNP program (Carter 1996) used for these calibration calculations requires input files with three main parts. The first is the geometry of the facility. This includes the sizes and shapes and locations and composition of the various objects in the KE-Basin general area. The second part of the input is the location and strength of the radiation sources. This includes the photon spectrum coming from the source as well. The third part of the input is the location of the detector points. Each of these is described separately below.

Computed dose rates and a comparison with the data are shown in Appendix A. Appendix B contains contour plots of the dose rates from each source. Later appendices give sample MCNP input data and software listings for reference purposes.

MCNP GEOMETRY INPUT

The position, shape, size, and composition of the various objects in KE-Basin was determined from various engineering drawings. In addition, the facility was inspected to verify the drawing information and note any objects that weren't on the drawings we had.

The geometry portion of the MCNP input was developed in a spreadsheet to facilitate unit conversions and other calculations. The spreadsheet took longer to set up initially, but changes to the input file were readily accommodated in the spreadsheet.

Sketches of the geometry model are shown in Appendix C. Also in Appendix C is a listing of the geometry portion of the input file. The coordinate system origin is the northwest corner of the building, corresponding to Column 16 and Column A. The X coordinate increases to the south. The Y coordinate increases to the east. The floor is Z=0. All lengths in the MCNP input have units of centimeters.

Composition of the air, concrete, and wet sand (sand filter media) are shown in Table 1. The air composition comes from ANSI/ANS-6.4.3-1991. The concrete composition is typical of that used at Hanford (Carter 1983). The wet sand composition is based on the data presented in Wittekind (1994). These assumptions are similar to those used in previous KE-Basin dose rate studies (Simons, 1995).

Table 1. Assumed Composition of Air, Soil, and Concrete

Element	Mass Fractions, percent		
	Air	Sand	Concrete
Hydrogen	0.048	1.741	0.31
Carbon	0.014		
Nitrogen	75.191		
Oxygen	23.464	56.245	44.07
Fluorine		0.009	
Sodium		1.182	1.82
Magnesium		0.094	3.76
Aluminum		3.960	6.07
Silicon		33.036	21.57
Phosphorus			0.09
Sulfur		0.035	0.09
Chlorine		0.016	
Argon	1.282		
Potassium		2.281	
Calcium		0.353	13.06
Titanium		0.005	0.49
Manganese			0.13
Iron		0.370	7.88
Krypton			0.66
Uranium		0.674	
Density:	0.0012 g/cc	1.60 g/cc 100 lb/ft^3	2.258 g/cc 141 lb/ft^3
Note: Air is at 80°F with a relative humidity of 20%.			

Many structural details were omitted on the basis that they would have little effect on the computed dose rates. For example, the posts that support the grating over the pool were not included. These posts are 5 inch diameter schedule 40 pipe positioned 14 feet apart in the north-south direction, and about 4 feet apart in the east-west direction. Another example is the ion exchange columns. These columns are inside thick concrete containers so the self-absorption characteristics do not matter. However, the activity needed to produce a given MCNP dose rate will differ from what is actually inside the container.

MCNP SOURCE INPUT

The KE-Basin contamination is primarily Cs-137 and Sr-90. Nearly all of the measured dose rates are due to the Cs-137 and it short-lived daughter Ba-137m. The Sr-90 and its daughter Y-90 are strictly beta emitters whose concentration is lower due to the lower solubility of strontium compounds compared to cesium compounds. Thus the source photon energy was assumed to be 0.662 MeV.

Two source shapes were used throughout the KE-Basin model, namely, rectangular boxes and cylinders. The cylinders were of two kinds: uniform throughout, and hollow. Hollow cylinders represent contamination on the inside of the pipes. For large sources (i.e. the sand filter and heat exchanger) hollow cylinders reduce the execution time since the inside will contribute little to the dose rate outside. A complete listing of all source input for MCNP is found in Appendix D.

The KE-Basin water source was modelled as a layer 8 inches (20 cm) thick on the surface of the pool. Thicker layers did not increase the dose rate significantly but did increase the execution time. Table 2 summarizes the results of these MCNP runs. A fixed water concentration was used to compute dose rates at point 3 feet above the floor grate at various point above the pool. From the table it is clear that the 20 cm layer represents the 200 cm layer far better than the 2 cm layer does. Not only is the dose rate ratio closer to 1.00, but also the variation of the dose rate from location to location is less.

Table 2. Comparison of Pool Water Depth Assumptions

Detector Location	MCNP Dose Rates, mrem/h			Dose Rate Ratios	
	2 cm	20 cm	200 cm	200/2cm	200/20cm
West Pool - N Edge	0.067	0.284	0.339	5.09	1.19
West Pool - W Edge	0.217	1.007	1.213	5.60	1.20
West Pool - Center	0.576	3.126	4.002	6.95	1.28
West Pool - S Edge	0.125	0.526	0.573	4.60	1.09
W Inner Wall - N Edge	0.134	0.490	0.545	4.06	1.11
W Inner Wall - Center	0.397	1.744	2.000	5.04	1.15
W Inner Wall - S Edge	0.144	0.529	0.565	3.93	1.07
Middle Pool - N Edge	0.069	0.296	0.341	4.94	1.15
Middle Pool - Center	0.590	3.157	4.041	6.85	1.28
Middle Pool - S Edge	0.259	1.168	1.309	5.06	1.12
E Inner Wall - N Edge	0.133	0.491	0.520	3.91	1.06
E Inner Wall - Center	0.399	1.751	2.026	5.08	1.16
E Inner Wall - S Edge	0.196	0.793	0.825	4.21	1.04
East Pool - N Edge	0.070	0.298	0.320	4.58	1.07
East Pool - E Edge	0.217	1.004	1.111	5.12	1.11
East Pool - Center	0.577	3.123	3.993	6.92	1.28
East Pool - S Edge	0.291	1.521	1.886	6.48	1.24

Note: Water surface is at 16'10". Detector points are 3 feet above the floor grate. Water concentration is about 15 μCi/L of Cs-137.

In the present MCNP model for KE-Basin sources, a 8 inch (20 cm) thick layer was used to represent the pool. In addition, the activity in the water was increased by 20 percent over what the assumed concentration would predict. It is also assumed that fuel and sludge materials on the bottom do not contribute significantly to the dose rates above the floor. In addition, to simplify the source definition, the water in the east pits (elevator, weasel, and viewing pits) as well as the discharge chute was input as a single source. The concrete details at these locations reduce the efficiency of the monte carlo source point selection. By using a large number of points this efficiency was found and applied to the source probability (sp) value for these sources. In other words, the activity was reduced by the observed efficiency to adjust for the simplified source input.

Pool wall sources were modelled as slabs 1/4 inch (0.635 cm) thick on the surface of the pool walls. The contamination was assumed to begin at the 16'0" level and go down 90 cm. Contamination below this depth does not contribute significantly to the total dose rate from the walls. The only pit wall found to be contaminated was the elevator pit. The other pits apparently have some type of coating to keep contamination to a minimum.

The hot filter on the north wall a few feet east of column 15 was modelled as a cylinder of water. The contamination was assumed to extend from 1 foot above the floor to 3.5 feet above the floor.

The sand filter was modelled as an upright cylinder full of wet sand (1.60 g/cc). The source region only involved the outer 8 inches of sand, and extends from 16 inches to 80 inches above the floor.

The three ion exchange columns in the concrete box west of the north loadout pit were modelled as upright cylinders full of water. The source region is assumed to extend from floor level to a height of 74 inches.

The number of ion exchange columns in the lead cave could not be determined, so this source was modelled as a rectangular box. The source region was assumed to almost fill the box. In the north-south direction, 4 inches was removed from each side, and in the east-west direction, 2 feet was removed. Vertically, the source region extends from 19 inches to 61 inches above floor level. The source medium was just the air inside the lead cave.

The two ion exchange modules south of the lead cave were modelled as concrete boxes with walls 19 inches thick. The source region was modelled as a rectangular boxes made of iron with a density of 1.573 g/cc. The source region extends from 19 inches to 61 inches above floor level. This iron density is the average density of the floor grate.

The various PVC pipes in the north loadout pit were modelled as a single rectangular box in the air 4 inches below and 1/2 inch above floor level.

The large drip pan located west of the south loadout pit had three hot locations, one at each end and one in the middle. These were modelled as cubes 8 inches on an edge. The source region extends from 61 inches to 68 inches above floor level. The source medium was just the air on the west side of the pool.

Near the intersection of column 10.9 and column C there is a sampling device with elevated dose rates on the west side near the floor. It was assumed that there is a radiation source under the floor grate to cause this increase. This source was modelled as a cube 18 inches on an edge centered on column C and pressing against the west side of the inner pool wall at column 10.9. The source region extends from 10 inches to 28 inches below floor level. The source medium was just the air between the floor grate and the pool water.

On the east side there is a concrete pump platform wrapped in plastic that reads 50 to 100 mR/h on contact. This was modelled as a rectangular box suspended in air. The box is 18 inches square and extends from 4 inches to 10 inches above floor level.

The heat exchanger tubesheet was modelled as a north-south cylinder made of iron with a density of 1.573 g/cc. The cylinder is 15.78 feet long, has a diameter of 38 inches, and its center is 29 inches above the floor. The inlet and outlet cooling water plenums are cylinders made of water at each end that are 41 inches long. The heat exchanger radioactivity was modelled as a hollow cylinder with inner radius 10.63 inches and outer radius 18.63 inches that extends the entire length of the tubesheet.

The chiller was modelled as a north-south cylinder made of water. The ends are made of iron 2 inches thick. The walls are made of iron 3/8 inch thick. The cylinder has outside dimensions of 13.25 feet long and 30 inches in diameter. The center is 21 inches above the floor. The chiller radioactivity was modelled as a hollow cylinder with inner radius 6.63 inches and outer radius 14.63 inches that is 12 feet long. The source cylinder is 1 inch from the south end and 10 inches from the north end of the chiller.

All other source regions were inside pipes. To simplify modelling, all pipes were assumed to have an 8 inch outside diameter and a wall thickness of 1/4 inch. They are all made of iron and filled with water. The source region is the outer 1/4 inch of water to represent contamination on the walls of the pipe.

The actual amounts of activity in each source are presented with the discussion of how these amounts were determined.

MCNP DETECTOR INPUT

Two types of detector locations were used, near source points and the regular grid. The near source locations were based on field readings taken during KE-Basin inspection trips between August 14, 1996, and October 8, 1996. The 73 near source locations are listed in Table 3. Actual detector coordinates are listed in Appendix D. The first guess at MCNP source strengths was based on the readings shown on Table 3. This table also gives the weighted sums of the MCNP readings and the modified relative error (MRE) for each.

The other group of detector locations was a nearly regular 4' by 4' grid over the entire KE-Basin. This grid was based on locations where health physics technicians took knee and chest level readings. A full listing of the grid locations is also provided in Appendix D, for reference.

Table 3. Near Source Data Versus MCNP

Detector Location	Data (mR/h)	MCNP (mrem/h)	MRE
Over Elevator Pit NW	15	13	-0.1
Over Elevator Pit E	15	13	-0.1
Over Elevator Pit SW	15	14	-0.1
Pump #2 Pedestal	60	51	-0.2
IXM #1 (G10) Chest	2	2	0.0
IXM #2 (K10) Chest	6	7	0.1
Drip Pan - Pit End	250	144	-0.7
Drip Pan - Middle	100	96	-0.0
Drip Pan - Door End	50	48	-0.0
Sampler at Col 10.9C	8	6	-0.3

Table 3. Near Source Data Versus MCNP

Detector Location	Data (mR/h)	MCNP (mrem/h)	MRE
PVC in N Loadout	150	48	-2.1
PVC in N Loadout - E	35	38	0.1
SF North Wall	6	6	0.0
SF Northwest Corner	6	1	-2.5
SF West Wall	6	7	0.1
Pipe Along IX Box - #3	40	28	-1.6
Pipe Along IX Box	45	38	-1.3
Pipe Along IX Box - #2	50	27	-1.4
Pipe Along IX Box	45	33	-1.1
Pipe Along IX Box - #1	40	60	-1.1
Between HX/Chiller - N	20	6	-2.0
Between HX/Chiller - S	15	18	0.2
E Side HX	7	7	0.0
NW Filter Media	120	109	-0.1
NW Filter Media at 1ft	30	27	-0.1
N Loadout Entry - Pit	50	39	-0.3
N Loadout Entry	30	25	-0.2
N Loadout Entry - Pool	20	18	-0.1
SF Pipes, lower E	110	28	-2.8
SF Pipes, upper E	120	65	-0.8
SF Pipes, lower W	60	51	-0.2
Beam at Col 13B	25	12	-1.0
Column 13D	15	13	-0.1
Col 13D - Above Head	25	14	-0.7
9.5' W Ovrhd - SE	70	54	-0.3
9.5' W Ovrhd - SE	50	46	-0.1
S Loadout Riser	100	90	-0.1
Pipe Along N Load, W	35	28	-0.2
Pipe Along N Load, Mid	40	38	-0.1
Elbow - N Loadout - N	60	27	-1.2
Elbow - N Load - Outer	60	33	-0.8
Elbow - N Load - Inner	60	60	0.0
S Wall Col 12.2	13	10	-0.3
S Wall Col 9.5	16	17	0.1
S Wall Col 7.7	25	25	0.0
E 10' NS Middle	15	14	-0.1
E 10' NS N Piece	45	25	-0.8
E 10' NS S Piece @ 2'	32	28	-0.1
View Pit Riser #1	50	33	-0.5
View Pit Riser #2	40	32	-0.2
View Pit Riser #3	30	27	-0.1
View Pit Risers - 1 ft	20	24	0.2

Table 3. Near Source Data Versus MCNP

Detector Location	Data (mR/h)	MCNP (mrem/h)	MRE
Bypass Loop - Inner	40	38	-0.1
Bypass Loop - East	40	36	-0.1
Bypass Loop - Above	100	100	0.0
Valve - S End Chiller	35	29	-0.2
Pump Overhead	45	42	-0.1
Pump #1 Riser	35	34	-0.0
Pump #1 Knee	12	12	0.0
Pump #2 Knee	7	9	0.3
N Wall Valve at Col 12	8	9	0.1
N Wall Valve at Col 10	6	7	0.1
N Wall Valve at Col 8	6	8	0.3
SF Pump Knee	50	28	-0.8
SF Pump Knee	50	27	-0.8
SF Pump	20	38	0.9
PVC Pipe Riser - NL	27	47	0.7
PVC Pipe - W Elbow	250	217	-0.2
PVC Hot Spot - Contact	1200	1067	-0.1
PVC Hot Spot - 6 in	250	291	0.2
PVC Hot Spot - 1 ft	130	143	0.1
PVC Pipe - 6 ft	45	49	0.1
PVC Pipe - S Elbow	20	29	0.4
Note: Detector coordinates are given in Appendix D.			

PREPARING MCNP INPUT FILES

This section summarizes the methods used to generate the hundreds of input files for the MCNP software. Since the activity in all sources except the water was not known, it was necessary to generate MCNP output for each radiation source. These could then be multiplied by a scale factor and added together to give the total dose rates for comparison with the data collected on September 23, 1996. In addition, knowing the relative strength of various radiation sources allows prioritization of cleanup/removal activities.

MCNP input preparation begins with the KE-GEOM.WQ1 spreadsheet. This spreadsheet has surface information in standard units of feet. Conversions to centimeters for input to MCNP are carried out in the spreadsheet. The cell definitions in the spreadsheet reference the surface ID numbers. Source information uses surface definitions. Finally, the location of detector points near sources is another block in the spreadsheet. Output from the spreadsheet is a text file named KE-GEOM.PRN, which has all the input data, but not in a usable order. The program named KE-GEOM.PAS converts the data in KE-GEOM.PRN into the three input parts (geometry, detector, and source).

The KE-GEOM.PAS program is listed in Appendix E. It was tested by comparison with output generated by hand to verify its correct operation in rearranging the KE-GEOM.PRN file. The files generated by KE-GEOM.PAS are listed in Table 4. The GEOM1.L3 file contains 3 lattices regions to represent the floor grate over the pool, the I-beam supports beneath it, and the posts above it. This file was modified by hand to remove the posts above the grate. The new file is named GEOM1.L2. This file was modified one more time to remove all the lattices. The new file is named GEOM1.X.

Lattice regions slow the computations. Therefore, the lattices case (GEOM1.L2) was only used for sources below the floor grate, such as the pool water, walls, and certain pipes. The geometry with no lattices (GEOM1.X) is used for all sources above the floor grate. The GEOM1.L3 file was not used in these MCNP runs.

Table 4. Output from KE-GEOM.PAS

File Name	Explanation
GEOM1.L3	cell and surface and material composition information
PT-NEAR	detector coordinates for the near source locations
S-ALL	source information of all radiation sources
S-WATER.1	pool water source only
S-W01 to S-W24	source information for pool walls only (24 files)
S-001 to S-077	source information for other radiation sources (77 files)

The various parts of the MCNP input files were combined using a batch file named MK-NEAR.BAT. This batch file is listed in Appendix E. Finally, a portion of the UNIX run streams actually used to run MCNP is listed at the end of Appendix E.

To determine the full KE-Basin grid, a spreadsheet named GRID-C.WQ1 was created to facilitate the preparation of the detector coordinate files. This spreadsheet will omit selected X & Y coordinates corresponding to inaccessible locations. A small amount of post-processing is necessary to put the PT-ALL.C (chest level) and PT-ALL.K (knee level) files in proper format for use by MCNP. The MK-NEAR.BAT file was then modified to use the chest level grid rather than the near source detector points. This batch file is called MK-CHST.BAT. Similarly, a batch file named MK-KNEE.BAT was used to generate input files for the knee level grid.

POST-PROCESSING OF MCNP OUTPUT

The point-kernel version of the MCNP software was used for these calculations rather than the full monte-carlo owing to time constraints. Approximately 92 hours of CPU time was needed nevertheless. Basically, the point-kernel calculation proceeds as follows: a point is randomly selected within a source and a line is drawn between this point and the detector location. The attenuation and buildup factors are computed and used for the total dose rate from that source location. This is repeated according to the input value for the number of source particles (nps), and the final total dose rate is computed. The point-kernel approach leads to sharp shadows since scattering off the air and any nearby objects is not considered. Somewhat larger than life volumetric sources were used to offset this effect.

The dose rates computed by MCNP for the unit source concentrations is in the form of MCTAL summary tables. One of these is listed in Appendix F for the PVC hot spot using near source detectors. These are difficult to use directly due to the layout of the numbers in the file. Since there are a total of 102 distinct sources, there are also 204 summary files for knee and chest level cases which must be used. For this reason, the MCNP output was rearranged using software written for this purpose (ALLTBL.PAS and BINCALI.PAS).

The output from the near source cases was rearranged in the form of individual source tables and a combined table for input to a spreadsheet. The program is named ALLTBL.PAS and is listed in Appendix F. A table file generated by ALLTBL.PAS is shown just after the MCTAL file for the same source. The large array for the spreadsheet has 102 rows and 73 columns. Actually, spreadsheets are not able to read lines with more than 250 characters. The combined output file is therefore broken into blocks with 102 rows and 20 columns. The blocks are easily recombined in a spreadsheet to form the needed 73 columns.

The formulas used in the calculations are best represented using matrices. In practice, one selects values for the 102 source strengths (the S vector) and then computes the 73 dose rates (the D vector) using the equation below.

$$\mathbf{D}_{n,1} = \mathbf{M}_{n,s}\,\mathbf{S}_{s,1}$$

where,

$\mathbf{D}_{n,1}$ = column vector with MCNP dose rates (mrem/h) at n locations

$\mathbf{M}_{n,s}$ = matrix with MCNP dose rates at n locations for s unit sources

$\mathbf{S}_{s,1}$ = column vector with the source strengths for s sources

This spreadsheet with the dose rates near the sources is called NEAR.WQ1. At each detector location the total dose is the weighted sum of the doses from individual sources. The spreadsheet was set up to facilitate trial-and-error estimates of source concentrations (the S vector in the above equation). This iterative process is the simplest way to arrive at a best estimate of the Cs-137 activity present in each source. The resulting source strengths are shown in Table 5 below. Note that the two columns of numbers are nearly the same. Asterisks mark values which differ. The resulting weighted sums of dose rates are shown in Table 3.

Table 5. Source Concentrations from NEAR.WQ1 and SSS.PAS

NEAR.WQ1	Source ID	SSS.PAS
2.70 μCi/L	Pool Water (16'10")	2.70 μCi/L
20.0 μCi/cm²	West Wall - North	20.0 μCi/cm²
23.0 μCi/cm²	West Wall - Middle	23.0 μCi/cm²
10.0 μCi/cm²	West Wall - South	10.0 μCi/cm²
25.0 μCi/cm²	N Wall - West	25.0 μCi/cm²
22.0 μCi/cm²	N Wall - Middle	22.0 μCi/cm²
20.0 μCi/cm²	N Wall - East	20.0 μCi/cm²
15.0 μCi/cm²	S Wall - West	15.0 μCi/cm²
22.0 μCi/cm²	S Wall - Discharge	22.0 μCi/cm²
20.0 μCi/cm²	S Wall - East	20.0 μCi/cm²
20.0 μCi/cm²	E Wall - North	20.0 μCi/cm²
70.0 μCi/cm²	E Wall - Middle	70.0 μCi/cm²
14.0 μCi/cm²	E Wall - Weasel	14.0 μCi/cm²
80.0 μCi/cm²	E Wall - Tech View	80.0 μCi/cm²
63.0 μCi/cm²	E Wall - South	63.0 μCi/cm²
35.0 μCi/cm²	Inner W - West	35.0 μCi/cm²
43.0 μCi/cm²	Inner W - East	43.0 μCi/cm²
33.0 μCi/cm²	Inner E - West	33.0 μCi/cm²
35.0 μCi/cm²	Inner E - East	35.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - N	40.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - E	40.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - SE	40.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - E	40.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - S	40.0 μCi/cm²
40.0 μCi/cm²	Elevator Pit - W	40.0 μCi/cm²
0.250 Ci/m3	E Pump #2 Pedestal	0.250 Ci/m3
2.00 Ci/m3	Lead Cave	2.00 Ci/m3
20.0 Ci/m3	IXM #1 (west)	20.0 Ci/m3
10.0 Ci/m3	IXM #2 (east)	10.0 Ci/m3
1.00 Ci/m3	S Load Drip W	* 2.50 Ci/m3
2.00 Ci/m3	S Load Drip Mid	2.00 Ci/m3
3.00 Ci/m3	S Load Drip E	* 1.50 Ci/m3
0.300 Ci/m3	Sampler 10.9C	0.300 Ci/m3
0.100 Ci/m3	PVC Pipes N Load	0.100 Ci/m3
6.50 Ci/m3	Sand Filter	6.50 Ci/m3
25.0 Ci/m3	IX #3 (west)	25.0 Ci/m3
30.0 Ci/m3	IX #2 (middle)	30.0 Ci/m3
50.0 Ci/m3	IX #1 (east)	50.0 Ci/m3
0.180 Ci/m3	Chiller	0.180 Ci/m3
0.400 Ci/m3	Heat Exchanger	0.400 Ci/m3
0.800 Ci/m3	NW Filter Media	* 0.600 Ci/m3
15.0 mCi/m	N Loadout Entry	15.0 mCi/m
10.0 mCi/m	SF to 13B Riser	* 5.00 mCi/m
8.00 mCi/m	Col 13B Riser	8.00 mCi/m
10.0 mCi/m	W 9.5' NS N	10.0 mCi/m
10.0 mCi/m	W 9.5' EW N	10.0 mCi/m
2.00 mCi/m	Col 13D Riser	* 1.00 mCi/m
15.0 mCi/m	W 9.5' NS S	* 5.00 mCi/m
8.00 mCi/m	W 9.5' EW S	* 4.00 mCi/m
30.0 mCi/m	S Loadout Riser	* 25.0 mCi/m
4.00 mCi/m	IX Box Outlet	4.00 mCi/m

Table 5. Source Concentrations from NEAR.WQ1 and SSS.PAS, Continued

NEAR.WQ1	Source ID		SSS.PAS
10.0 mCi/m	IX Box NS		10.0 mCi/m
7.00 mCi/m	N Loadout Chest	*	5.00 mCi/m
9.00 mCi/m	W Ovrhd Riser		9.00 mCi/m
20.0 mCi/m	W 10' NS N		20.0 mCi/m
5.00 mCi/m	W 10' to IXM		5.00 mCi/m
5.00 mCi/m	W 10' NS S		5.00 mCi/m
4.00 mCi/m	South Overhead		4.00 mCi/m
2.00 mCi/m	S Riser 12.2		2.00 mCi/m
4.00 mCi/m	S Riser 9.5	*	7.00 mCi/m
6.00 mCi/m	S Riser 7.7		6.00 mCi/m
3.00 mCi/m	East Ovrhd NS		3.00 mCi/m
10.0 mCi/m	East Ovrhd EW S		10.0 mCi/m
15.0 mCi/m	East Over HX		15.0 mCi/m
10.0 mCi/m	East Ovrhd EW N		10.0 mCi/m
5.00 mCi/m	TV #2 NS N		5.00 mCi/m
10.0 mCi/m	TV #2 NS S		10.0 mCi/m
5.00 mCi/m	Chiller Riser		5.00 mCi/m
5.00 mCi/m	TV #2 Bypass		5.00 mCi/m
2.00 mCi/m	TV Riser #2		2.00 mCi/m
10.0 mCi/m	TV Riser #1	*	6.00 mCi/m
7.00 mCi/m	TV Riser #3	*	3.00 mCi/m
5.00 mCi/m	TV #3 Bypass	*	6.00 mCi/m
30.0 mCi/m	TV #3 NS		30.0 mCi/m
2.00 mCi/m	TV #3 EW		2.00 mCi/m
10.0 mCi/m	E Pumps Ovrhd	*	15.0 mCi/m
7.00 mCi/m	Ovrhd #1 East	*	4.00 mCi/m
5.00 mCi/m	Horiz #1 East	*	6.00 mCi/m
5.00 mCi/m	Pool #1 East	*	8.00 mCi/m
5.00 mCi/m	Ovrhd #2 East	*	3.00 mCi/m
2.00 mCi/m	Horiz #2 East	*	5.00 mCi/m
1.00 mCi/m	Pool #2 East	*	4.00 mCi/m
10.0 mCi/m	E Wall Plenum		10.0 mCi/m
30.0 mCi/m	E Wall North		30.0 mCi/m
20.0 mCi/m	North Wall		20.0 mCi/m
4.00 mCi/m	West Wall		4.00 mCi/m
3.00 mCi/m	Riser N Col 12	*	4.00 mCi/m
3.00 mCi/m	Riser N Col 10		3.00 mCi/m
3.00 mCi/m	Riser N Col 8		3.00 mCi/m
5.00 mCi/m	Horiz N Col 12	*	6.00 mCi/m
2.00 mCi/m	Horiz N Col 10		2.00 mCi/m
4.00 mCi/m	Horiz N Col 8		4.00 mCi/m
10.0 mCi/m	Sand Fltr Riser		10.0 mCi/m
10.0 mCi/m	Sand Fltr Pump		10.0 mCi/m
2.00 mCi/m	PVC Riser in NL		2.00 mCi/m
0.070 Ci	PVC Hot Spot		0.070 Ci
5.00 mCi/m	PVC NS in West		5.00 mCi/m
10.0 mCi/m	SF Pipe #1		10.0 mCi/m
20.0 mCi/m	SF Pipe #2		20.0 mCi/m
10.0 mCi/m	SF Pipe #3		10.0 mCi/m
5.00 mCi/m	SF Pipe #4		5.00 mCi/m
1.00 mCi/m	SF Pipe #5		1.00 mCi/m

Output from the survey grid cases was much larger, with 966 dose rates for both the knee level and the chest level grids. These MCTAL files were read by BINCALI.PAS which stores them in a 2 dimensional array and writes them to a binary format for ease of use by other programs. This program also generates a text file with the dose rates and monte carlo relative errors positioned in a 2 dimensional array for ease of reading. In addition, a text file with the array of dose rates transposed is printed. This transposed array format is able to be read by spreadsheets since the lines are less than 250 characters. Using the standard spreadsheet function to transpose a matrix, the original layout is easily obtained. BINCALI.PAS is listed in Appendix G.

The final problem is to find values for source concentrations that approximate the readings taken by technicians in September, 1996. The calculation is simple enough, as shown in the matrix equation. Multiply the knee and chest level dose rates for each source times the source concentration and add them up. The problem is that 197,064 numbers need to be combined to give a result that is made of 1932 numbers. Initially, it was thought that this could be done in a spreadsheet, as had been done in the past. However, the size of the problem required the writing of another program to work with the numbers.

The program SSS.PAS was written to be the spreadsheet substitute. The program listing for SSS.PAS is in Appendix H. The program reads the source initialization file, (SOURCE.INI), the two MCNP dose rate files (CHST1.BIN and KNEE1.BIN), and finally, the instrument reading files (9CHST.BIN and 9KNEE.BIN). Using the source concentrations in SOURCE.INI, the total dose rates are computed and displayed using a single character to represent each grid location, and coloring that character to represent the dose rate.

The SSS.PAS software also displays a modified relative error (MRE) between the measured values and the computed values. This modified relative difference is computed using the equation below.

$$\mathbf{MRE} = \frac{\mathbf{Data - Calc}}{\mathbf{1 + Min(Data,Calc)}}$$

The denominator is increased by 1 to decrease the importance of small dose rates. Neither the Data nor the Calculated dose rates were considered to be suitable reference values, so the minimum of the two was used in the denominator. The sum of the absolute values of the modified relative differences is used as a figure of merit on the closeness of the approximation. The source concentrations were adjusted to minimize this figure of merit.

Having a stand-alone program to compute dose rates also gives more flexibility to apply more advanced numerical methods, such as linear least squares fits. Linear least squares fitting of data can be represented using matrices in the equation below.

$$\mathbf{M}_{s,n}\,\mathbf{M}_{n,s}\,\mathbf{S}_{s,1} = \mathbf{M}_{s,n}\,\mathbf{D}_{n,1}$$

where,

$\mathbf{M}_{s,n}$ = transpose of the matrix with MCNP dose rates

$\mathbf{M}_{n,s}$ = matrix with MCNP dose rates at n locations for s unit sources

$\mathbf{S}_{s,1}$ = column vector with the source strengths for s sources

$\mathbf{D}_{n,1}$ = column vector with MCNP dose rates (mrem/h) at n locations

The above equation is a system of s(=102) equations in s unknowns (the S vector). The only constraint is that n must be larger than s. Since there are n=966 data points and s=102 sources, a solution is typically possible.

Linear least squares fitting (LLSQ) of the data was included in the SSS.PAS utility, but the results include negative source concentrations and are largely useless. The SSS program was modified to improve the LLSQ calculation by allowing the user to select which sources to use for fitting and which data points. This feature was used in debugging the program by selecting a few point near strong sources. It was also used to estimate the source vector by just using data and sources on the west end or east end. Negative sources were still predicted. An iterative procedure was followed in which the reasonable sized sources were fixed and LLSQ was repeated.

The initial approximations using the near source readings were improved by trial and error using SSS.PAS and the MRE figure of merit. The resulting solution was used again in the NEAR.WQ1 spreadsheet to further refine the near-source calculations. This is the approach used to generate the source strengths shown in Table 5.

The last column of Table 5 shows the results of the trial-and-error approach using SSS.PAS and the entire grid of data. Asterisks mark sources whose magnitude changed between the near-source case and the general grid case. For many of the sources, the concentrations decreased. This suggests that the MCNP sources are larger and more uniform than the sources actually present in KE-Basin. The near source locations typically required a higher concentration than the general area grid.

The dose rates from MCNP as well as the measured data are presented in Appendix A. The comparisons between the measured and computed dose rates at various grid locations are also shown in this appendix. The letters across the top and the numbers down the side are the grid reference locations where data was collected. These are about 4 feet apart. The pool lies between columns O and AT, and rows 2 to 18. The west inner wall is between columns Y & Z, and the east inner wall is at column AJ.

It must be noted that the trial and error process of improving the MCNP representation of the data could not be automated due to the excessively long computing times needed to complete the optimization. For example, if each source were adjusted upward and downward by 20 percent to find an improved fit to the data, then the number of cases to compute would be 3 raised to the 102 power, which is 4.6E+48. If the figure of merit for one combination of source strengths could be computed in 1 second, then the complete calculation would require 1.5E+41 years! If only 30 sources were optimized in this way, the calculations would still require 6 million years!

Contour plots of the MCNP results are presented in Appendix B. These were generated by Victor Roetman using PVWAVE™ Version 6 software (PVWAVE is a trademark of Visual Numerics Corporation). The sources were grouped to reduce the number of plots needed.

REFERENCES

American National Standard for Gamma-Ray Attenuation Coefficients and Buildup Factors for Engineering Materials, ANSI/ANS-6.4.3-1991, American Nuclear Society, August, 1991.

Carter, L. L., "Bulk Shield Design for Neutron Energies Below 50 MeV", *Nuclear Technology/Fusion*, Vol. 3, pp 165-180, March, 1983.

Carter, L. L., "Certification of MCNP Version 4A for WHC Computer Platforms", WHC-SD-MP-SWD-30001, Rev. 8, May, 1996.

Simons, R. L., "KE-Basin Dose Rate Reduction by Cleaning, Coating, and Raising the Water Level", Internal Memo 8M730-RLS-95-014, December 28, 1995.

Van Riper, K. A., "SABRINA User's Guide", LA-UR-93-3696, Los Alamos National Laboratory, October, 1993.

Wittekind, W. D., "Criticality Safety Evaluation for K Basins Sand Filters", EDT 130158, WHC-SD-NR-CSER-013 Rev 0, April, 1994.

Appendix A. MCNP Dose Rates, Modified Relative Errors, and Data

MCNP Dose Rates (mrem/h) -- Chest Level

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1.2	2.6	9.4	3.2	1.4	1.0	1.1	1.9	2.5	2.9	2.1	2.9	3.4	3.5	3.3	3.5	4.8	3.1	2.5
2		0.8	1.2	2.0	3.3	2.7	2.3	1.8	1.2	2.5	5.2	3.8	4.1	6.1	7.2	7.6	6.9	6.6	6.3	6.0	5.8
3	0.7	0.8	1.1	1.4	1.9	2.4	3.0	4.1	5.1				12.6	11.2	8.5	6.8	5.7	5.0	4.6	4.3	4.3
4	0.7	0.8	1.0	1.2	1.6	2.4	3.3	4.7	6.1				38.4	13.7	8.6	6.3	4.9	4.2	3.7	3.5	3.5
5	0.6	0.7	0.8	0.9	1.4	2.5	3.7	5.3	8.2	13.5	17.7	21.2	21.2	14.1	9.5	6.5	4.9	3.9	3.4	3.1	3.1
6	0.8	0.9	1.0	1.1	1.0	2.4	11.1	13.0	18.0				24.5	16.9	10.8	6.7	4.9	3.9	3.3	3.0	3.1
7	0.8	1.0	1.2	1.6	2.0								27.4	17.2	10.8	6.7	4.8	3.8	3.2	2.9	3.0
8	0.8	0.9	1.0	1.2	1.4					8.6	12.9	18.7	19.7	14.3	9.9	6.5	4.7	3.6	3.1	2.8	2.9
9	0.8	0.9	1.1	1.2	1.1	0.6				5.9	8.9	12.3	14.1	10.7	8.2	6.0	4.4	3.5	3.0	2.7	2.8
10	0.8	0.9	1.1	1.5	2.0	2.5				6.3	7.8	9.4	10.7	9.4	7.3	5.6	4.1	3.3	2.8	2.6	2.6
11	0.8	1.0	1.4	2.1	2.7	3.0	4.9	4.3	5.5	7.0	8.1	9.4	10.1	9.9	6.9	5.0	3.7	3.0	2.6	2.5	2.5
12	0.8	1.1	1.9	4.2	9.4	6.3	9.3	8.6	10.7				10.8	8.4	6.0	4.6	3.5	2.9	2.5	2.4	2.4
13	0.8	1.2	2.0	5.4	22.3	7.7	15.9	11.0	17.8				11.2	7.5	5.2	4.2	3.3	2.8	2.5	2.3	2.4
14	0.9	1.2	1.8	3.0	4.5	4.5	5.2	5.6	6.1				9.2	6.2	4.8	3.9	3.2	2.8	2.5	2.4	2.4
15	0.8	1.0	1.4	1.8	2.3	2.7	3.0	3.4	3.9	4.7	6.3	7.7	7.0	5.4	4.4	3.8	3.2	2.9	2.7	2.6	2.6
16	0.7	0.9	1.1	1.4	1.6	1.9	2.2	2.5	2.8	3.4	4.3	5.3	5.5	4.6	4.3	4.0	3.7	3.5	3.4	3.2	3.2
17	0.6	0.8	0.9	1.1	1.3	1.5	1.7	1.8	2.1	2.5	3.0	3.8	4.2	3.9	3.6	3.4	3.1	3.1	3.6	2.9	2.7
18	0.6	0.7	0.8	0.9	1.0	1.2	1.3	1.5	1.6	1.9	2.1	2.5	2.8	2.8	2.7	2.5	2.3	1.8	0.4	2.2	2.0
19	0.5	0.6	0.7	0.7	0.8	1.0	1.1	1.2		1.5	1.6	1.7	1.9	1.9	1.9	1.7	1.5	1.4	1.1	1.2	1.1
20	0.5	0.5	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.4	1.3	1.2	1.1			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	2.4	2.7	1.8	1.8	2.4	1.9	1.9	2.3	3.3	1.9	1.8	2.0	2.4	1.6	1.6	2.2	2.1	2.3	3.5	4.3	2.7
2	6.0	6.6	4.1	4.2	6.1	5.2	4.9	5.1	5.1	4.9	5.0	5.4	6.1	3.4	4.0	5.7	5.3	5.4	5.7	5.8	6.1
3	4.7	6.0	3.1	3.3	5.6	4.0	3.5	3.5	3.5	3.5	3.7	4.2	5.6	2.6	3.0	5.1	4.1	3.9	4.0	4.1	4.8
4	4.1	5.5	2.6	2.7	5.1	3.3	2.7	2.7	2.6	2.6	2.9	3.5	5.1	2.1	2.5	4.6	3.3	3.0	3.2	3.3	4.2
5	3.8	5.5	2.3	2.5	4.9	2.8	2.2	2.1	2.0	2.1	2.4	3.0	4.9	1.7	2.1	4.3	2.9	2.5	2.7	2.8	3.9
6	3.9	5.9	2.3	2.6	5.0	2.6	2.0	1.9	1.8	1.8	2.1	2.9	4.9	1.6	2.0	4.2	2.7	2.3	2.5	2.7	3.8
7	3.9	6.2	2.5	2.7	4.9	2.5	1.8	1.8	1.7	1.7	2.0	2.7	4.7	1.5	1.9	4.1	2.6	2.2	2.4	2.6	3.7
8	3.8	6.1	2.5	2.7	4.8	2.5	1.8	1.7		1.7	2.0	2.7	4.6	1.4	1.8	4.1	2.5	2.2	2.3	2.5	3.6
9	3.6	5.5	2.0	2.3	4.7	2.4	1.8	1.7		1.7	2.0	2.7	4.6	1.4	1.8	4.0	2.5	2.1	2.3	2.5	3.4
10	3.4	5.1	1.9	2.1	4.6	2.4	1.7	1.7		1.7	2.0	2.7	4.6	1.4	1.8	4.0	2.5	2.1	2.3	2.4	3.3
11	3.2	4.9	1.8	2.0	4.6	2.4	1.7	1.7	1.6	1.7	2.0	2.7	4.6	1.4	1.9	4.1	2.5	2.1	2.3	2.4	3.1
12	3.0	4.8	1.8	2.0	4.5	2.4	1.8	1.7	1.6	1.7	2.0	2.7	4.6	1.5	1.9	4.0	2.5	2.1	2.3	2.4	2.9
13	3.0	4.7	1.8	2.0	4.5	2.4	1.8	1.8	1.7	1.8	2.1	2.8	4.7	1.6	2.0	4.1	2.6	2.2	2.3	2.4	2.9
14	3.0	4.7	1.9	2.0	4.5	2.5	1.9	1.9	1.9	2.0	2.3	3.0	4.8	1.7	2.1	4.1	2.7	2.3	2.4	2.5	3.0
15	3.2	4.8	2.1	2.2	4.6	2.7	2.2	2.2	2.2	2.4	2.7	3.4	5.1	2.0	2.3	4.3	2.9	2.6	2.6	2.8	3.2
16	3.6	4.8	2.5	2.7	4.8	3.2	2.7	2.8	2.9	3.4	3.9	4.6	5.5	2.6	3.0	4.7	3.6	3.3	3.3	3.6	4.3
17	2.8	3.5	2.2	2.3	3.6	2.6	2.4	2.4	2.5	3.0	4.3	6.5	4.3	2.5	2.6	3.6	2.9	2.8	2.9	3.4	6.0
18	2.0	0.3	1.5	1.7	2.0	1.8	1.3	1.8	0.9	0.1		0.6	3.0	2.1	2.0	1.7	2.0	2.2		2.2	
19	1.2	1.2	1.0	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.6		1.3	1.5
20		0.9	0.9	0.7	0.8	0.9	1.1												1.3	1.2	1.2

North

	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	2.8	3.2	2.0	1.7	1.1			0.9	0.9				
2	6.3	7.8	4.7	3.9	3.2			2.1	1.4	1.2	1.0		
3	5.3	7.7	5.6					6.5	2.5	1.8	1.4		
4	4.8	8.1	5.1	10.8	11.7	8.7	7.7	4.8	3.2		2.0		
5	4.6	9.1	4.9	6.8	7.6	6.6	6.3	5.9	5.4		3.0		
6	4.6	9.6	5.7	7.9	13.0	8.5	9.0				5.4	3.4	2.4
7	4.5	9.5	6.1	9.0	11.6	10.7	11.6					4.2	2.8
8	4.4	9.2	6.3	10.0	15.1	12.1	12.8					4.3	3.0
9	4.1	8.8	5.7	8.5	11.8	12.5	13.3	17.7					2.8
10	3.9	8.2	5.4	6.9	9.4	11.8	14.5	13.2	9.8	6.4		3.3	2.5
11	3.6	6.8	5.0	5.8	7.4	10.6	22.1	15.0	8.9	5.8	4.0	3.0	2.3
12	3.3	5.5	4.4	5.3	6.7	10.2	16.7	13.8			3.8		
13	3.2	5.1	4.0	4.7	5.7	8.7	16.8	11.1	6.5	4.3	3.1		
14	3.3	5.5	3.8	4.0	4.5	6.2					2.4		
15	3.5	5.6	3.6	3.5	3.5	3.9	4.1	3.8	3.2	2.4	2.0	1.6	
16	4.5	6.6	3.9	3.2					2.0	1.8	1.6	1.4	
17	4.8	5.6	3.3	2.6	1.9	1.6	1.4	1.4	1.3				
18	4.3	2.9	2.4	1.3	1.3	1.1	1.0	0.9	0.9				
19	1.9	1.7	1.0	1.1	0.9		0.7	0.7	0.7				
20	1.3	0.9	1.0	0.9	0.7	0.6	0.6	0.5	0.5				

MCNP Dose Rates (mrem/h) -- Knee Level

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1.2	3.0	36.9	3.7	1.5	1.0	1.0	1.7	2.1	2.5	2.0	2.9	3.8	3.6	3.4	3.8	10.8	3.4	2.6
2		0.8	1.2	2.1	3.8	2.8	2.2	1.7	1.1	1.8	3.4	3.0	4.2	5.9	9.4	8.8	8.2	8.0	7.9	7.2	6.9
3	0.7	0.8	1.1	1.4	1.8	2.3	2.9	3.7	4.0				13.3	16.1	10.2	5.9	4.9	4.5	4.1	3.7	3.6
4	0.6	0.8	1.0	1.2	1.6	2.3	3.2	4.4	5.2				14.1	11.6	9.9	5.3	4.2	3.7	3.3	2.9	2.8
5	0.6	0.7	0.8	0.9	1.4	2.4	3.7	5.0	7.3	10.2	12.3	13.2	13.1	10.5	10.1	5.7	4.4	3.6	3.1	2.7	2.6
6	0.7	0.8	1.0	1.1	1.0	2.2	5.5	7.1	11.7				19.8	15.2	10.6	5.8	4.5	3.7	3.1	2.6	2.7
7	0.7	0.9	1.1	1.5	1.9								19.0	14.3	10.4	5.8	4.4	3.7	3.0	2.6	2.6
8	0.7	0.9	1.0	1.1	1.3					5.4	7.4	10.1	12.0	10.0	9.9	5.6	4.3	3.5	3.1	2.6	2.6
9	0.7	0.9	1.0	1.1	1.0	0.5				4.8	7.0	9.1	9.8	8.1	9.2	5.3	4.1	3.5	2.9	2.5	2.5
10	0.7	0.8	1.1	1.4	1.9	1.9				5.3	6.6	7.5	8.0	7.3	8.6	5.0	3.9	3.3	2.8	2.4	2.4
11	0.7	0.9	1.3	1.9	2.4	2.7	4.0	3.5	4.3	5.5	6.2	7.0	7.3	7.8	7.9	4.4	3.5	3.1	2.6	2.3	2.3
12	0.7	1.0	1.6	3.1	5.0	4.7	5.8	6.0	6.8				7.8	6.7	6.8	4.1	3.4	2.9	2.6	2.2	2.2
13	0.7	1.0	1.7	3.5	6.4	5.3	6.8	6.9	7.4				7.4	6.0	5.6	3.9	3.2	2.9	2.5	2.2	2.2
14	0.7	1.0	1.5	2.4	3.3	3.6	4.3	4.7	5.0				6.4	5.0	5.2	3.5	3.1	2.8	2.5	2.2	2.2
15	0.6	0.9	1.2	1.6	2.0	2.5	2.8	3.2	3.6	4.2	5.2	5.9	5.2	4.4	5.0	3.4	3.0	2.8	2.6	2.3	2.3
16	0.6	0.8	0.9	1.2	1.6	1.8	2.1	2.4	2.7	3.2	3.7	4.2	4.2	3.7	4.8	3.5	3.4	3.3	3.1	2.8	2.8
17	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.1	2.4	2.6	3.1	3.2	3.2	4.4	3.4	3.2	3.3	3.8	2.9	2.7
18	0.6	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.7	1.9	2.0	2.3	2.4	2.4	2.3	2.1	1.9	1.5	0.3	1.8	1.6
19	0.5	0.6	0.7	0.7	0.8	1.0	1.1	1.2		1.4	1.5	1.6	1.7	1.7	1.7	1.5	1.4	1.3	0.9	1.0	1.0
20	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.1			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	2.3	2.3	1.9	1.9	1.9	1.9	2.1	2.8	9.4	2.1	1.9	2.0	2.1	1.6	1.7	1.9	2.1	2.4	4.5	6.1	2.6
2	6.9	8.2	4.3	4.8	6.6	6.0	6.1	6.5	6.6	6.1	6.1	6.4	7.7	3.5	4.5	6.3	6.4	6.7	7.1	7.1	7.0
3	3.8	6.0	2.5	2.8	3.9	3.0	2.9	3.0	3.0	2.9	3.0	3.4	6.0	1.8	2.6	3.6	3.2	3.3	3.4	3.5	3.8
4	3.0	5.3	2.0	2.2	3.0	2.2	2.1	2.1	2.1	2.0	2.1	2.6	5.2	1.4	2.0	2.8	2.4	2.4	2.5	2.7	3.1
5	2.9	5.7	1.9	2.1	2.9	1.9	1.7	1.7	1.7	1.7	1.8	2.3	5.2	1.2	1.8	2.7	2.0	2.0	2.2	2.4	2.9
6	3.2	7.1	2.0	2.4	2.9	1.8	1.6	1.6	1.5	1.5	1.7	2.2	5.5	1.1	1.8	2.6	1.9	1.9	2.1	2.3	2.9
7	3.2	8.6	3.1	2.8	2.8	1.7	1.6	1.5	1.5	1.5	1.6	2.1	5.2	1.1	1.8	2.5	1.9	1.9	2.0	2.3	2.8
8	3.2	8.6	3.0	2.7	2.8	1.7	1.5	1.5		1.5	1.6	2.1	5.2	1.1	1.8	2.5	1.9	1.9	2.1	2.3	2.8
9	2.9	6.2	1.8	2.2	2.7	1.7	1.5	1.5		1.5	1.6	2.1	5.0	1.1	1.8	2.6	1.9	1.9	2.1	2.3	2.8
10	2.7	5.6	1.7	2.0	2.7	1.7	1.5	1.5		1.5	1.7	2.2	5.2	1.2	1.8	2.5	1.9	1.9	2.1	2.3	2.7
11	2.5	5.0	1.7	1.9	2.7	1.7	1.6	1.5	1.5	1.5	1.7	2.2	5.1	1.2	1.9	2.6	1.9	1.9	2.1	2.3	2.7
12	2.5	5.3	1.8	2.0	2.8	1.8	1.6	1.6	1.6	1.6	1.8	2.3	5.5	1.3	1.9	2.7	2.0	2.0	2.1	2.3	2.6
13	2.5	5.1	1.8	1.9	2.7	1.8	1.7	1.7	1.7	1.7	1.8	2.4	5.3	1.3	1.9	2.7	2.1	2.1	2.2	2.3	2.6
14	2.4	4.7	1.8	1.9	2.7	1.8	1.7	1.7	1.8	1.8	1.9	2.4	5.1	1.5	2.0	2.7	2.1	2.1	2.2	2.3	2.6
15	2.6	5.1	1.9	2.1	2.9	2.0	1.9	1.9	2.0	2.1	2.3	2.8	5.7	1.6	2.2	2.9	2.3	2.2	2.4	2.5	2.8
16	2.9	4.9	2.1	2.4	3.3	2.5	2.3	2.4	2.6	3.0	3.4	4.1	5.9	2.1	2.7	3.5	2.9	2.8	2.9	3.1	3.8
17	2.7	3.5	2.0	2.2	2.8	2.4	2.2	2.3	2.5	3.2	4.4	6.5	4.6	2.4	2.6	3.1	2.9	2.8	2.8	3.3	6.0
18	1.4	0.2	1.1	1.3	1.3	1.2	1.1	1.5	0.6	0.0		0.5	2.1	1.6	1.5	1.0	1.5	1.7		1.9	
19	1.0	1.0	0.9	0.9	0.8	0.9	1.2	1.2	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5		1.3	1.3
20		0.7	0.7	0.6	0.7	0.7	1.1												1.4	1.3	1.0

North

	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	2.7	3.3	2.3	1.5	1.0			0.9	0.9				
2	7.4	10.0	5.3	2.9	1.5			1.3	1.2	1.1	0.9		
3	4.5	7.8	4.0					6.3	1.8	1.5	1.1		
4	4.0	7.9	3.6	13.3	14.3	7.6	7.3	4.1	2.5		1.1		
5	4.1	9.3	4.9	6.3	6.4	5.3	5.1	4.0	3.5		1.5		
6	4.2	9.8	6.4	11.8	14.9	7.3	8.0				3.5	2.7	2.1
7	4.2	9.5	6.5	9.5	10.3	9.0	10.4					3.2	2.5
8	4.0	8.9	7.1	14.8	15.0	9.9	11.3					3.3	2.6
9	4.0	8.6	5.4	7.9	9.6	9.8	10.8	9.2					2.4
10	3.8	8.1	5.0	5.9	7.6	9.3	10.6	9.5	7.7	0.2		2.7	2.3
11	3.4	6.2	4.5	5.1	6.5	8.7	16.0	10.8	7.5	4.7	3.4	2.5	2.1
12	3.2	4.9	3.9	4.8	6.0	8.5	11.9	10.0			3.5		
13	3.1	4.6	3.7	4.4	5.3	8.0	14.6	9.0	5.9	4.0	2.9		
14	3.2	5.4	3.5	3.6	4.2	6.1					2.3		
15	3.3	5.4	3.2	3.3	3.3	4.0	4.3	3.9	3.3	2.5	1.9	1.6	
16	4.2	6.3	3.4	2.5					2.1	1.8	1.5	1.3	
17	5.0	6.1	3.2	2.2	1.7	1.5	1.4	1.3	1.3				
18	3.7	2.2	2.0	1.1	1.2	1.0	0.9	0.9	0.9				
19	1.7	1.5	0.8	1.1	0.9		0.7	0.7	0.7				
20	1.1	0.8	0.9	0.9	0.7	0.6	0.6	0.5	0.5				

MCNP Compared with Measured Dose Rates -- Chest Level

Modified Relative Differences are Shown (Total MRE is 211)

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1				0.4	0.7	0.0	-0.1	0.0	-0.2	0.5	0.2	0.7	-0.3	-0.3	-0.1	-0.1	-0.2	-0.1	-0.0	0.0	-0.4
2		0.1		0.1	-0.4	0.0	0.3	0.4	0.0	-0.2	-0.1	-0.1	-0.8	0.0	-0.1	0.2	0.3	0.5	0.8	0.3	0.1
3	0.1	-0.0	0.0	0.0	-0.1	0.1	-1.5	0.3	0.0				-0.3	-0.4	-0.3	-0.0	0.3	0.2	0.2	0.2	0.1
4	-0.0	-0.0	0.0	0.0	-0.1	0.1	-0.4	0.1	-0.1				-0.0	0.0	-0.4	-0.2	0.2	0.0	0.2	0.2	0.2
5	-0.1		0.1	-0.1	-0.1	0.1	-0.3	-0.4	0.0	0.0	0.1	0.1	-0.4	-0.3	-0.0	-0.1	-0.0	-0.0	0.1	0.1	0.1
6	-0.1	0.2	0.2	-0.1	-0.2	-0.1	0.0		-0.3				0.1	-0.0	-0.0	-0.0	-0.2	-0.0	0.1	0.1	0.2
7	-0.1	-0.0	0.1	0.2	0.4								-0.1	-0.1	0.1	-0.2	-0.0	0.2	0.0	0.1	0.1
8	-0.2	-0.3	0.0	0.1	0.2					0.2	0.2	-0.0	-0.2	-0.0	0.1	-0.1	0.1	0.2	0.1	0.1	0.1
9	-0.5	-0.2	-0.1	-0.1	0.6	-0.3				-0.0	-0.0	-0.2	-0.3	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.1
10			-0.1	-0.3	0.2	0.1				0.0	-0.1	-0.2	-0.3	1.1	-0.1	-0.2	0.0	0.0	0.1	0.1	0.0
11			-0.1	0.1	-0.1	-0.3	0.2	0.3	0.6	0.1	0.0	-0.1	-0.1	0.4	-0.0	-0.2	-0.1	0.2	0.1	0.1	0.1
12	-0.6	-0.1	-0.2	0.2	0.0	-0.6	0.5	0.2	0.5				0.1	0.0	-0.1	-0.1	0.1	0.0	0.0	0.0	0.1
13	-0.2	0.0	-0.1	-0.1	0.2	-2.0	0.7	-1.1	0.2				0.1	-0.2	-0.1	-0.1	0.1	0.0	0.0	0.1	0.1
14	-0.1	0.1	0.0	-0.2	-0.1	-0.1	-0.3	-0.2	-0.4				-0.1	-0.3	-0.2	-0.2	-0.2	0.1	0.1	0.1	0.1
15	-0.1	0.0	-0.0	0.4	-0.1					-0.4	0.0	0.1	0.1	0.6	-0.3	-0.0	-0.2	0.1	0.1	0.2	0.1
16	-0.0	-0.0	-0.0	0.5	0.5					-0.6	-0.1	0.1	0.3	0.1	-0.3	-0.2	-0.1	0.2	0.1	0.1	0.1
17	-0.2	-0.1	-0.0	0.6	-0.2	-0.5	-1.6	-2.2	-2.5	-1.0	-0.3	0.1	0.2	0.4	-0.5	-0.4	-0.7	-0.5	-0.1	-0.0	-0.3
18	0.0	0.0	-0.0	0.0	-0.3	-0.5	-1.0	-1.9	-0.9	-0.7	-0.2	0.0	0.3	0.5	-6.0	-0.1	-0.3	-1.5	-2.3	0.1	0.1
19	0.3	0.3	0.2	0.1	0.1	-0.2	-0.4	-0.3		-0.1	0.0	0.1	0.2	0.3	0.1	0.0	-0.4	-0.7	-0.6	-0.1	-3.6
20	0.2	0.1	0.2	0.2	0.1	0.2	0.3	0.4	0.4	0.1	0.2	0.3	0.4	0.3	-4.1	0.0	-0.1	-0.2			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	-0.2	-0.4	-0.4	-0.8	-0.5	-0.4	-0.4	-0.8	-0.2	-1.0	-1.1	-1.0	-1.1	-0.9	-0.9	-0.9	-0.2	-0.8	-0.3	-0.1	-0.6
2	0.2	0.3	0.0	-0.1	0.0	0.2	-0.0	0.4	0.2	-0.0	-0.2	-0.1	-0.1	0.0	-0.0	-0.2	-0.1	0.1	0.3	0.5	0.0
3	0.1	-0.0	0.0	-0.0	-0.1	0.0	-0.1	0.0	0.0	-0.1	-0.0	-0.0	-0.1	-0.0	-0.2	0.0	0.1	0.1	0.2	0.2	0.2
4	0.2	0.1	0.2	-0.0	0.0	0.1	0.1	0.2	0.2	-0.0	0.0	-0.0	0.0	0.3	-0.1		0.3	0.1	0.3	0.2	0.1
5	0.4	-0.1	0.1	-0.0	-0.0	-0.0	-0.1	0.0	0.2	-0.0	-0.0	0.1	-0.0	0.0	-0.3	0.0	0.1	0.0	0.2	0.1	0.1
6	0.1	0.1	-0.2	-0.4	0.2	-0.0	-0.2	-0.0	0.0	0.0	0.0	0.1	0.4	-0.1	-0.3	0.6	0.1	0.0	0.2	0.1	0.1
7	-0.1	0.0	-0.4	-0.6	-0.4	0.0	-0.1	0.0	-0.0	-0.0	0.1	0.1	0.1	-0.0	-0.4	0.1	0.2	0.1	0.2	0.2	0.2
8	0.0	0.2	-0.2	-0.3	-0.2	-0.0	-0.1	0.0		0.0	0.1	0.1	0.1	0.0	-0.8	0.2	0.2	0.1	0.2	0.2	0.1
9	0.0	0.1	-0.1	-0.2	-0.2	-0.0	-0.2	-0.0		0.1	0.1	0.1	0.1	0.0	-0.4	0.1	0.1	0.0	0.1	0.0	0.1
10	0.0	0.0	-0.0	-0.1	-0.1	-0.0	-0.1	0.0		0.1	0.1	0.2	-0.1	0.0	-0.4	0.0	0.2	0.0	0.2	0.1	0.2
11	0.1	-0.0	-0.5	-0.4	-0.1	0.1	0.0	0.2	0.1	0.1	0.2	0.2	0.1	0.1	-0.1	0.1	0.2	0.1	0.1	0.2	0.2
12	0.1	0.2	-0.0	-0.2	0.1	0.1	-0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	-0.1	0.1	0.2	0.0	0.1	0.1	0.2
13	0.1	-0.0	-0.2	-0.1	0.1	0.1	-0.1	0.1	0.0	0.0	0.1	0.1	-0.1	0.0	-0.0	0.1	0.2	0.1	0.1	0.1	0.2
14	0.2	-0.0	-1.0	-0.3	-0.1	0.1	-0.0	0.2	0.1	0.1	0.1	0.2	0.2	0.1	-0.0	0.1	0.2	0.0	0.1	0.1	0.3
15	0.2	-0.0	-0.1	-0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.1	0.2	0.0	0.1	0.0	-0.1	0.2	0.0	0.0	0.1	0.2
16	0.0	0.2	-0.0	-0.1	-0.0	0.1	0.0	0.1	0.0	0.0	0.1	-0.2	0.1	-0.1	0.0	-0.0	0.2	0.2	0.1	0.1	0.2
17	-0.0	-0.1	-0.2	-0.1	-0.3	-0.1	-0.1	-0.2	-0.4	-0.4	-0.3	0.1	-0.1	-0.3	-0.2	-0.5	-0.1	-0.1	-0.1	-0.1	-0.1
18	0.1	-0.7	0.1	0.1	0.2	0.1	-0.1	-0.3	0.2	-0.3		-2.2	-0.1	-0.2	-0.5	0.1	-0.2	0.0		0.0	
19	0.1	0.3	0.1	0.1	0.1	0.1	-0.0	-0.1	-0.0	-0.1	-0.3	-0.5	-0.3	-0.1	-0.0	0.1	0.1	0.0		-0.5	-0.3
20		0.4	0.1	0.0	0.1	0.1	0.0												-0.1	-0.2	-0.0

North

	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	-0.9	-0.6	-0.6	0.0	-0.5			-0.3	-0.2				
2	-0.1	0.1	-0.6	-0.2	-0.7			-1.0	-0.2	-0.3	-0.5		
3	0.1	-0.2	-0.2					-0.2	0.0	-0.3	-0.4		
4	0.2	0.0	-0.1	0.1	0.2	0.4	0.6	-0.0	0.1		-0.1		
5	0.2	0.0	-0.2	-0.0	0.1	0.3	0.0	-0.0	-1.0		-0.8		
6	0.2	0.2	-0.3	-0.2	0.4	0.2	0.4				-0.9	-0.6	0.6
7	0.2	0.2	-0.1	-0.0	0.1	0.2	0.6					-0.2	1.0
8	0.1	0.1	-0.2	-0.1	-0.4	0.1	0.4					0.1	1.2
9	0.1	-0.0	-0.3	-0.1	-0.0	0.2	0.4	1.1					1.3
10	0.0	0.0	-0.3	-0.0	-0.2	0.1	0.6	0.4	0.4	0.2		-0.4	1.1
11	0.1	0.3	-0.0	-0.2	-0.2	-0.3	1.1	0.2	-0.1	-0.3	-0.4	0.1	0.7
12	0.1	-0.1	0.0	-0.3	-0.0	0.1	0.5	0.2			-0.0		
13	0.1	0.0	-0.0	0.0	-0.1	0.1	0.4	0.0	-0.3	-0.3	-0.1		
14	0.1	0.3	-0.0	0.1	-0.1	-0.2					-0.3		
15	0.2	0.1	0.1	-0.0	-0.1	-0.2	-0.6	-0.9	-0.2	-0.2	-0.3	0.5	
16	0.1	0.1	-0.1	-0.0					0.4	0.8	0.5	0.8	
17	0.2	-0.1	-0.1	0.2	0.5	0.3	0.3	0.2	0.4				
18	-0.1	-0.1	0.3	0.1	0.3	0.2	0.3	-0.3	0.3				
19	-0.3	0.0	0.0	0.0	0.3		0.2	-0.4	0.4				
20	-0.2	-0.0		-0.0	0.1	0.3	0.2	0.2	0.4				

MCNP Compared with Measured Dose Rates -- Knee Level
Modified Relative Differences are Shown (Total MRE is 250)

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1				0.2	1.9	0.2	0.1	0.2	-0.1	0.2	0.0	0.2	-0.3	-0.8	-0.3	-0.3	-0.1	-0.0	0.2	-0.3	-0.6
2		0.2		-0.0	-0.7	0.1	0.2	0.2	-0.2	-0.5	-0.2	-0.5	-0.9	-0.3	0.0	0.4	0.5	0.5	0.7	0.0	-0.1
3	0.0	0.0	0.0	-0.0	-0.1	-0.0	-0.3	0.3	-0.4				-0.4	-0.2	-0.3	-0.2	-0.0	-0.1	0.2	0.1	0.1
4	-0.0	-0.1	0.0	-0.1	-0.1	-0.1	-0.4	0.1	-0.5				-0.7	-0.5	-0.4	-0.3	0.0	-0.1	0.1	0.1	0.1
5	0.1		-0.0	-0.2	-0.4	-0.6	-0.5	-0.8	-0.3	-0.2	-0.1	-0.1	-0.3	-0.3	0.0	0.1	-0.1	-0.3	0.2	0.1	0.1
6	0.1	0.1	0.1	-0.1	-0.3	-2.1	-1.2	-0.1	-0.3				0.2	0.0	-0.0	-0.2	-0.3	-0.3	0.1	0.1	0.0
7	-0.2	0.1	0.1	0.1	1.1								-0.1	-0.1	0.0	-0.3	-0.1	-0.3	0.1	0.1	0.1
8	-0.4	-0.2	-0.0	0.1	0.8					-0.3	-0.4	-0.2	-0.5	0.4	0.1	-0.2	-0.1	0.1	0.1	0.1	0.1
9	-0.4	-0.2	-0.2	-0.1	0.4	-0.5				-0.4	-0.4	-0.3	-0.0	0.1	0.0	-0.4	-0.2	-0.0	0.1	-0.0	0.1
10			-0.1	-0.8	0.0	-0.2				0.0	-0.2	-0.3	-0.1	0.4	0.1	-0.3	-0.0	-0.0	0.1	0.1	0.1
11			0.1	-0.0	-0.8	-0.1		-0.3	-0.1	0.1	0.0	-0.3	-0.2	0.5	0.1	-0.3	-0.1	0.1	0.0	0.1	0.2
12	-0.7	-0.3	-0.2	0.2	-0.0	-0.4	0.1	0.2	-0.1				-0.0	0.1	0.1	-0.2	-0.1	-0.0	0.1	0.0	0.2
13	-0.3	-0.1	-0.2	-0.8	-0.2	-0.3	-0.2	-0.0	-0.2				-0.1	-0.1	-0.1	-0.2	0.1	0.0	0.1	0.1	0.2
14	-0.3	-0.0	-0.1	-0.8	-0.8	-0.5	-0.5	-0.2	-0.8				0.1	-0.5	-0.1	-0.3	0.0	0.1	0.1	0.1	0.1
15	-0.2	-0.1	-0.2	0.2	-0.1					-0.4	-0.5	-0.0	-0.1	0.3	-0.0	-0.1	-0.5	0.0	0.0	0.1	0.0
16	-0.3	-0.0	-0.1	-0.2	0.0					-0.7	-0.2	0.0	-0.2	-0.1	-0.2	-0.3	-0.4	0.0	0.0	-0.0	0.1
17	-0.1	-0.2	-0.1	0.6	-0.2	-0.4	-3.9	-3.6	-5.1	-1.1	-0.3	0.0	0.1	0.3	-0.9	-0.4	-0.9	-0.9	-0.1	0.0	-0.2
18	-0.1	-0.0	-0.1	0.6	-0.3	-0.7	-1.0	-1.9	-1.2	-0.8	-0.2	0.0	0.1	0.4	0.3	0.2	-0.1	-1.8	-1.1	0.1	0.2
19	0.2	0.3	0.2	0.0	0.1	0.0	-0.2	-0.3		-0.1	-0.0	0.1	0.1	0.3	0.2	0.1	-0.3	-0.5	-0.3	0.0	0.1
20	0.2	0.1	0.2	0.3	0.3	0.5	0.2	0.2	0.4	0.4	0.3	0.3	0.4	0.4	0.2	0.1	-0.1	-0.1			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	-0.8	-0.8	-1.1	-1.0	-1.1	-0.4	-0.6	-1.1	-0.1	-1.0	-1.8	-1.4	-1.6	-1.1	-1.1	-1.1	-0.6	-0.7	-0.1	0.0	-1.2
2	-0.0	0.1	-0.1	-0.2	-0.2	-0.1	0.2	0.3	0.3	-0.1	-0.1	-0.3	-0.0	0.0	-0.4	-0.1	-0.1	-0.0	0.3	0.4	0.1
3	-0.3	-0.0	-0.1	-0.2	-0.4	-0.1	-0.3	-0.1	0.0	-0.2	-0.4	-0.1	-0.0	-0.1	-0.4	-0.7	-0.2	0.0	0.0	0.1	-0.0
4	0.0	-0.3	-0.3	-0.2	-0.7	-0.2	-0.1	0.1	0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.7	-0.4	0.5	0.0	0.1	0.1	0.0
5	-0.1	-0.2	-0.4	-0.4	-1.1	-0.3	-0.1	-0.0	-0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.8	-0.4	-0.1	-0.1	-0.1	0.0	-0.1
6	-0.1	-0.1	-0.4	-0.8	-1.3	-0.4	-0.1	-0.0	-0.1	-0.1	-0.0	-0.1	-0.1	-0.2	-0.8	-0.4	-0.2	-0.1	-0.0	0.1	-0.0
7	-0.0	-0.2	-0.9	-1.1	-1.4	-0.3	0.0	-0.1	-0.0	-0.0	-0.0	-0.1	-0.5	-0.1	-0.4	-0.4	-0.1	0.0	0.0	0.1	-0.0
8	-0.0	0.1	-0.3	-0.4	-1.1	-0.4	-0.1	-0.0		-0.1	-0.0	-0.0	-0.1	-0.2	-0.8	-0.3	-0.1	-0.0	0.1	0.1	-0.0
9	-0.1	-0.1	-0.3	-0.4	-1.4	-0.3	-0.1	-0.1		-0.0	0.0	-0.1	0.0	-0.1	-0.8	-0.4	-0.0	-0.0	0.0	-0.0	-0.0
10	0.0	-0.1	-0.2	-0.4	-0.9	-0.2	-0.1	0.0		0.0	0.0	-0.0	-0.1	-0.1	-0.8	-0.4	-0.1	0.0	0.0	0.1	0.0
11	-0.3	0.0	-0.7	-1.0	-0.6	-0.2	0.0	0.1	0.1	0.0	0.0	-0.0	0.0	-0.0	-0.4	-0.3	-0.0	0.1	0.1	0.1	0.0
12	0.0	-0.1	-0.2	-0.3	-0.6	-0.2	-0.1	0.1	0.0	0.0	-0.0	-0.0	0.1	-0.1	-0.3	-0.3	-0.1	0.0	0.1	0.1	0.1
13	0.0	-0.3	-0.4	-0.4	-0.9	-0.1	-0.1	0.1	0.1	-0.0	-0.0	0.0	0.1	-0.1	-0.2	-0.4	-0.1	0.0	0.1	0.0	0.0
14	-0.0	-0.6	-2.9	-0.9	-0.6	-0.2	-0.1	0.1	0.1	-0.1	-0.1	-0.0	0.0	-0.0	-0.3	-0.2	-0.1	0.0	0.1	0.0	0.1
15	-0.0	0.0	-0.1	-0.2	-0.5	-0.1	0.0	0.0	-0.0	0.0	0.0	-0.1	-0.0	-0.1	-0.6	-0.8	-0.1	-0.0	0.0	0.0	0.0
16	0.0	-0.3	-0.0	-0.3	-0.6	-0.0	0.0	0.0	0.1	0.1	-0.0	-0.0	-0.0	0.0	-0.2	-0.3	-0.0	0.1	0.0	-0.1	0.0
17	-0.3	-0.8	-0.5	-0.3	-1.1	-0.4	-0.1	-0.1	-0.4	-0.1	-0.5	-0.1	-0.3	-0.4	-0.5	-1.2	-0.1	-0.2	-0.0	-0.1	-0.6
18	0.2	-0.6	0.0	0.1	0.2	0.0	-0.1	-0.0	0.0	-0.5		-1.2	-0.6	0.5	-0.2	-0.2	-0.1	0.1		0.0	
19	0.2	0.2	0.1	0.2	-0.1	0.0	-0.0	0.1	0.2	0.1	0.1	-0.1	-0.2	-0.1	-0.1	0.1	0.1	0.1		-0.2	-0.1
20		0.3	-0.5	-0.1	-0.0	0.1	-0.0												-0.1	-0.1	-0.2

North

	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	-0.9	-0.6	-0.8	-0.0	-0.1			-0.1	-0.2				
2	-0.2	0.0	-0.4	0.0	-1.8			-0.8	-0.3	-0.3	-0.4		
3	0.0	-0.0	-0.8					-0.5	-0.4	-0.1	-0.1		
4	0.1	-0.1	-0.7	0.3	0.2	0.4	0.5	-0.2	-0.3		-0.1		
5	0.1	-0.1	-0.5	-0.1	-0.1	-0.3	-0.3	-0.4	-1.9		-0.9		
6	0.1	-0.0	-0.2	0.2	1.0	-0.1	0.3				-0.1	0.0	0.5
7	0.2	-0.0	-0.2	0.1	0.3	0.2	0.3					-0.0	0.9
8	0.1	-0.1	-0.2	0.3	0.6	-0.0	0.1					-0.1	1.0
9	0.2	-0.1	-0.4	-0.2	0.1	-0.1	0.2	-0.1					1.3
10	0.1	-0.2	-0.7	-0.3	-0.2	-0.1	0.2	0.3	0.1	-1.8		-1.2	0.9
11	0.1	0.0	0.1	-0.3	-0.3	-0.2	0.3	0.2	0.1	-0.0	-1.7	-0.2	0.5
12	0.0	-0.2	0.0	-0.0	-0.1	-0.2	0.3	0.1			-0.3		
13	0.1	-0.1	-0.0	0.1	-0.1	-0.0	0.2	-0.4	-0.0	0.2	0.2		
14	0.1	-0.1	-0.0	0.0	-0.2	-0.1					0.1		
15	0.1	0.1	-0.1	0.1	-0.0	0.0	-0.5	-0.8	-0.1	0.1	-0.0	0.3	
16	-0.2	0.0	-0.2	0.1					0.2	0.9	0.6	0.6	
17	-0.2	0.0	-0.1	0.2	0.4	0.2	0.3	0.2	0.2				
18	0.4	0.1	0.2	0.0	0.2	0.3	0.3	0.2	0.2				
19	-0.0	-0.0	-0.1	0.0	0.2		0.1	0.2	0.2				
20	-0.0	-0.1	0.1	0.0	0.1	0.2	0.2	0.3	0.3				

105 K East Basin General Area Survey Data - Chest Elevation

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		0.80		1.6	5.0	3.0	1.6	0.90	1.5	0.90	1.9	1.3	3.0	4.0	4.0	4.0	4.0	4.0	5.0	3.0	4.0
2		0.70		1.7	5.0	2.6	1.6	1.0	1.2	3.1	6.0	4.0	8.0	6.0	8.0	6.0	5.0	4.0	3.1	4.4	5.0
3	0.60	0.90	1.0	1.3	2.0	2.0	9.0	2.9	5.0				17.0	16.0	11.0	7.0	4.0	4.0	3.5	3.4	3.6
4	0.70	0.90	0.90	1.2	1.8	2.1	5.0	4.3	7.0				40.0	13.0	12.0	8.0	4.0	4.0	3.0	2.6	2.8
5	0.80		0.60	1.2	1.6	2.2	5.0	8.0	8.0	13.0	16.0	20.0	29.0	18.0	10.0	7.0	5.0	4.0	2.8	2.6	2.6
6	0.90	0.60	0.70	1.3	1.4	2.7	11.0	13.0	23.0				22.0	17.0	11.0	7.0	6.0	4.0	3.1	2.5	2.5
7	1.0	1.0	0.90	1.2	1.2								29.0	19.0	10.0	8.0	5.0	3.0	3.0	2.5	2.5
8	1.1	1.5	1.0	1.1	1.0					7.0	11.0	19.0	23.0	15.0	9.0	7.0	4.0	3.0	2.7	2.5	2.6
9	1.8	1.4	1.4	1.4	0.30	1.0				6.0	9.0	15.0	19.0	13.0	9.0	7.0	5.0	3.3	2.8	2.5	2.5
10			1.4	2.2	1.6	2.2				6.0	9.0	12.0	14.0	4.0	8.0	7.0	4.0	3.2	2.6	2.2	2.5
11			1.6	1.9	3.0	4.4	4.0	3.0	3.0	6.0	8.0	10.0	11.0	7.0	7.0	6.0	4.0	2.5	2.3	2.1	2.1
12	1.9	1.4	2.3	3.2	9.0	11.0	6.0	7.0	7.0				10.0	8.0	7.0	5.0	3.0	2.7	2.5	2.2	2.2
13	1.2	1.1	2.3	6.0	19.0	25.0	9.0	24.0	15.0				10.0	9.0	6.0	5.0	3.0	2.6	2.4	2.1	2.1
14	1.0	1.0	1.7	4.0	5.0	5.0	7.0	7.0	9.0				10.0	8.0	6.0	5.0	4.0	2.3	2.3	2.0	2.1
15	1.0	1.0	1.4	1.1	2.6					7.0	6.0	7.0	6.0	3.0	6.0	4.0	4.0	2.5	2.4	2.0	2.2
16	0.80	0.90	1.2	0.60	0.80					6.0	4.9	4.7	4.0	4.0	6.0	5.0	4.0	2.7	3.1	2.8	2.7
17	0.90	0.90	1.0	0.30	1.7	2.6	6.0	8.0	10.0	6.0	4.0	3.5	3.5	2.6	6.0	5.0	6.0	5.0	4.1	3.0	3.9
18	0.50	0.60	0.80	0.80	1.6	2.3	3.6	6.0	4.0	4.0	2.7	2.5	2.0	1.5	25.0	2.7	3.2	6.0	3.5	2.0	1.7
19	0.20	0.20	0.40	0.60	0.70	1.3	1.9	1.8		1.7	1.5	1.5	1.4	1.2	1.5	1.6	2.4	3.0	2.4	1.4	8.9
20	0.20	0.40	0.30	0.40	0.50	0.50	0.40	0.40	0.50	0.90	0.90	0.80	0.70	0.80	11.0	1.2	1.5	1.6			
21	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.40	0.50	0.60	0.70	0.70	0.70	0.90	1.0	1.0	1.0			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	3.0	4.0	3.0	4.0	4.0	3.0	3.0	5.0	4.0	5.0	5.0	5.0	6.0	3.8	3.9	5.0	2.8	5.0	5.0	5.0	5.0
2	5.0	5.0	4.0	5.0	6.0	4.0	5.0	3.3	4.0	5.0	6.0	6.0	7.0	3.2	4.0	7.0	6.0	5.0	4.0	3.4	6.0
3	4.0	6.0	3.0	3.4	6.0	3.8	4.0	3.4	3.4	3.7	3.8	4.4	6.0	2.7	4.0	5.0	3.8	3.6	3.3	3.4	4.0
4	3.1	5.0	2.0	2.9	5.0	3.0	2.4	2.1	2.0	2.7	2.8	3.5	5.0	1.3	3.0	4.6	2.3	2.6	2.2	2.5	3.6
5	2.5	6.0	2.0	2.6	5.0	3.0	2.5	2.0	1.5	2.1	2.4	2.7	5.0	1.7	3.0	4.2	2.4	2.4	2.1	2.5	3.5
6	3.5	5.0	2.8	4.0	4.0	2.7	2.5	1.9	1.7	1.8	2.1	2.4	3.2	1.8	3.0	2.3	2.3	2.2	2.0	2.3	3.3
7	4.1	6.0	4.0	5.0	7.0	2.5	2.0	1.7	1.7	1.8	1.8	2.3	4.0	1.5	3.0	3.6	2.1	2.0	1.8	2.1	3.0
8	3.6	5.0	3.0	3.6	6.0	2.5	2.0	1.7		1.6	1.7	2.3	4.0	1.4	4.0	3.4	2.0	2.0	1.9	2.0	3.1
9	3.6	5.0	2.4	3.0	6.0	2.5	2.2	1.7		1.5	1.8	2.3	4.0	1.3	3.0	3.7	2.1	2.0	2.0	2.3	3.0
10	3.2	5.0	1.9	2.5	5.0	2.4	2.0	1.6		1.5	1.8	2.2	5.0	1.4	3.0	3.8	1.9	2.0	1.7	2.1	2.7
11	2.8	5.0	3.3	3.1	5.0	2.0	1.7	1.3	1.3	1.4	1.6	2.2	4.0	1.2	2.2	3.6	1.9	1.9	2.0	1.9	2.5
12	2.8	4.0	1.9	2.6	4.0	2.1	1.8	1.4	1.5	1.6	1.8	2.3	4.0	1.4	2.2	3.7	2.0	2.0	2.0	2.0	2.3
13	2.7	5.0	2.4	2.4	4.0	2.2	2.0	1.6	1.6	1.7	1.8	2.4	5.0	1.5	2.0	3.7	2.1	2.0	2.0	2.1	2.2
14	2.5	5.0	5.0	3.0	5.0	2.3	2.0	1.5	1.7	1.8	2.1	2.4	4.0	1.5	2.1	3.8	2.2	2.2	2.0	2.3	2.1
15	2.5	5.0	2.3	2.6	4.0	2.2	2.0	1.8	2.1	2.1	2.5	2.8	5.0	1.8	2.2	5.0	2.4	2.5	2.5	2.4	2.4
16	3.4	4.0	2.6	3.2	5.0	2.8	2.6	2.4	2.8	3.3	3.7	5.9	5.0	2.9	3.0	5.0	2.9	2.6	2.9	3.3	3.3
17	3.0	4.0	2.8	2.8	5.0	2.9	2.7	3.0	3.8	4.5	6.0	6.0	5.0	3.7	3.3	6.0	3.2	3.3	3.3	3.7	7.0
18	1.7	1.2	1.2	1.4	1.4	1.5	1.6	2.5	0.60	0.50		4.1	3.5	2.8	3.4	1.6	2.5	2.2		2.2	
19	1.0	0.60	0.80	0.90	0.80	1.0	1.3	1.4	1.3	1.6	1.9	2.5	2.1	1.7	1.6	1.3	1.4	1.5		2.4	2.2
20		0.30	0.70	0.70	0.60	0.70	1.0												1.6	1.6	1.3
21		0.20	0.50	0.70	0.50	0.50	0.80	1.0	1.0	1.3	1.1	1.3	1.4	2.4	2.1	1.3	1.1	1.0	1.0	4.0	0.70

North

	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	6.0	6.0	4.0	1.6	2.2			1.5	1.2				
2	7.0	7.0	8.0	5.0	6.0			5.0	1.8	1.8	2.1		
3	4.8	9.0	7.0					8.0	2.4	2.5	2.3		
4	3.8	8.0	6.0	10.0	10.0	6.0	4.4	5.0	2.8		2.2		
5	3.8	9.0	6.0	7.0	7.0	5.0	6.0	6.0	12.0		6.0		
6	3.8	8.0	8.0	10.0	9.0	7.0	6.0				11.0	6.0	1.1
7	3.6	8.0	7.0	9.0	10.0	9.0	7.0					5.0	0.90
8	3.7	8.0	8.0	11.0	21.0	11.0	9.0					4.0	0.80
9	3.8	9.0	8.0	9.0	12.0	10.0	9.0	8.0					0.60
10	3.8	8.0	7.0	7.0	11.0	11.0	9.0	9.0	7.0	5.0		5.0	0.70
11	3.1	5.0	5.0	7.0	9.0	14.0	10.0	12.0	10.0	8.0	6.0	2.6	0.90
12	3.0	6.0	4.2	7.0	7.0	9.0	11.0	11.0			4.0		
13	2.9	5.0	4.0	4.6	6.0	8.0	12.0	11.0	9.0	6.0	3.7		
14	2.9	4.0	3.8	3.6	5.0	8.0					3.5		
15	2.6	5.0	3.3	3.6	3.8	4.8	7.0	8.0	4.0	3.1	2.8	0.80	
16	4.0	6.0	4.2	3.2					1.2	0.50	0.70	0.30	
17	4.0	6.0	3.6	2.1	0.90	1.0	0.90	1.0	0.70				
18	4.8	3.3	1.6	1.0	0.70	0.70	0.50	1.5	0.50				
19	2.7	1.7	1.0	1.1	0.50		0.40	1.4	0.20				
20	1.7	1.0	1.0	0.90	0.50	0.30	0.30	0.30	0.10				
21	0.50	0.90	0.70	0.50	0.50	0.40	0.30	0.20	0.10				
22				0.30	0.30								
23				0.30	0.30	0.30							
24				0.40	0.30	0.30	0.10						
25				0.40	0.20	0.20	0.10						

105 K East Basin General Area Survey Data - Knee Elevation

North

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		0.40		2.2	12.0	3.0	1.2	0.70	1.3	1.2	2.0	2.0	3.0	6.0	5.0	5.0	4.0	4.0	9.0	4.9	5.0
2		0.50		2.3	7.0	2.6	1.8	1.3	1.5	3.3	4.5	5.0	9.0	8.0	9.0	6.0	5.0	5.0	4.2	7.0	8.0
3	0.60	0.80	1.0	1.5	2.0	2.4	4.0	2.6	6.0				19.0	19.0	14.0	7.0	5.0	5.0	3.3	3.2	3.0
4	0.70	0.90	0.90	1.5	2.0	2.7	5.0	4.0	8.0				24.0	18.0	14.0	7.0	4.0	4.0	2.8	2.4	2.4
5	0.50		0.80	1.2	2.3	4.5	6.0	10.0	10.0	12.0	13.0	15.0	18.0	14.0	10.0	5.0	5.0	5.0	2.5	2.3	2.2
6	0.60	0.70	0.80	1.3	1.5	9.0	13.0	8.0	15.0				17.0	15.0	11.0	7.0	6.0	5.0	2.6	2.4	2.5
7	1.0	0.80	1.0	1.3	0.40								20.0	16.0	10.0	8.0	5.0	5.0	2.7	2.3	2.3
8	1.4	1.3	1.0	1.0	0.30					7.0	11.0	12.0	19.0	7.0	9.0	7.0	5.0	3.0	2.8	2.3	2.2
9	1.5	1.2	1.4	1.4	0.40	1.3				7.0	10.0	12.0	10.0	7.0	9.0	8.0	5.0	3.5	2.6	2.5	2.2
10			1.4	3.5	1.8	2.4				5.0	8.0	10.0	9.0	5.0	8.0	7.0	4.0	3.3	2.6	2.2	2.0
11			1.1	2.0	5.0	3.1	4.0	5.0	5.0	5.0	6.0	9.0	9.0	5.0	7.0	6.0	4.0	2.8	2.5	2.1	1.8
12	1.9	1.7	2.3	2.5	5.0	7.0	5.0	5.0	8.0				8.0	6.0	6.0	5.0	4.0	3.0	2.4	2.2	1.8
13	1.2	1.2	2.2	7.0	8.0	7.0	8.0	7.0	9.0				8.0	7.0	6.0	5.0	3.0	2.8	2.3	2.0	1.8
14	1.2	1.0	1.8	5.0	7.0	6.0	7.0	6.0	10.0				6.0	8.0	6.0	5.0	3.0	2.6	2.3	2.0	1.8
15	1.0	1.0	1.5	1.2	2.3					6.0	8.0	6.0	6.0	3.0	5.0	4.0	5.0	2.8	2.4	2.0	2.2
16	1.0	0.80	1.2	1.7	1.5					6.0	4.6	4.0	5.0	4.0	6.0	5.0	5.0	3.2	3.0	3.0	2.4
17	0.80	1.0	1.0	0.30	1.6	2.3	12.0	12.0	18.0	6.0	3.6	3.0	3.0	2.3	9.0	5.0	7.0	7.0	4.5	2.9	3.5
18	0.70	0.70	0.90	0.20	1.6	2.6	3.6	6.0	5.0	4.0	2.5	2.1	2.2	1.5	1.6	1.6	2.3	6.0	1.8	1.5	1.2
19	0.20	0.20	0.40	0.70	0.70	0.90	1.5	1.8		1.7	1.6	1.5	1.4	1.1	1.3	1.3	2.0	2.4	1.5	0.90	0.80
20	0.20	0.40	0.30	0.30	0.30	0.20	0.60	0.70	0.50	0.50	0.70	0.70	0.60	0.60	0.90	1.1	1.3	1.3			
21	0.20	0.30	0.30	0.30	0.30	0.30	0.40	0.50	0.50	0.50	0.70	0.70	0.60	0.70	0.70	0.80	0.90	0.80			

North

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1	5.0	5.0	5.0	5.0	5.0	3.0	4.0	7.0	11.0	5.0	7.0	6.0	7.0	4.6	4.6	5.0	4.0	5.0	5.0	6.0	7.0
2	7.0	7.0	5.0	6.0	8.0	7.0	5.0	4.8	5.0	7.0	7.0	9.0	8.0	3.5	7.0	7.0	7.0	7.0	5.0	4.8	6.0
3	5.0	6.0	3.0	3.6	6.0	3.5	4.0	3.2	2.8	3.5	4.5	4.0	6.0	2.2	4.0	7.0	4.0	3.2	3.2	3.2	4.0
4	2.9	7.0	3.0	3.0	6.0	2.7	2.4	1.8	1.8	2.3	2.5	2.8	6.0	1.3	4.0	4.3	1.3	2.4	2.3	2.4	3.0
5	3.1	7.0	3.0	3.2	7.0	2.8	2.0	1.8	1.8	1.8	2.0	2.5	5.0	1.5	4.0	4.3	2.4	2.4	2.4	2.3	3.3
6	3.5	8.0	3.2	5.0	8.0	3.0	2.0	1.6	1.8	1.8	1.8	2.5	6.0	1.5	4.0	3.9	2.5	2.2	2.2	2.1	3.0
7	3.3	11.0	7.0	7.0	8.0	2.6	1.5	1.7	1.6	1.5	1.7	2.4	8.0	1.4	3.0	3.8	2.2	1.8	2.0	2.0	3.0
8	3.3	8.0	4.0	4.3	7.0	2.8	1.9	1.5		1.6	1.7	2.2	6.0	1.5	4.0	3.5	2.3	2.0	1.9	2.0	3.0
9	3.2	7.0	2.5	3.5	8.0	2.5	1.9	1.8		1.5	1.6	2.3	5.0	1.3	4.0	3.9	2.0	2.0	2.0	2.3	2.8
10	2.7	6.0	2.3	3.2	6.0	2.3	1.7	1.5		1.5	1.6	2.3	6.0	1.3	4.0	3.8	2.1	1.9	2.0	2.1	2.7
11	3.5	5.0	3.6	4.8	5.0	2.3	1.5	1.3	1.2	1.5	1.6	2.2	5.0	1.3	3.0	3.6	2.0	1.7	1.8	2.0	2.5
12	2.5	6.0	2.3	2.8	5.0	2.2	1.9	1.4	1.5	1.6	1.8	2.4	5.0	1.4	2.7	3.8	2.2	2.0	1.9	2.0	2.4
13	2.5	7.0	2.8	3.2	6.0	2.2	1.9	1.4	1.5	1.7	1.9	2.3	5.0	1.5	2.5	4.0	2.3	2.0	2.0	2.2	2.5
14	2.5	8.0	10.0	4.7	5.0	2.3	1.9	1.5	1.6	2.0	2.1	2.5	5.0	1.5	2.8	3.5	2.4	2.0	2.0	2.2	2.4
15	2.6	5.0	2.3	2.8	5.0	2.4	1.8	1.8	2.0	2.0	2.2	3.1	6.0	1.8	4.0	6.0	2.6	2.4	2.3	2.5	2.7
16	2.9	7.0	2.2	3.5	6.0	2.6	2.2	2.3	2.3	2.6	3.6	4.2	6.0	2.0	3.5	5.0	3.0	2.5	2.8	3.4	3.6
17	3.8	7.0	3.4	3.1	7.0	3.8	2.5	2.8	3.8	3.5	7.0	7.0	6.0	3.9	4.4	8.0	3.2	3.7	2.9	3.7	10.0
18	1.0	0.90	1.0	1.0	0.90	1.2	1.2	1.5	0.60	0.50		2.3	4.0	0.80	1.9	1.5	1.6	1.5		1.8	
19	0.70	0.60	0.70	0.60	0.90	0.80	1.3	1.0	0.80	1.0	1.0	1.6	1.8	1.7	1.6	1.3	1.4	1.3		1.8	1.4
20		0.30	1.6	0.80	0.80	0.60	1.2												1.6	1.5	1.4
21		0.20	0.50	0.70	0.60	0.50	0.80	1.0	1.3	1.3	1.5	1.4	1.8	2.3	2.3	1.2	1.1	1.0	1.2	1.0	0.70

North

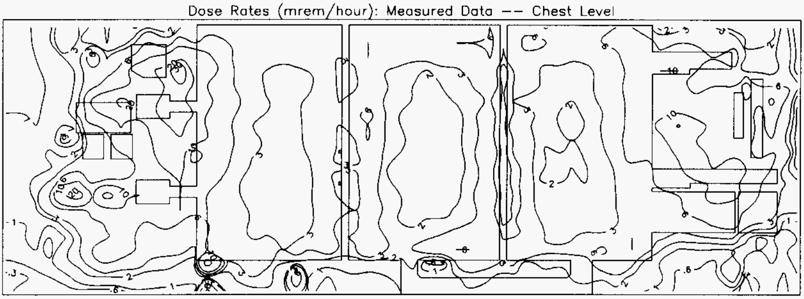
	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	6.0	6.0	5.0	1.5	1.2			1.2	1.3				
2	9.0	10.0	8.0	2.8	6.0			3.0	1.8	1.7	1.7		
3	4.4	8.0	8.0					10.0	3.0	1.8	1.3		
4	3.6	9.0	7.0	10.0	12.0	5.0	4.5	5.0	3.6		1.3		
5	3.8	10.0	8.0	7.0	7.0	7.0	7.0	6.0	12.0		3.8		
6	3.6	10.0	8.0	10.0	7.0	8.0	6.0				4.0	2.5	1.1
7	3.4	10.0	8.0	9.0	8.0	7.0	8.0					3.4	0.80
8	3.4	10.0	9.0	11.0	9.0	10.0	10.0					3.6	0.80
9	3.2	10.0	8.0	10.0	9.0	11.0	9.0	10.0					0.50
10	3.4	10.0	9.0	8.0	9.0	10.0	9.0	7.0	7.0	2.2		7.0	0.70
11	3.0	6.0	4.1	7.0	9.0	11.0	12.0	9.0	7.0	5.0	11.0	3.2	1.0
12	3.0	6.0	3.8	5.0	7.0	10.0	9.0	9.0			5.0		
13	2.8	5.0	3.7	4.0	6.0	8.0	12.0	13.0	6.0	3.1	2.3		
14	2.8	6.0	3.6	3.5	5.0	7.0					2.1		
15	3.0	5.0	3.5	2.9	3.4	3.8	7.0	8.0	3.6	2.2	2.0	1.0	
16	5.0	6.0	4.2	2.1					1.5	0.50	0.60	0.40	
17	6.0	6.0	3.5	1.7	1.0	1.0	0.90	1.0	0.90				
18	2.3	2.0	1.6	1.0	0.80	0.50	0.50	0.60	0.60				
19	1.8	1.5	1.0	1.0	0.50		0.50	0.40	0.40				
20	1.2	1.0	0.80	0.80	0.50	0.30	0.30	0.20	0.20				
21	0.70	0.60	0.50	0.50	0.50	0.30	0.30	0.20	0.20				
22				0.30	0.30								
23				0.40	0.50								
24				1.8	0.40	0.30	0.10						
25				0.60	0.30	0.20	0.10						

Appendix B. Contour Plots of MCNP Dose Rates

List of Contour Plots:

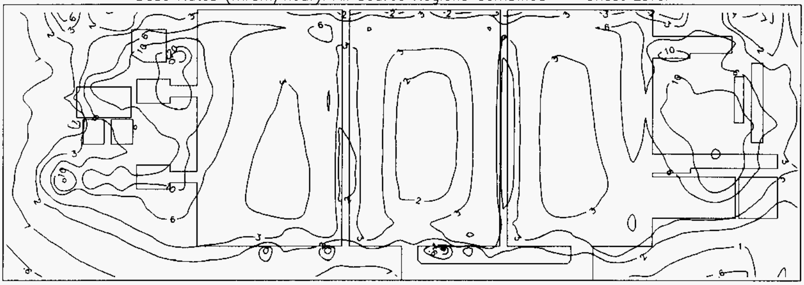
Chest Level Dose Rates -- September 1996 Data

Dose Rates (mrem/hour): Measured Data -- Chest Level

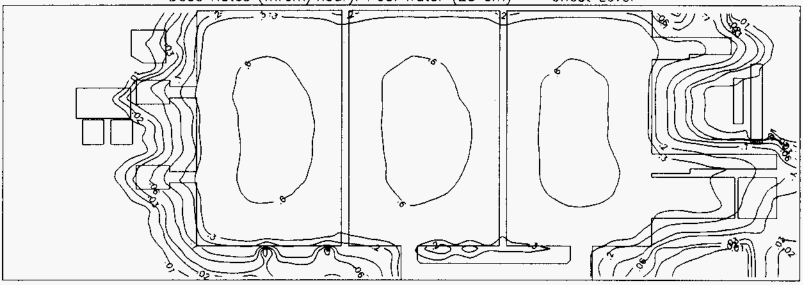


Chest Level Dose Rates -- MCNP Dose Rates to Match September 1996 Data

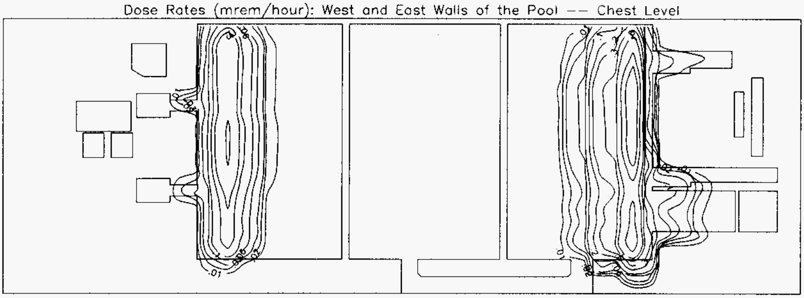
Dose Rates (mrem/hour): All Source Regions Combined -- Chest Level



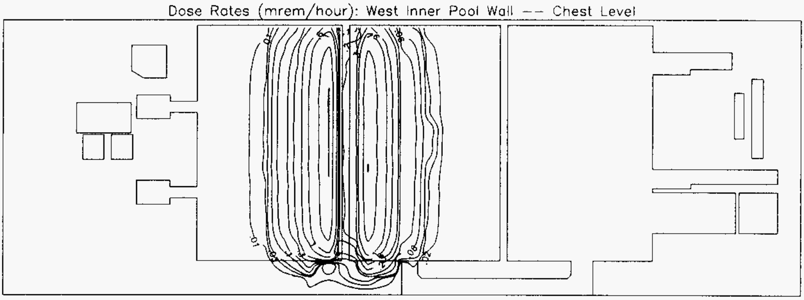
Dose Rates (mrem/hour): Pool Water (20 cm) -- Chest Level



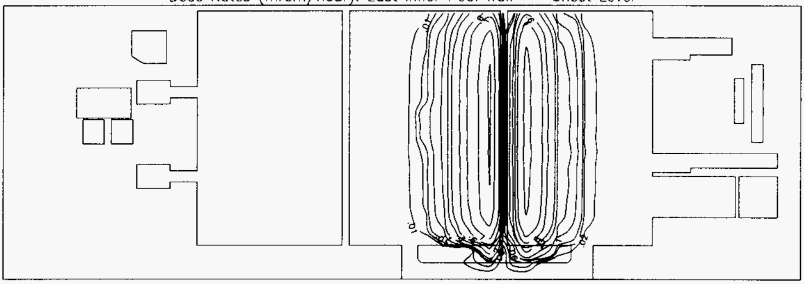
Dose Rates (mrem/hour): West and East Walls of the Pool -- Chest Level



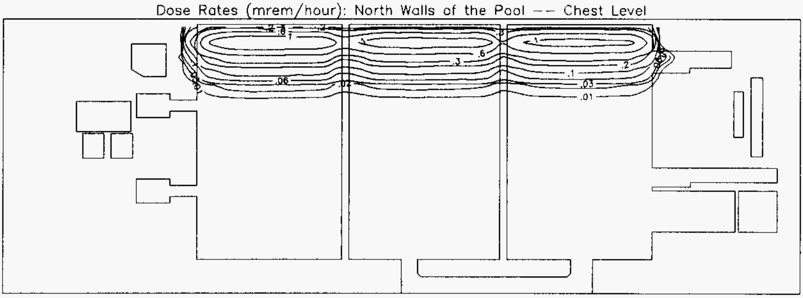
Dose Rates (mrem/hour): West Inner Pool Wall -- Chest Level



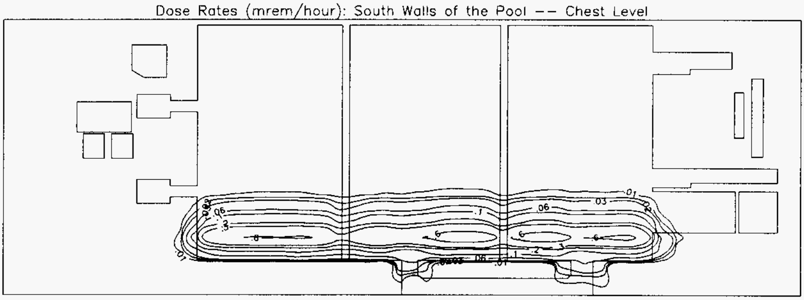
Dose Rates (mrem/hour): East Inner Pool Wall -- Chest Level



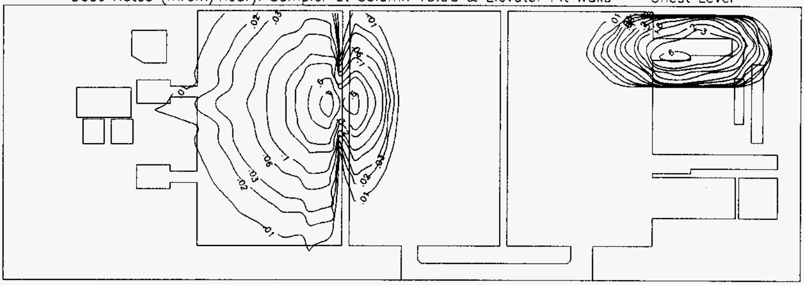
Dose Rates (mrem/hour): North Walls of the Pool -- Chest Level



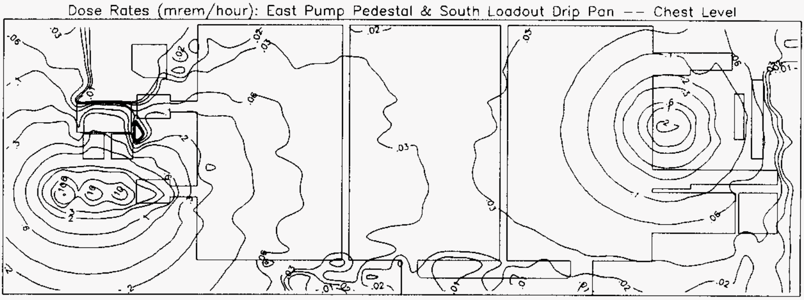
Dose Rates (mrem/hour): South Walls of the Pool -- Chest Level



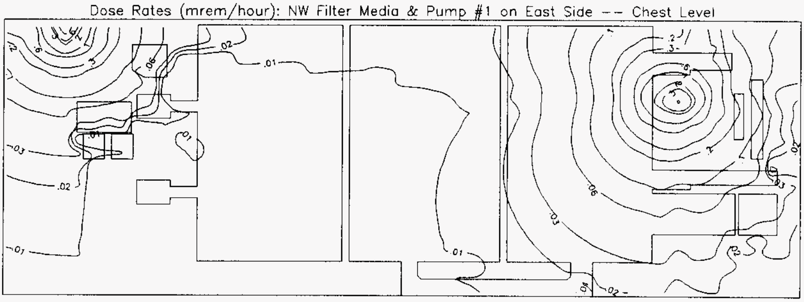
Dose Rates (mrem/hour): Sampler at Column 10.9C & Elevator Pit Walls -- Chest Level



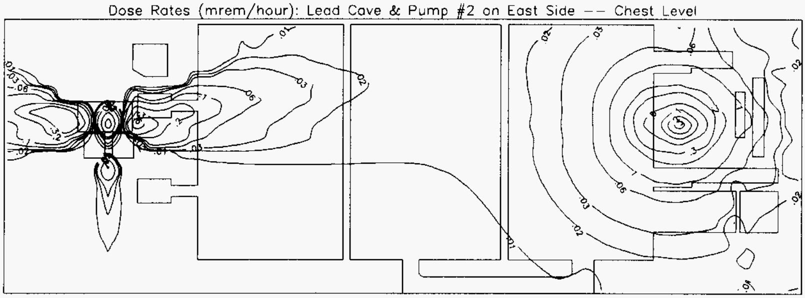
Dose Rates (mrem/hour): East Pump Pedestal & South Loadout Drip Pan -- Chest Level



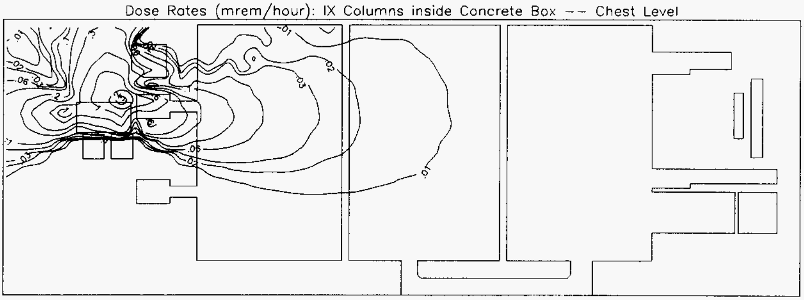
Dose Rates (mrem/hour): NW Filter Media & Pump #1 on East Side -- Chest Level



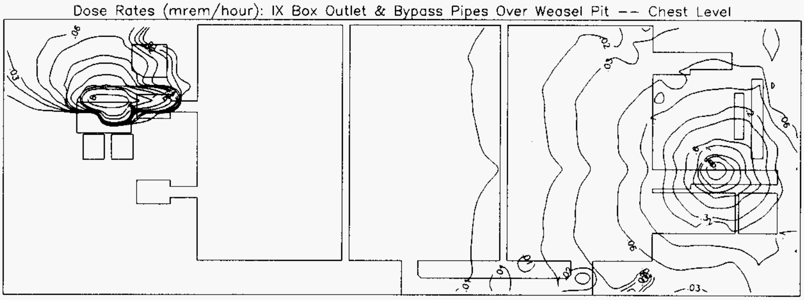
Dose Rates (mrem/hour): Lead Cave & Pump #2 on East Side -- Chest Level



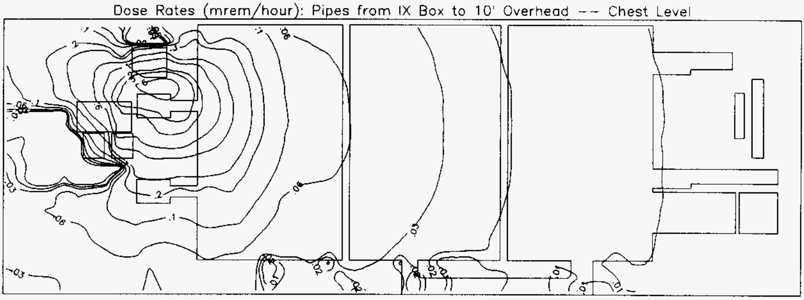
Dose Rates (mrem/hour): IX Columns inside Concrete Box -- Chest Level



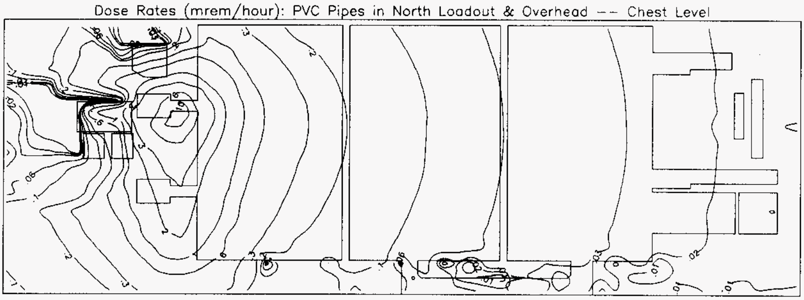
Dose Rates (mrem/hour): IX Box Outlet & Bypass Pipes Over Weasel Pit -- Chest Level



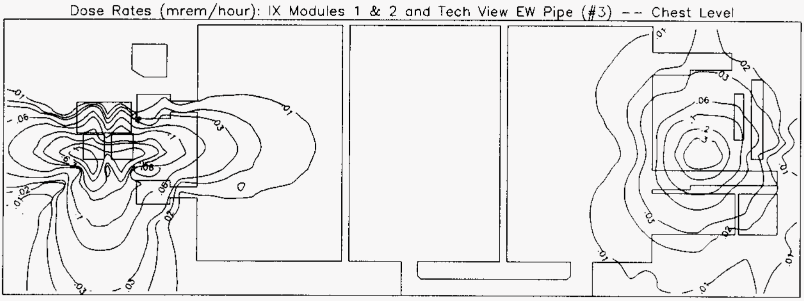
Dose Rates (mrem/hour): Pipes from IX Box to 10' Overhead -- Chest Level



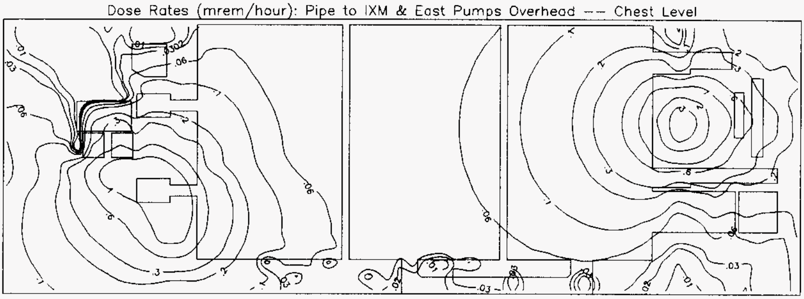
Dose Rates (mrem/hour): PVC Pipes in North Loadout & Overhead -- Chest Level



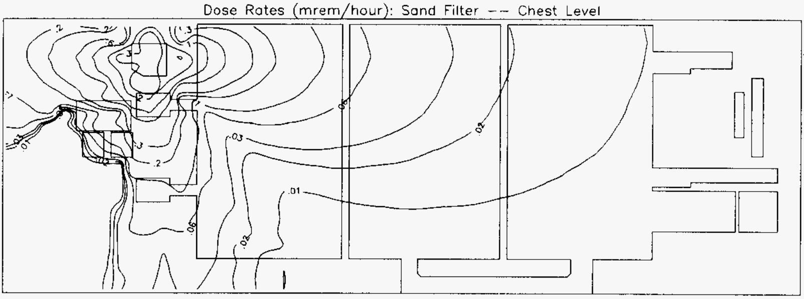
Dose Rates (mrem/hour): IX Modules 1 & 2 and Tech View EW Pipe (#3) -- Chest Level



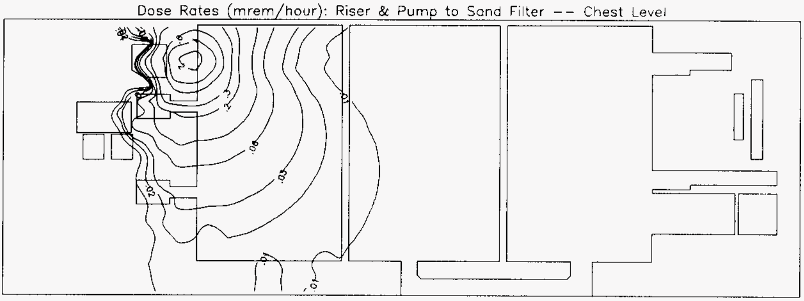
Dose Rates (mrem/hour): Pipe to IXM & East Pumps Overhead -- Chest Level



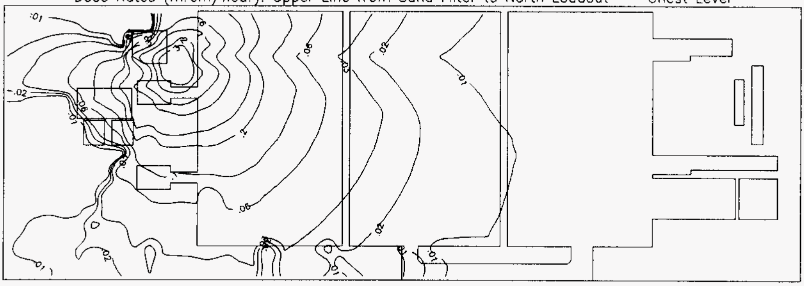
Dose Rates (mrem/hour): Sand Filter -- Chest Level



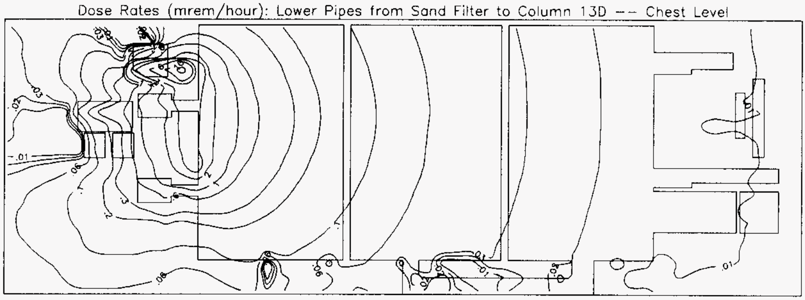
Dose Rates (mrem/hour): Riser & Pump to Sand Filter -- Chest Level



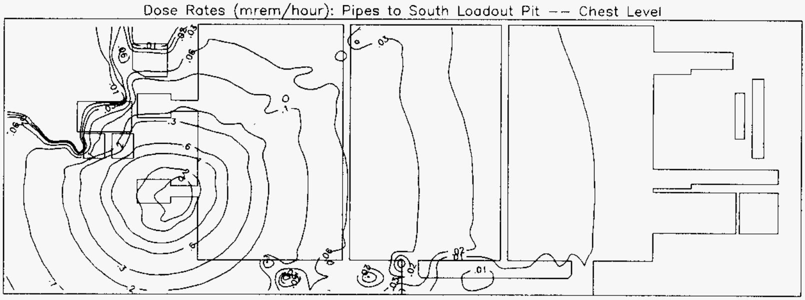
Dose Rates (mrem/hour): Upper Line from Sand Filter to North Loadout -- Chest Level



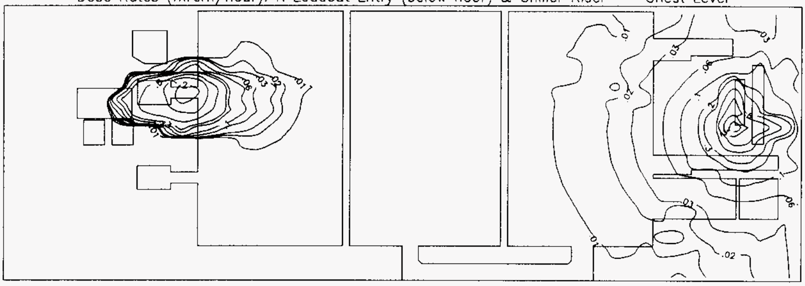
Dose Rates (mrem/hour): Lower Pipes from Sand Filter to Column 13D -- Chest Level



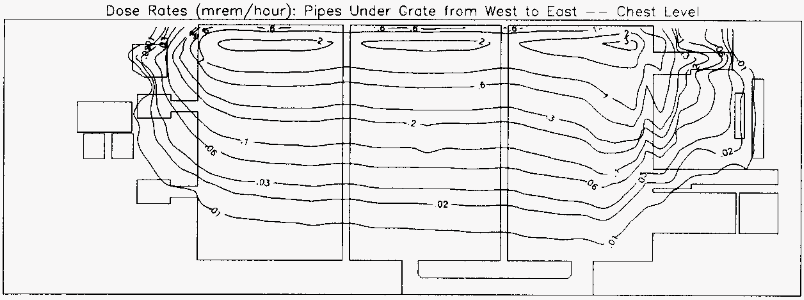
Dose Rates (mrem/hour): Pipes to South Loadout Pit -- Chest Level



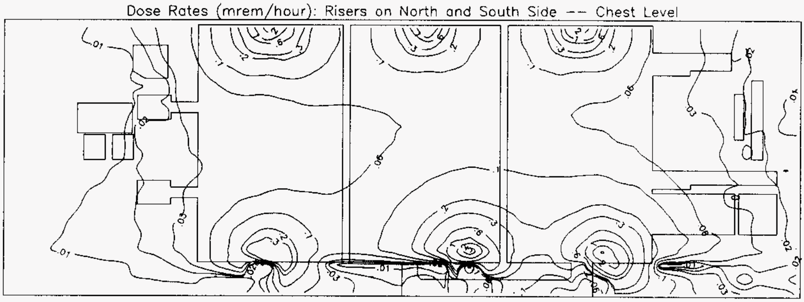
Dose Rates (mrem/hour): N Loadout Entry (below floor) & Chiller Riser -- Chest Level



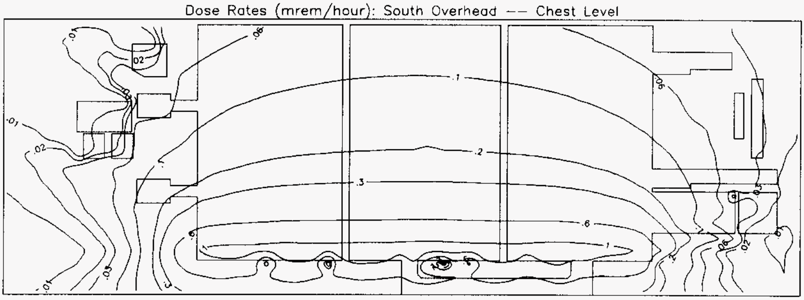
Dose Rates (mrem/hour): Pipes Under Grate from West to East -- Chest Level



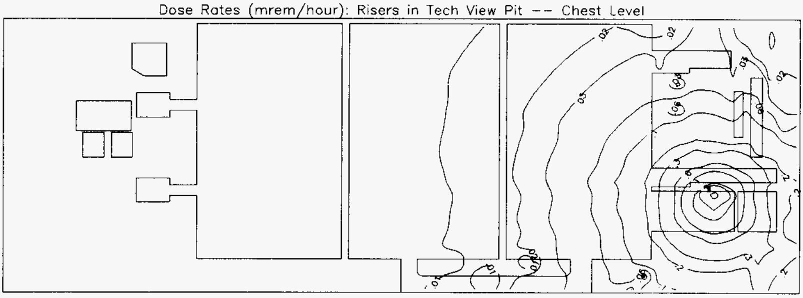
Dose Rates (mrem/hour): Risers on North and South Side -- Chest Level



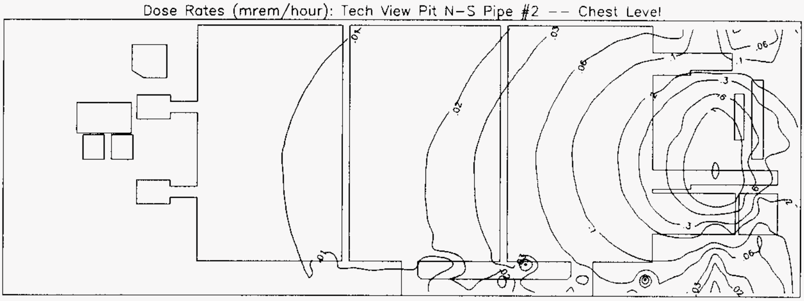
Dose Rates (mrem/hour): South Overhead -- Chest Level



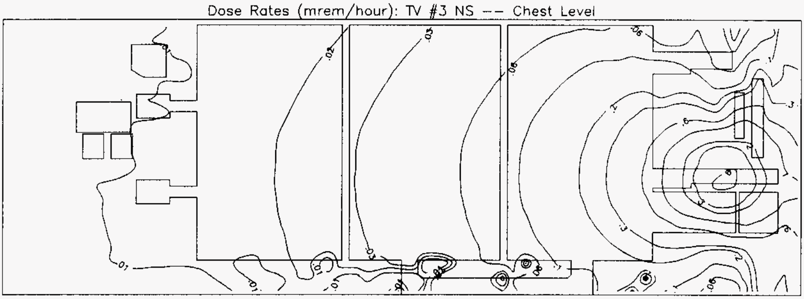
Dose Rates (mrem/hour): Risers in Tech View Pit -- Chest Level



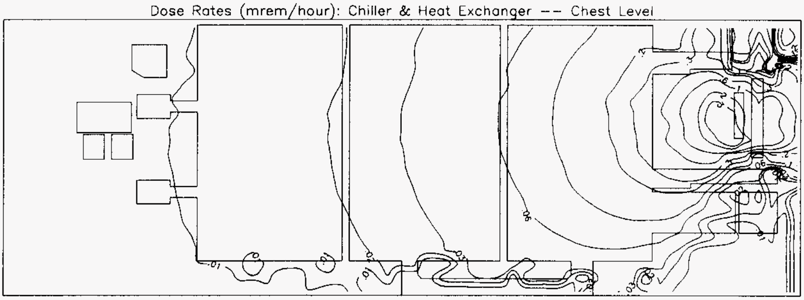
Dose Rates (mrem/hour): Tech View Pit N-S Pipe #2 -- Chest Level



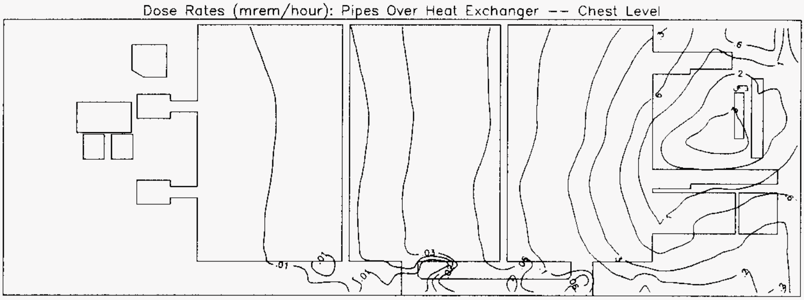
Dose Rates (mrem/hour): TV #3 NS -- Chest Level



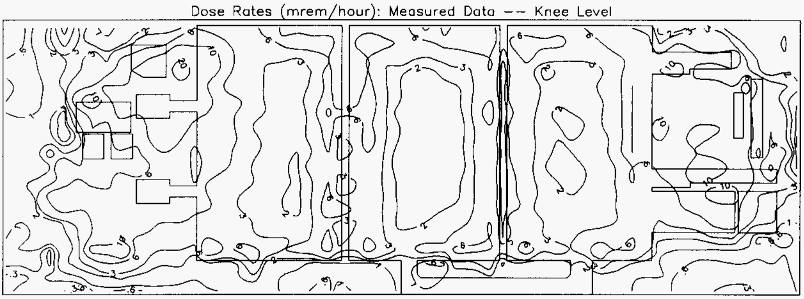
Dose Rates (mrem/hour): Chiller & Heat Exchanger -- Chest Level



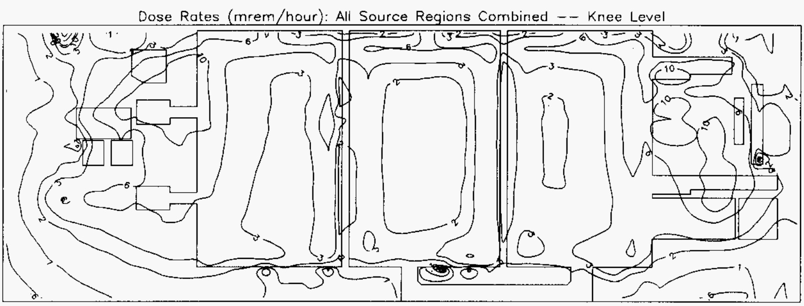
Dose Rates (mrem/hour): Pipes Over Heat Exchanger -- Chest Level



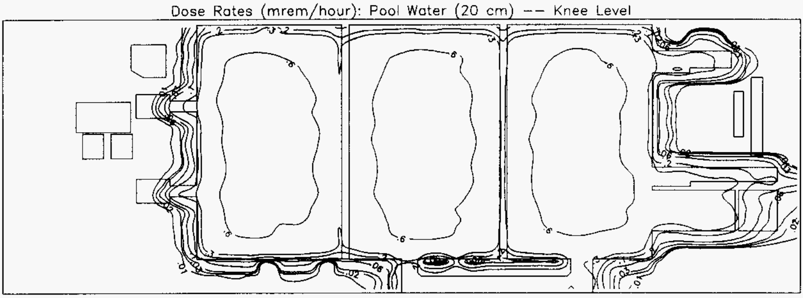
Knee Level Dose Rates -- September 1996 Data



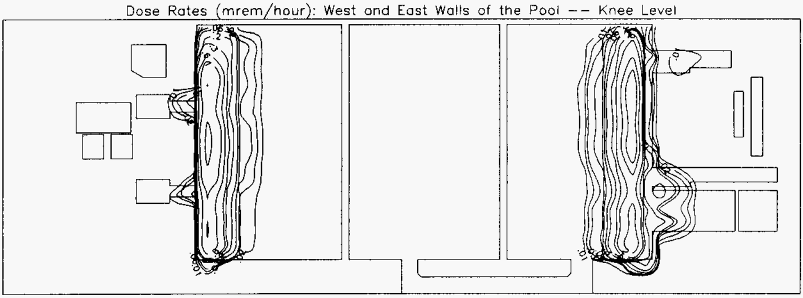
Knee Level Dose Rates -- MCNP Dose Rates to Match September 1996 Data



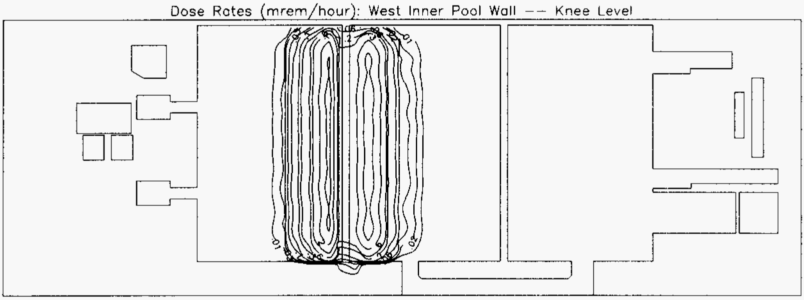
Dose Rates (mrem/hour): Pool Water (20 cm) -- Knee Level



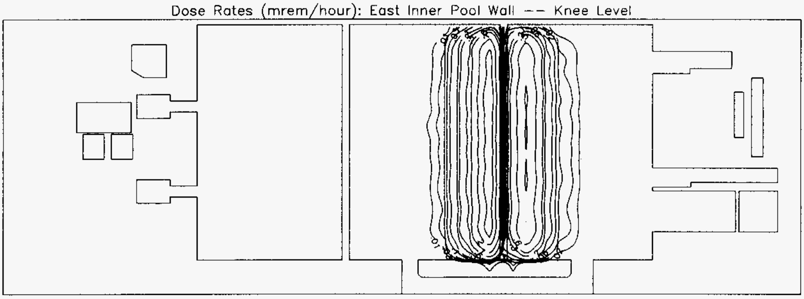
Dose Rates (mrem/hour): West and East Walls of the Pool -- Knee Level



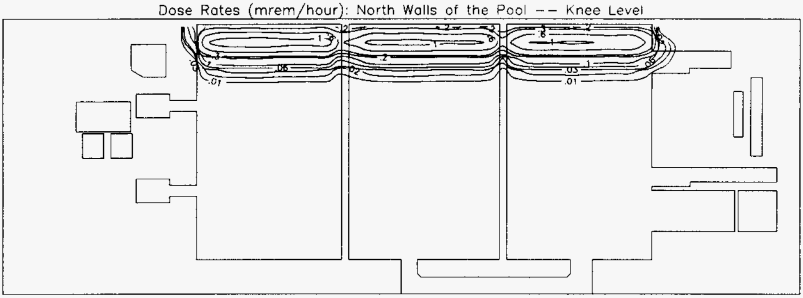
Dose Rates (mrem/hour): West Inner Pool Wall -- Knee Level



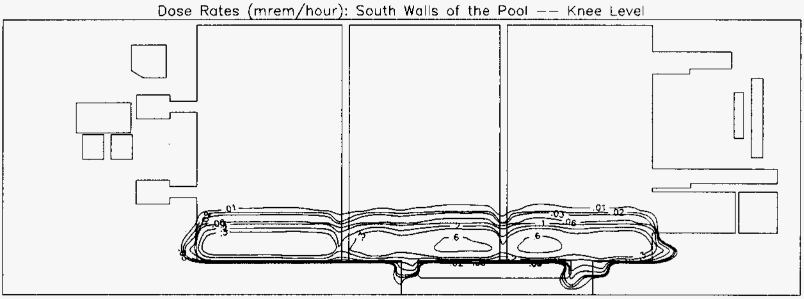
Dose Rates (mrem/hour): East Inner Pool Wall -- Knee Level



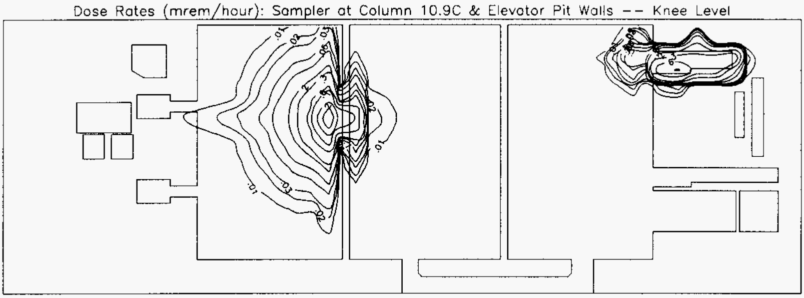
Dose Rates (mrem/hour): North Walls of the Pool -- Knee Level



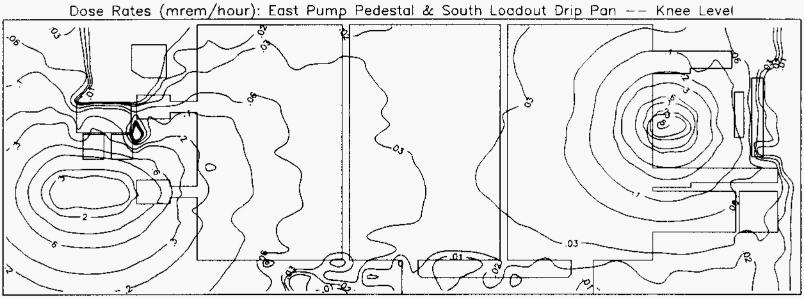
Dose Rates (mrem/hour): South Walls of the Pool -- Knee Level



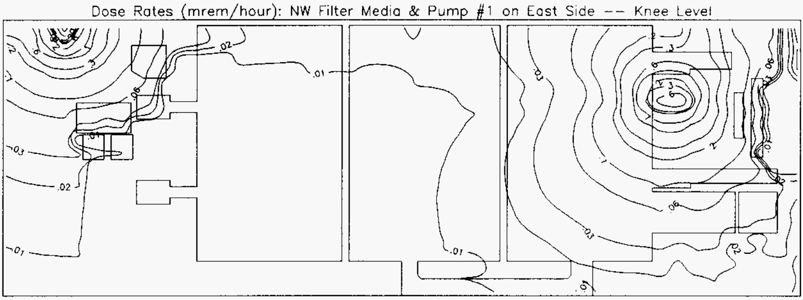
Dose Rates (mrem/hour): Sampler at Column 10.9C & Elevator Pit Walls -- Knee Level



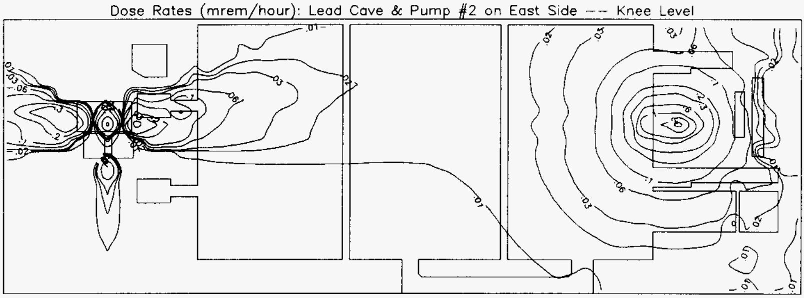
Dose Rates (mrem/hour): East Pump Pedestal & South Loadout Drip Pan -- Knee Level



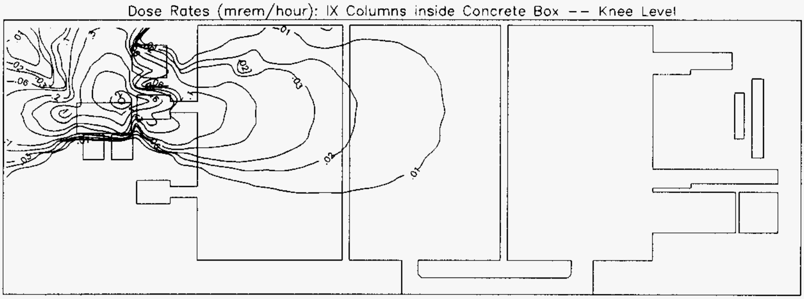
Dose Rates (mrem/hour): NW Filter Media & Pump #1 on East Side -- Knee Level



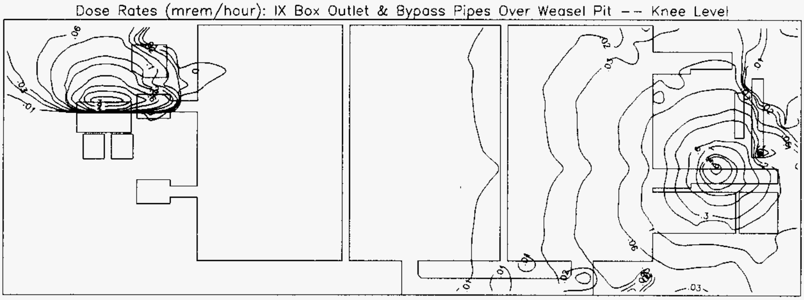
Dose Rates (mrem/hour): Lead Cave & Pump #2 on East Side -- Knee Level



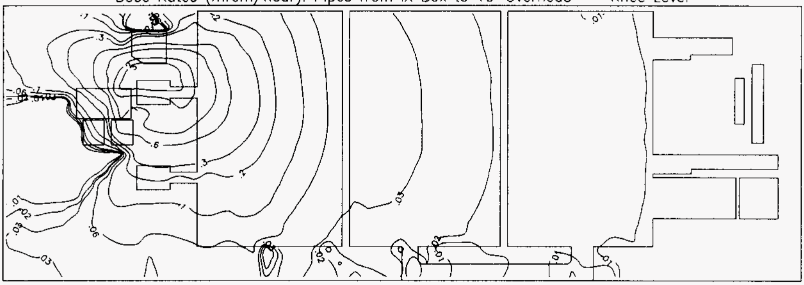
Dose Rates (mrem/hour): IX Columns inside Concrete Box -- Knee Level



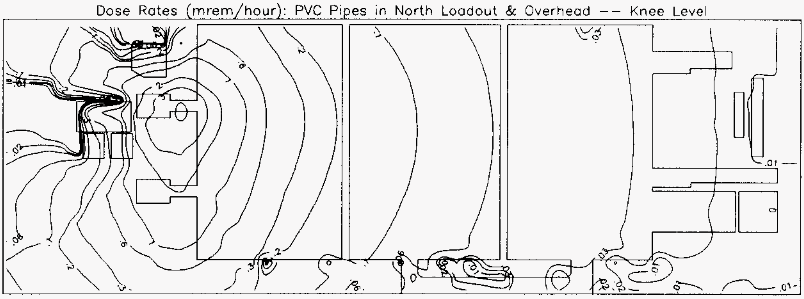
Dose Rates (mrem/hour): IX Box Outlet & Bypass Pipes Over Weasel Pit -- Knee Level



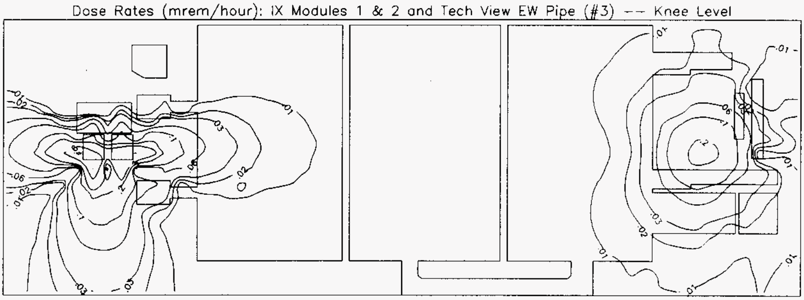
Dose Rates (mrem/hour): Pipes from IX Box to 10' Overhead -- Knee Level



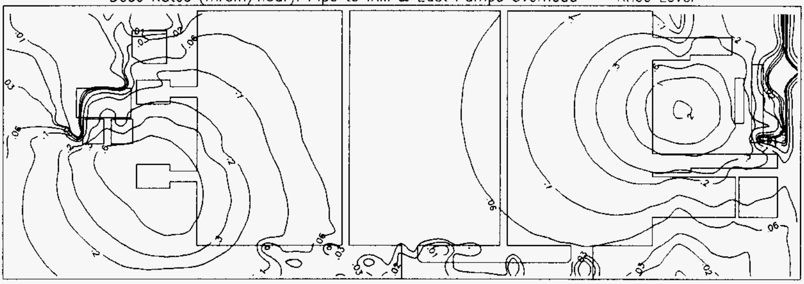
Dose Rates (mrem/hour): PVC Pipes in North Loadout & Overhead -- Knee Level



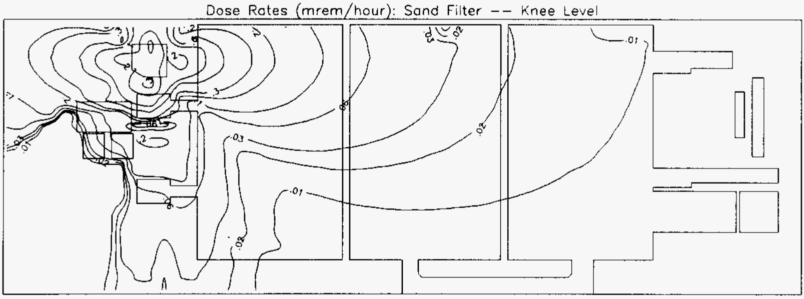
Dose Rates (mrem/hour): IX Modules 1 & 2 and Tech View EW Pipe (#3) -- Knee Level



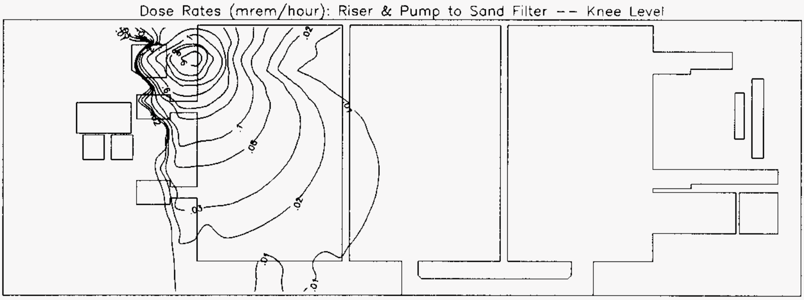
Dose Rates (mrem/hour): Pipe to IXM & East Pumps Overhead -- Knee Level



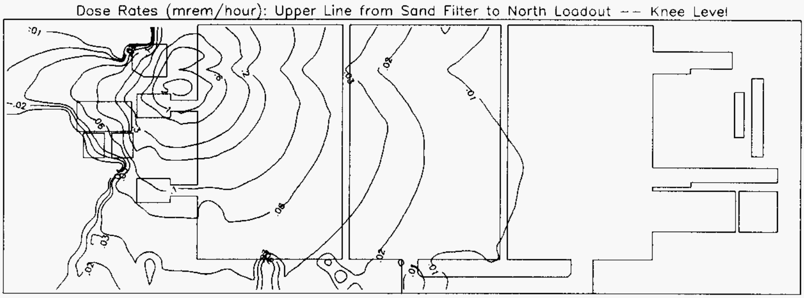
Dose Rates (mrem/hour): Sand Filter -- Knee Level



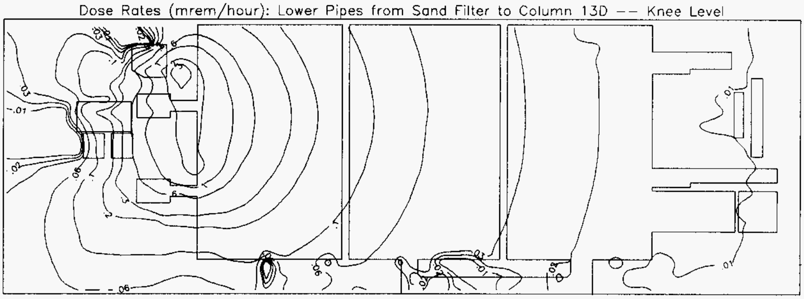
Dose Rates (mrem/hour): Riser & Pump to Sand Filter -- Knee Level



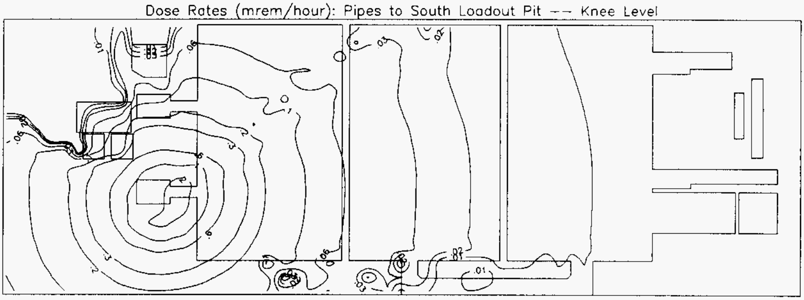
Dose Rates (mrem/hour): Upper Line from Sand Filter to North Loadout -- Knee Level



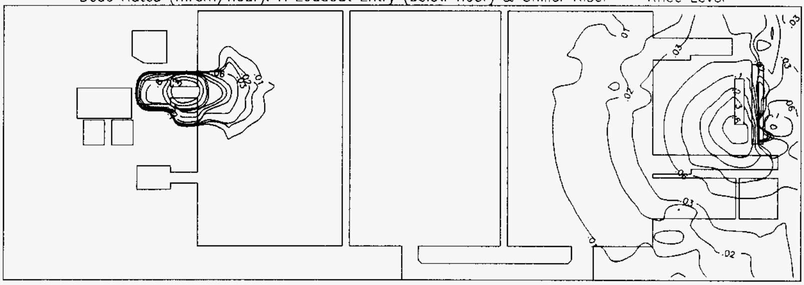
Dose Rates (mrem/hour): Lower Pipes from Sand Filter to Column 13D -- Knee Level



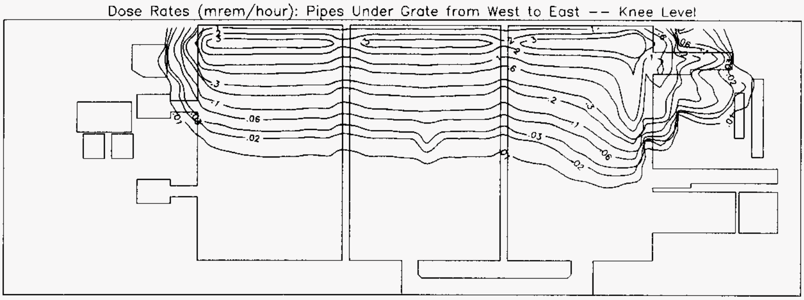
Dose Rates (mrem/hour): Pipes to South Loadout Pit -- Knee Level



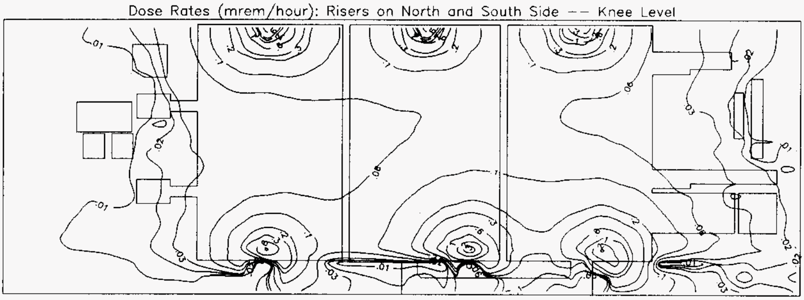
Dose Rates (mrem/hour): N Loadout Entry (below floor) & Chiller Riser -- Knee Level



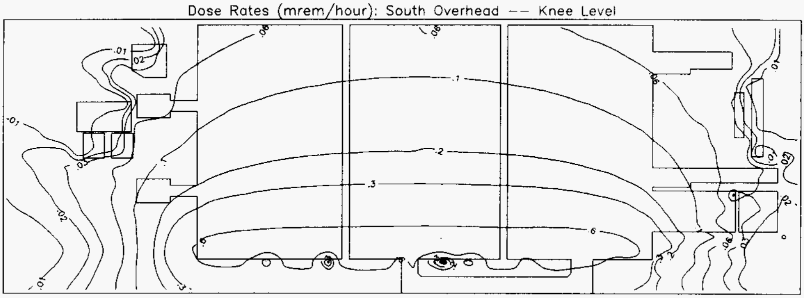
Dose Rates (mrem/hour): Pipes Under Grate from West to East -- Knee Level



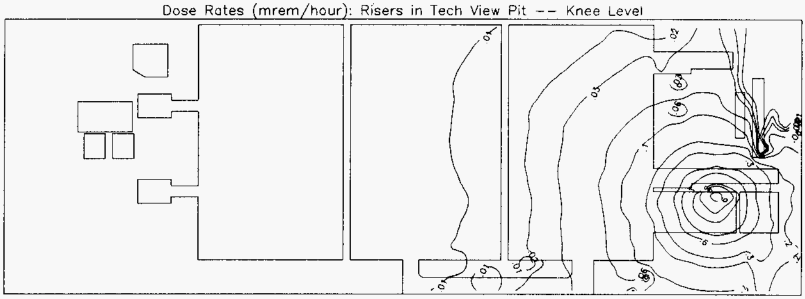
Dose Rates (mrem/hour): Risers on North and South Side -- Knee Level



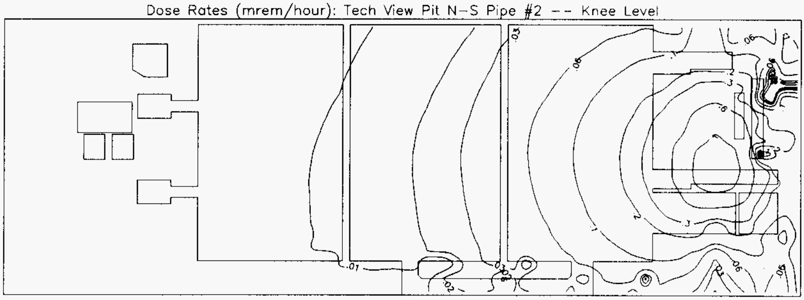
Dose Rates (mrem/hour): South Overhead -- Knee Level



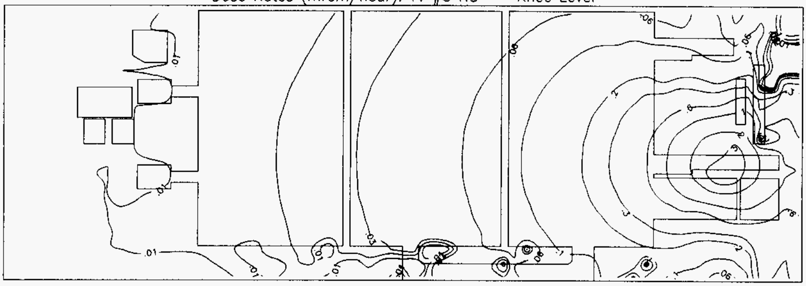
Dose Rates (mrem/hour): Risers in Tech View Pit -- Knee Level



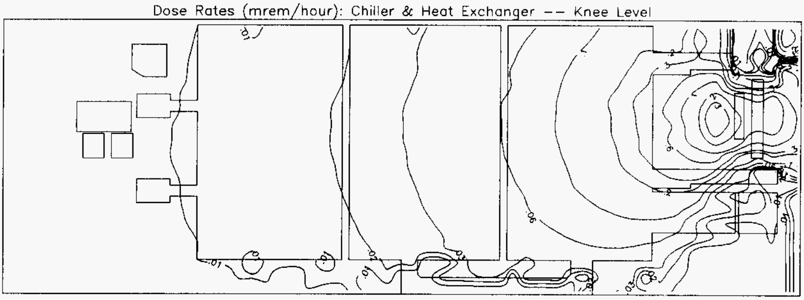
Dose Rates (mrem/hour): Tech View Pit N-S Pipe #2 -- Knee Level



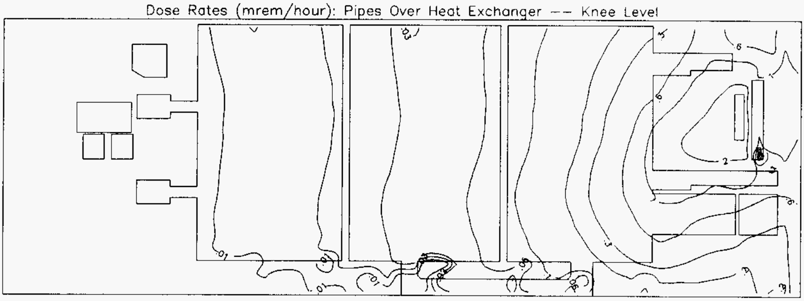
Dose Rates (mrem/hour): TV #3 NS -- Knee Level



Dose Rates (mrem/hour): Chiller & Heat Exchanger -- Knee Level

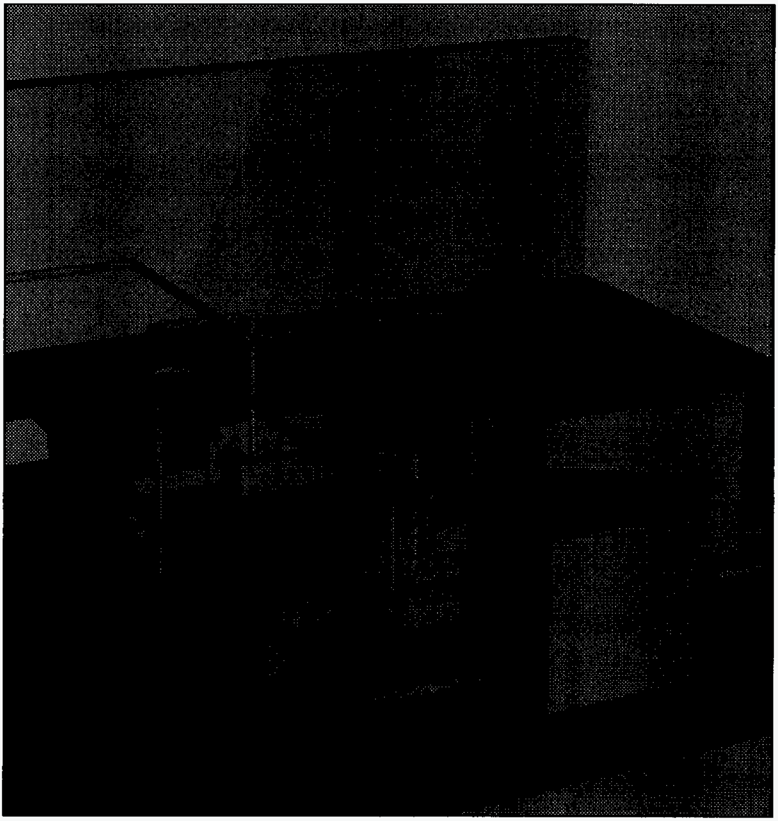


Dose Rates (mrem/hour): Pipes Over Heat Exchanger -- Knee Level

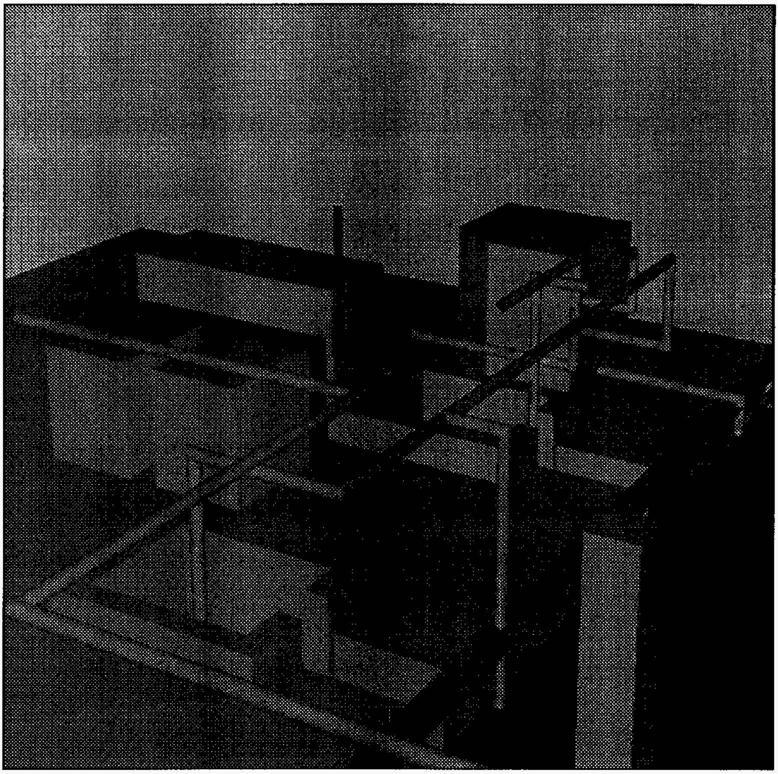


Appendix C. MCNP Geometry Data and Sketches Using SABRINA

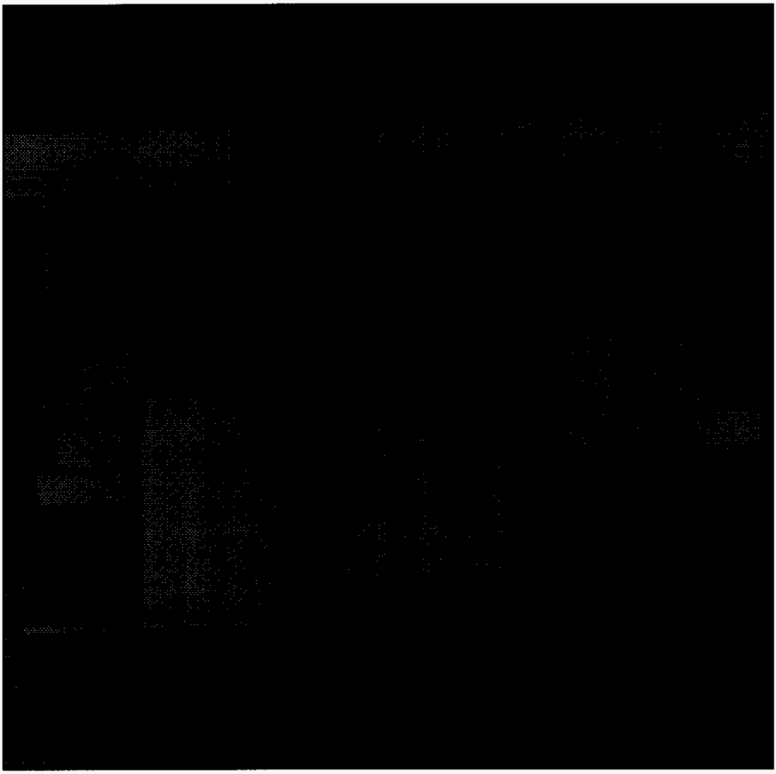
View of the West End from the North



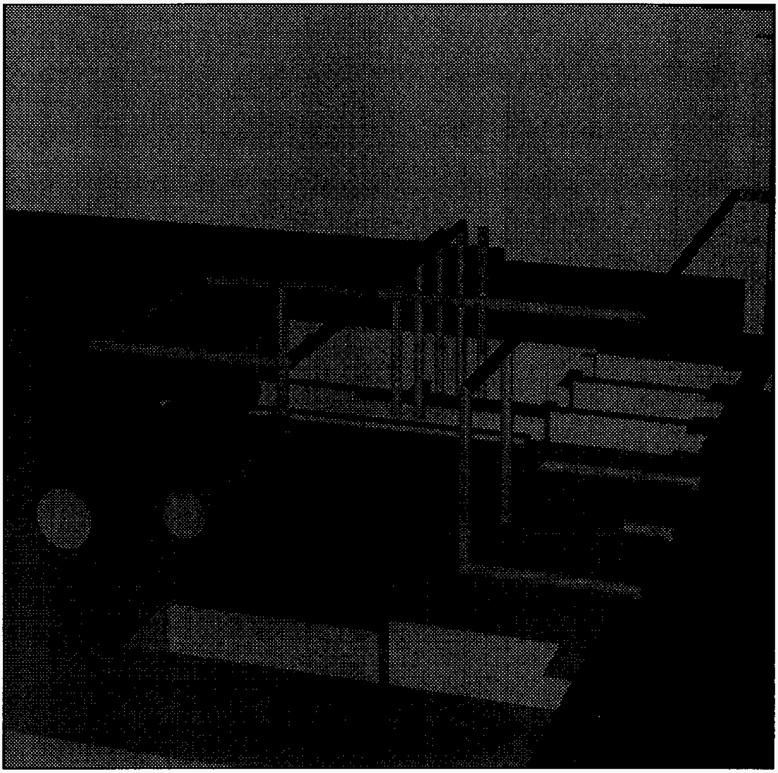
View of the West End from the South



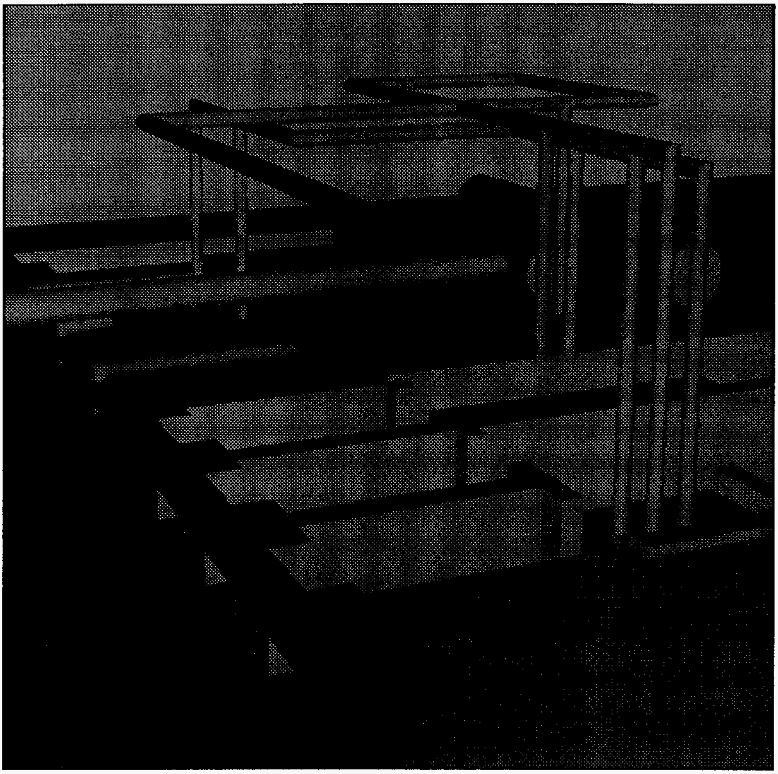
View of the West End from the West



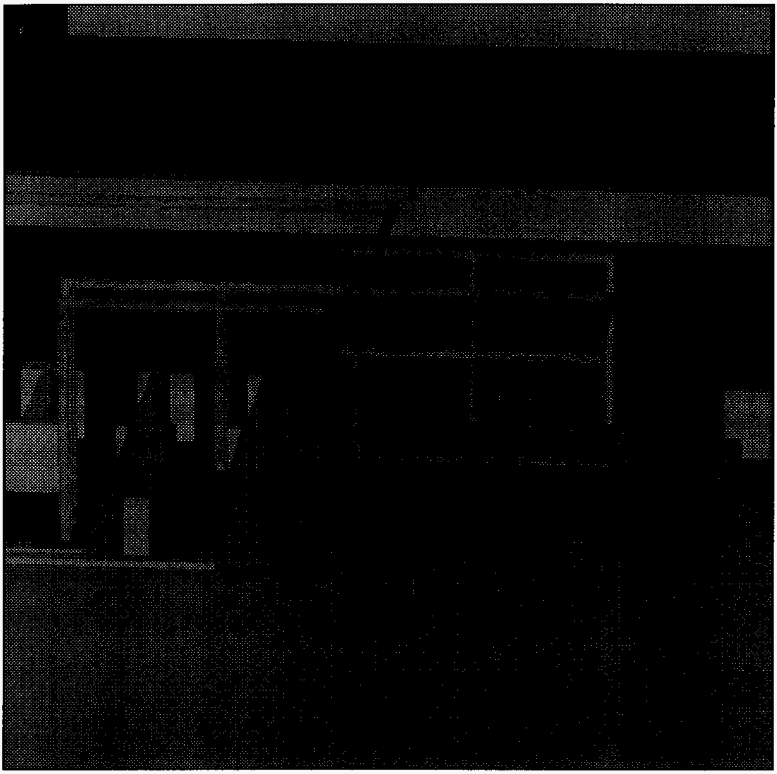
View of the East End from the North



View of the East End from the South



View of the East End from the East



Listing of the Geometry Portion of the MCNP Input

```
KE Basin Geometry -- Water Level is 16'10" -- Floor Lattices
   1  0        (-1:79:-80:95:-230:201)             $ Outside world
c  Stuff at the West End   -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
   2   6 -1.6000 -305  215 -207                    $ Sand in Filter
   3   4 -7.8600 -306  216 -206 (305:207:-215)     $ Sand Filter Vessel
   4   2 -0.0012   15  -18  123 -126  219 -205     $ Air around tank
           -125 (306:206:-216)
   5   5 -1.5730   16  -17  127 -128  212 -204     $ Pipe Opening
   6   1 -2.2580   14  -19  122 -128  219 -204 -124 $ Sand Filter Walls
         (-16:17:-127:-212) (-15:18:-123:126:205:125)
   7   2 -0.0012   29  -30   97  -98  222 -217     $ Washing Pit Air
         (-99:-31)
   8   1 -2.2580   28  -27   96 -118  222 -217     $ Wash Pit Concrete
         (-99:-31)   (-29:30:-97:98)
   9   3 -1.0000 -302  219 -206                    $ IX Cell #3
  10   3 -1.0000 -303  219 -206                    $ IX Cell #2
  11   3 -1.0000 -304  219 -206                    $ IX Cell #1
  12   2 -0.0012   32  -33  100 -101  219 -206  302 $ IX Cell #3 Air
  13   2 -0.0012   32  -33  102 -103  219 -206  303 $ IX Cell #2 Air
  14   2 -0.0012   32  -33  104 -105  219 -206  304 $ IX Cell #1 Air
  15   1 -2.2580   31  -27   99 -118  222 -204     $ IX Box Concrete
         (-32:33:(-100:(101 -102):(103 -104):105):-219:206)
  16   2 -0.0012   27  -34  107 -108  219 -209     $ Lead Cave Air
  17   8 -11.350   27  -35  106 -109  219 -208  #16 $ Lead Cave
  18   5 -1.5730   37  -38  111 -112  214 -211     $ IXM #2 Tanks
  19   1 -2.2580   36  -39  110 -113  219 -210  #18 $ IXM #2 Concrete
  20   5 -1.5730   37  -38  115 -116  214 -211     $ IXM #1 Tanks
  21   1 -2.2580   36  -39  114 -117  219 -210  #20 $ IXM #1 Concrete
  22   3 -1.0000   21  -26  119 -120  230 -226  317 $ N Loadout Water
  23   3 -1.0000   23  -24  120 -121  230 -226     $ N Loadout Water
  24   3 -1.0000   22  -25  121 -129  229 -226     $ N Loadout Water
  25   2 -0.0012   21  -26  119 -120  226 -213  277  317  355 $ N L Air
  26   2 -0.0012   23  -24  120 -121  226 -213  277 $ N Loadout Air
  27   2 -0.0012   22  -25  121 -129  226 -219  277 $ N Loadout Air
  28   3 -1.0000  119 -129 -278                    $ Pipe Water
  29   4 -7.8600  119 -129  278 -277               $ Pipe in N Loadout
  30   1 -2.2580   20  -27  118 -121  230 -213     $ N Loadout Concrete
         (-21:26:-119:120) (-23:24:-120:121:-230)
  31   3 -1.0000   41  -46  119 -120  230 -226  325 $ S Loadout Water
  32   3 -1.0000   43  -44  120 -121  230 -226     $ S Loadout Water
  33   3 -1.0000   42  -45  121 -129  229 -226     $ S Loadout Water
  34   2 -0.0012   41  -46  119 -120  226 -213  325 $ S Loadout Air
  35   2 -0.0012   43  -44  120 -121  226 -213     $ S Loadout Air
  36   2 -0.0012   42  -45  121 -129  226 -219     $ S Loadout Air
  37   3 -1.0000  128  198 -268                    $ Water - SF Upper
  38   4 -7.8600  128  198  268 -267               $ Pipe - SF Upper
  39   3 -1.0000 -198  170 -316                    $ Water - SF #2
  40   4 -7.8600 -198  170  316 -315               $ Pipe - SF #2
  41   3 -1.0000 -170 -199 -242                    $ Water - SF #3
  42   4 -7.8600 -170 -199  242 -241               $ Pipe - SF #3
  43   3 -1.0000 -200  199 -270                    $ Water - SF #4
  44   4 -7.8600 -200  199  270 -269               $ Pipe - SF #4
  45   3 -1.0000  230  200 -318                    $ N Load Riser Water
  46   4 -7.8600  230  200  318 -317               $ N Load Riser Pipe
  47   3 -1.0000  128  169 -280                    $ Water - SF Lower
  48   4 -7.8600  128  169  280 -279               $ Pipe - SF Lower
  49   3 -1.0000 -169  170 -322                    $ Water - 13B Riser
  50   4 -7.8600 -169  170  322 -321               $ Pipe - 13B Riser
  51   3 -1.0000 -170  171 -248                    $ Water in N-S Pipe
  52   4 -7.8600 -170  171  248 -247               $ N-S Pipe (9.5 ft)
  53   3 -1.0000 -171 -172 -282                    $ Water Short EW
  54   4 -7.8600 -171 -172  282 -281               $ Pipe Short EW
  55   3 -1.0000  229  172 -324                    $ Water Riser 13D
  56   4 -7.8600  229  172  324 -323               $ Pipe Riser 13D
  57   3 -1.0000   64 -173 -248                    $ Water S Ovrhd
  58   4 -7.8600   64 -173  248 -247               $ Pipe S Ovrhd
  59   3 -1.0000 -174  173 -284                    $ Water from S Load
  60   4 -7.8600 -174  173  284 -283               $ Jog Pipe by S Load
  61   3 -1.0000  230  174 -326                    $ S Load Riser Water
  62   4 -7.8600  230  174  326 -325               $ S Load Riser Pipe
  63   1 -2.2580   40  -47  118 -121  230 -213     $ S Loadout Concrete
         (-41:46:-119:120) (-43:44:-120:121:-230)
```

```
 64  1 -2.2580    1  -22  121 -129  229 -219       $ West Wall of Pool
 65  1 -2.2580   25  -42  121 -129  229 -219       $ West Wall of Pool
 66  1 -2.2580   45  -13  121 -129  229 -219       $ West Wall of Pool
 67  1 -2.2580    1  -27   80 -121  230 -219       $ Loadout Floor N
       (-20:-118)  (-28:-96:118:-222)
 68  1 -2.2580   27  -78   80 -121  230 -219       $ Loadout Floor S
       (-40:47:-118)
 69  3 -1.0000  219 -211 -301                      $ NW Filter Media
 70  3 -1.0000  128 -175 -272                      $ Water in SF Pump
 71  4 -7.8600  128 -175  272 -271                 $ Sand Fltr Pump
 72  3 -1.0000  100  197 -276                      $ Water IX Box Out
 73  4 -7.8600  100  197  276 -275                 $ IX Box Outlet
 74  3 -1.0000 -197  196 -244                      $ Water IX/Loadout
 75  4 -7.8600 -197  196  244 -243                 $ IX Box/N Loadout
 76  3 -1.0000 -196  195 -274                      $ N Loadout Water
 77  4 -7.8600 -196  195  274 -273                 $ N Loadout Pipe
 78  3 -1.0000 -195  194 -320                      $ W Riser Water
 79  4 -7.8600 -195  194  320 -319                 $ W Riser
 80  3 -1.0000 -194  -27 -246                      $ W OvrHd Water N
 81  4 -7.8600 -194  -27  246 -245                 $ W Overhead N
 82  3 -1.0000  101  193 -286                      $ OvrHd to IXM
 83  4 -7.8600  101  193  286 -285                 $ Pipe to IXM
 84  3 -1.0000 -193  192 -246                      $ W OvrHd Water S
 85  4 -7.8600 -193  192  246 -245                 $ W Overhead S
 86  2 -0.0012  226 -201 -355                      $ PVC Riser in NL
 87  2 -0.0012    1   -8 -264                      $ PVC Pipe NS
 88  2 -0.0012    1  -19   80 -129  219 -201       $ North Air to SF S
       (-14:-122:128:204:124) (-128:271) (301:211)
       (267:-128:-198) (315:198:-170) (241:170)    264
       (279:-128:-169) (321:169:-170) (247:170)
 89  2 -0.0012   19  -27   80 -129  219 -201  355 $ Air SF S to NL S
       (-20:-118:121:213) (-28:-96:118:217)  (317:-200)  247 264
       (-31:-99:118:204) (245:194) (319:-194:195) (273:-195:196)
       (241:199) (269:200:-199)    (243:-196:197) (275:-100:-197)
 90  2 -0.0012   27  -11   80 -129  219 -201       $ South Air
       (-36:39:-110:117:210:(113 -114)) (287:192)
       (285:-101:-193) (245:193:-192)   (264:8)
       (35:-106:109:208) (-40:47:-118:121:213)    (-64:173:247)
       (247:-171) (281:171)   (283:174:-173) (-174:325)
c  Stuff in the Pool Area  -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
 91  1 -2.2580    2   -4  132 -135  229 -221       $ NW Gate Conc
 92  3 -1.0000    2   -6  132 -136  229 -226       $ NW Gate Water
       (135:(4 -5))
 93  2 -0.0012    2   -6  132 -136  226 -221       $ NW Gate Air
       (135:(4 -5))       265
 94  1 -2.2580    5   -8  132 -136  229 -221       $ West Inner Wall
       (6:-135) (-7:133)
 95  2 -0.0012    7  -11  132 -136  226 -221       $ SW Gate Air
       (-133:(8 -9))
 96  3 -1.0000    7  -11  132 -136  229 -226       $ SW Gate Water
       (-133:(8 -9))
 97  1 -2.2580    9  -11  133 -136  229 -221       $ SW Gate Conc
 98  1 -2.2580    2   -4  145 -148  229 -221       $ NE Gate Conc
 99  3 -1.0000    2   -6  145 -149  229 -226       $ NE Gate Water
       (148:(4 -5))
100  2 -0.0012    2   -6  145 -149  226 -221       $ NE Gate Air
       (148:(4 -5))       265
101  1 -2.2580    5   -8  145 -149  229 -221       $ East Inner Wall
       (6:-148) (-7:146)
102  2 -0.0012    7  -11  145 -149  226 -221       $ SE Gate Air
       (-146:(8 -9))
103  3 -1.0000    7  -11  145 -149  229 -226       $ SE Gate Water
       (-146:(8 -9))
104  1 -2.2580    9  -11  146 -149  229 -221       $ SE Gate Conc
c Upper piping along N Wall
105  3 -1.0000 -176  175 -308                      $ W Riser Water
106  4 -7.8600 -176  175  308 -307                 $ W Riser Upper
107  3 -1.0000  176  177 -232                      $ W Pipe Water
108  4 -7.8600  176  177  232 -231                 $ W Pipe Upper
109  3 -1.0000 (-177 179 -266):(223 178(-310:-312:-314))   $ N Water
110  4 -7.8600 ((-177 179 -265):(223 178(-309:-311:-313)))
               #109                                  $ N Upper Pipe
111  3 -1.0000    1 -178 -234                      $ Valve Water
112  4 -7.8600    1 -178  234 -233                 $ Horiz Col 12
113  3 -1.0000    1 -178 -236                      $ Valve Water
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 114   4 -7.8600    1 -178  236 -235                 $ Horiz Col 10
 115   3 -1.0000    1 -178 -238                      $ Valve Water
 116   4 -7.8600    1 -178  238 -237                 $ Horiz Col 8
 117   3 -1.0000 -179  -58 -240                      $ NE Pipe Water
 118   4 -7.8600 -179  -58  240 -239                 $ NE Pipe
 119   3 -1.0000 (59 -38 -240):(223 180(-334:-336:-338)) $ E Pipe Water
 120   4 -7.8600 ((59 -38 -239):(223 180(-333:-335:-337)))
               #119                                       $ E Pipe Plenum
c Overhead piping along S Wall
 121   3 -1.0000 -192  191 -288                      $ S Ovrhd Water
 122   4 -7.8600 -192  191  288 -287                 $ S Pipe Ovrhd
 123   3 -1.0000  229 -210 -328                      $ S Ovrhd Water W
 124   4 -7.8600  229 -210  328 -327                 $ S Pipe Ovrhd W
 125   3 -1.0000  229 -210 -330                      $ S Ovrhd Water Mid
 126   4 -7.8600  229 -210  330 -329                 $ S Pipe Ovrhd Mid
 127   3 -1.0000  229 -210 -332                      $ S Ovrhd Water E
 128   4 -7.8600  229 -210  332 -331                 $ S Pipe Ovrhd E
c Fuel Cannisters and Pool Water
 129   7 -3.0000   18  -45  130 -131  229 -228       $ West Pool Fuel
 130   7 -3.0000   18  -45  137 -144  229 -228       $ Middle Pool Fuel
 131   7 -3.0000   18  -45  150 -157  229 -228       $ East Pool Fuel
 132   3 -1.0000    2  -11  129 -132  229 -226       $ West Pool Water
                                      323  327 #129
 133   3 -1.0000    2  -11  136 -145  229 -226       $ Middle Pool Water
                                           329 #130
 134   3 -1.0000    2  -11  149 -158  229 -226       $ East Pool Water
                                           331 #131
 135   2 -0.0012    2  -11  129 -132  226 -221  327 $ West Pool Air
         (-223:309) (265:177)   (176:307) (-177:-176:231) 323
 136   2 -0.0012    2  -11  136 -145  226 -221  329 $ Middle Pool Air
         (-223:311)             265
 137   2 -0.0012    2  -11  149 -158  226 -221  331 $ East Pool Air
         (-223:(313 333 335 337))    (-179:265) (179:58:239)
         (-59:38:239)
 138   1 -2.2580    1   -2  129 -158  229 -219       $ North Pool Wall
 139   1 -2.2580    1  -79  121  -95  230 -229       $ Bottom of Pool
         (-78:165)
c Lead sheets on grating
 140   8 -11.350    2   -3  129 -158  219 -218            $ Lead North
                                           309  311  313
 141   8 -11.350    3  -10  129 -130  219 -218  307  323 $ Lead West
 142   2 -0.0012    3  -10  130 -131  219 -218            $ Air West
 143   8 -11.350    3  -10  131 -132  219 -218       $ Lead Inner W
 144   2 -0.0012    3  -10  132 -136  219 -218       $ Air Inner W
 145   8 -11.350    3  -10  136 -137  219 -218       $ Lead Inner W
 146   2 -0.0012    3  -10  137 -144  219 -218       $ Air Middle
 147   8 -11.350    3  -10  144 -145  219 -218       $ Lead Inner E
 148   2 -0.0012    3  -10  145 -149  219 -218       $ Air Inner E
 149   8 -11.350    3  -10  149 -150  219 -218       $ Lead Inner E
 150   2 -0.0012    3  -10  150 -157  219 -218       $ Air East
 151   8 -11.350    3  -10  157 -158  219 -218            $ Lead East
                                           333  335  337
 152   8 -11.350   10  -11  129 -158  219 -218            $ Lead South
                                           327  329  331
 153   0                2  -11  129 -134  221 -220  309  327 $ W Supports
              307  323  fill=1  ( 850.90 2795.27 -25.40 )
 154   0                2  -11  134 -147  221 -220  311  329 $ Mid Supports
                        fill=1  ( 850.90 3694.43 -25.40 )
 155   0                2  -11  147 -158  221 -220  313  331 $ E Supports
              333  335  337  fill=1  ( 850.90 4593.59 -25.40 )
 156   0                2  -11  129 -158  220 -219       307 $ Grating
                  309  311  313  323  327  329  331  333  335  337
         fill=3  ( 1064.26 3692.53 -3.18 )
 157   2 -0.0012    2  -11  129 -134  218 -201       $ W Grate Posts
         (178:233) (-178:309)   (210:327)  287 (-175:307) (175:271)
         (-172:323) (172:281)
 158   2 -0.0012    2  -11  134 -147  218 -201       $ Mid Grate Posts
         (178:235) (-178:311)   (210:329)  287
 159   2 -0.0012    2  -11  147 -158  218 -201       $ E Grate Posts
         (178:237) (-178:313)   (210:331)  287
         (180:(291 293 295))    (-180:(333 335 337))
 160   2 -0.0012    1   -2  129 -158  219 -201  233  235  237
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c  Stuff at the South Side -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
 161   1 -2.2580    11  -13  129 -140  229 -219      $ South Pool Wall
         (76:-139)
 162   1 -2.2580    13  -78  121 -138  229 -219      $ South Floor W
 163   1 -2.2580    11  -77  141 -153  229 -219      $ Discharge Island
         (76:(142 -152))   -143  151
 164   3 -1.0000    13  -78  138 -156  229 -226      $ Discharge Water
         (77:-141:143:-151:153)
 165   3 -1.0000    11  -13  139 -142  229 -226      $ Discharge Water
         (-76:(140 -141))
 166   3 -1.0000    11  -13  152 -155  229 -226      $ Discharge Water
         (-76:(153 -154))
 167   2 -0.0012    13  -78  138 -156  226 -219      $ Discharge Air
         (77:-141:143:-151:153)
 168   2 -0.0012    11  -13  139 -142  226 -219      $ Discharge Air
         (-76:(140 -141))
 169   2 -0.0012    11  -13  152 -155  226 -219      $ Discharge Air
         (-76:(153 -154))
 170   1 -2.2580    13  -79  156  -95  229 -219      $ South Floor E
         (-78:165)
 171   1 -2.2580    11  -13  154 -158  229 -219      $ South Pool Wall
         (76:155)
 172   1 -2.2580    11  -13   81  -82  219 -201      $ Concrete Col 12.2
 173   8 -11.350    11  -12   82  -83  219 -209      $ Lead at Col 12.2
 174   1 -2.2580    11  -13   84  -85  219 -201      $ Concrete Col 11.2
 175   1 -2.2580    11  -13   86 -138  219 -201      $ Concrete Col 10.4
 176   8 -11.350    11  -12   87  -88  219 -209      $ Lead at Col 9.5
 177   1 -2.2580    11  -13   88  -89  219 -201      $ Concrete Col 9.5
 178   8 -11.350    11  -12   89  -90  219 -209      $ Lead at Col 9.5
 179   1 -2.2580    11  -13   91  -92  219 -201      $ Concrete Col 8.6
 180   1 -2.2580    11  -13  156  -93  219 -201      $ Concrete Col 7.7
 181   8 -11.350    11  -12   93  -94  219 -209      $ Lead at Col 7.7
 182   1 -2.2580    11  -13  158 -159  219 -201      $ Concrete Col 7.1
 183   2 -0.0012    11  -79   80  -95  219 -201      $ Air in South Side
         (-78:165)    (13:((-81:82) (-84:85) (-86:138)))
         (13:((-88:89) (-91:92) (-156:93) (-158:159)))
         (12:((-82:83) (-87:88) (-89:90) (-93:94)):209)
 184   1 -2.2580    78  -79   80 -165  230 -201      $ Reactor Face
c  Stuff at the East End   -=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
 185   1 -2.2580    59  -64  158 -159  229 -219      $ East Wall of Pool
 186   1 -2.2580    73  -13  158 -159  229 -219      $ East Wall of Pool
 187   3 -1.0000 -252   55  -56                      $ Chiller Innards
 188   4 -7.8600 -251   54  -57 (252:-55:56)         $ Chiller Vessel
 189   3 -1.0000 -254   49  -50                      $ Heat Exch Water
 190   5 -1.5730 -254   50  -51                      $ Heat Exch Innards
 191   3 -1.0000 -254   51  -52                      $ Heat Exch Water
 192   4 -7.8600 -253   48  -53 (254:-49:52)         $ Heat Exch Vessel
 193   8 -11.350 -255   48  -53  253                 $ Heat Exch Lead
 194   3 -1.0000 -180  181 -292                      $ E Pipe Water
 195   4 -7.8600 -180  181  292 -291                 $ E Pipe #1
 196   3 -1.0000 -180 -159 -294                      $ E Pipe Water
 197   4 -7.8600 -180 -159  294 -293                 $ E Pipe #2
 198   3 -1.0000 -180  181 -296                      $ E Pipe Water
 199   4 -7.8600 -180  181  296 -295                 $ E Pipe #3
 200   3 -1.0000 -181  182 -340                      $ #1/Riser Water
 201   4 -7.8600 -181  182  340 -339                 $ #1/Riser Pipe
 202   3 -1.0000 (219 -203 -342):(-182 183 -263)     $ #2 Riser/Ohd Watr
 203   4 -7.8600 ((219 -203 -341):(-182 183 -262)) #202  $ #2 Pipe
 204   3 -1.0000 -183  184 -290                      $ Over Pump #3 Watr
 205   4 -7.8600 -183  184  290 -289                 $ Over Pump #3 Pipe
 206   3 -1.0000 (-184 -185 -261):(217 -203 -346)    $ TV $3 Water
 207   4 -7.8600 ((-184 -185 -260):(217 -203 -345)) #206 $ TV #3 Pipe
 208   3 -1.0000  229  185 -352                      $ TV Riser #3 Water
 209   4 -7.8600  229  185  352 -351                 $ TV Riser #3 Pipe
 210   3 -1.0000  229 -202 -348                      $ TV Riser #1 Water
 211   4 -7.8600  229 -202  348 -347                 $ TV Riser #1 Pipe
 212   3 -1.0000  229  186 -350                      $ TV Riser #2 Water
 213   4 -7.8600  229  186  350 -349                 $ TV Riser #2 Pipe
 214   3 -1.0000 (187 -186 -259):(217 -202 -344):    $ Big Cross Water
                 (-190 189 -298):(219 -202 -354)
 215   4 -7.8600 ((187 -186 -258):(217 -202 -343):   $ Big Cross Pipe
                  (-190 189 -297):(219 -202 -353)) #214
 216   3 -1.0000 -188 -189 -257                      $ Over HX Water
 217   4 -7.8600 -188 -189  257 -256                 $ Over HX Pipe
 218   3 -1.0000 -187  188 -300                      $ To HX Water
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 219   4 -7.8600 -187  188  300 -299              $ To HX Pipe
 220   3 -1.0000  190 -191 -250                   $ E Ovrhd Water
 221   4 -7.8600  190 -191  250 -249              $ E Ovrhd NS
 222   3 -1.0000   58  -61  158 -161  229 -226    $ Water in Elevator
         (-59:159) (-60:-160)
 223   2 -0.0012   58  -61  158 -161  226 -219    $ Air in Elevator
         (-59:159) (-60:-160)
 224   1 -2.2580   62  -75  162 -168  219 -217    $ SE Pit's Curb
         (-63:74:167)
 225   2 -0.0012   63  -74  162 -167  219 -217    $ Air over SE Pits
                             347  349  351
 226   1 -2.2580   63  -64  162 -163  229 -219    $ Weasel N Concrete
 227   3 -1.0000   63  -66  158 -167  229 -226    $ Weasel Pit Water
         ((64 -65):159) (64:-162:163) (-65:-162:165)
 228   2 -0.0012   63  -66  158 -167  226 -219    $ Weasel Pit Air
         ((64 -65):159) (64:-162:163) (-65:-162:165)
 229   1 -2.2580   65  -68  158 -167  229 -219    $ Weasel/Viewing
         ((66 -67):-159:162) (66:-165) (-67:-163)
 230   1 -2.2580   69  -72  158 -163  229 -219    $ Viewing Pit Wall
         ((70 -71):-159:162)
 231   3 -1.0000   67  -74  158 -164  229 -226    $ Viewing Pit Water
         ((68 -73):(159 -162:163)) #230    347  349  351
 232   2 -0.0012   67  -74  158 -164  226 -219    $ Viewing Pit Air
         ((68 -73):(159 -162:163)) #230    347  349  351
 233   1 -2.2580   73  -74  162 -163  229 -219    $ Viewing S Concrete
 234   1 -2.2580   67  -74  164 -167  229 -224    $ Viewing Pit Floor
         (-166:-225) (-165:166:-227)
 235   2 -0.0012   67  -74  164 -167  227 -219    $ Viewing Pit Air
         (-166:225) (165:224)
 236   1 -2.2580    1  -13  158  -95  229 -219    $ East Floor
         (-58:61:(60 160):161)  (-63:74:167)   (-58:159)
 237   2 -0.0012    1  -57  158  -95  219 -201    $ East Air North
         (-54:251)     (-48:255)       (159:293)
         (-181:291) (181:-182:339)    (182:262) (203:341)
         (187:-188:299)     (-187:258) (188:256)
 238   2 -0.0012   57  -62  158  -95  219 -201    $ East Air Middle
         (-181:295)    (184:260) (183:-184:289) (-183:262)
             258 (-190:249) (189:256) (-189:190:297)
         (202:353)     (53:255)
 239   2 -0.0012   62  -11  158  -95  219 -201    $ East Air South
         (75:-162:168:217) (-191:287) (191:249)
         (202:343) (-186:349) (186:258)    (202:347)
         (203:345) (-185:351) (185:260)
c  Universes to Represent the Grating & Supports  -=-=-=-=-=-=-=-=-=-
 240   0            356 -363  364 -369 fill=2 u=1 lat=1    $ Support Beams
 241   2 -0.0012 ( 357 -362 365 -368 370 -371 ):          $  Air
                 ( 360 -361 366 -367)  u=2
 242   4 -7.8600 ( -357:362:-365:368:-370:371 )           $  Beams
                 ( -360:361:-366:367)  u=2
 243   0            356 -359      fill=4 u=3 lat=1        $ Grating
 244   2 -0.0012  357 -358      u=4                        $  Air
 245   4 -7.8600 ( -357:358 )   u=4                        $  Grate

c    X Coordinates
c      PX      0.00  $ Column A
c      PX    424.18  $ Column B
c      PX    614.68  $ Column Bd
c      PX    850.90  $ Column C
c      PX   1277.62  $ Column D
c      PX   1704.34  $ Column E
c      PX   2131.06  $ Column F
c      PX   2580.64  $ Column G
c Pool walls
   1   PX    -25.40  $ N Wall Outer
   2   PX     20.32  $ North Wall
   3   PX     91.44  $ Lead Boundary
   4   PX     40.64  $ North Gate N
   5   PX    137.16  $ North Gate S
   6   PX    157.48  $ North Indent
   7   PX   1971.04  $ South Indent
   8   PX   1991.36  $ South Gate N
   9   PX   2087.88  $ South Gate S
  10   PX   2037.08  $ Lead Boundary
  11   PX   2108.20  $ South Wall
  12   PX   2113.28  $ S Lead Wall
  13   PX   2153.92  $ S Wall Outer
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c Sand Filter Walls
  14  PX    197.49  $ N Wall Outer
  15  PX    227.97  $ N Wall Inner
  16  PX    421.01  $ Pipe Gap N
  17  PX    441.33  $ Pipe Gap S
  18  PX    456.57  $ S Wall Inner
  19  PX    487.05  $ S Wall Outer
c North Loadout Pit Details
  20  PX    596.90  $ Outer wall N Curb
  21  PX    637.54  $ Inner wall N Curb
  22  PX    695.96  $ N Side Opening to Pool
  23  PX    711.20  $ Inner Gate N
  24  PX    777.24  $ Inner Gate S
  25  PX    792.48  $ S Side Opening to Pool
  26  PX    850.90  $ Inner wall S Curb
  27  PX    891.54  $ Outer wall S Curb
c Washing Pit & IX Modules
  28  PX    546.10  $ Washing Pit N Curb
  29  PX    566.42  $ Washing Pit N Wall
  30  PX    871.22  $ Washing Pit S Wall
  31  PX    708.66  $ IX Box N Wall Outer
  32  PX    754.38  $ IX Box N Wall Inner
  33  PX    845.82  $ IX Box S Wall Inner
  34  PX    967.74  $ Lead Cave S Inner
  35  PX    972.82  $ Lead Cave S Outer
  36  PX    988.06  $ IX Modules N Wall
  37  PX   1036.32  $ IX Modules N Wall Inner
  38  PX   1158.24  $ IX Modules S Wall Inner
  39  PX   1206.50  $ IX Modules S Wall
c South Loadout Pit Details
  40  PX   1351.28  $ Outer wall N Curb
  41  PX   1391.92  $ Inner wall N Curb
  42  PX   1450.34  $ N Side Opening to Pool
  43  PX   1465.58  $ Inner Gate N
  44  PX   1531.62  $ Inner Gate S
  45  PX   1546.86  $ S Side Opening to Pool
  46  PX   1605.28  $ Inner wall S Curb
  47  PX   1645.92  $ Outer wall S Curb
c Heat Exchanger Equipment
  48  PX    492.76  $ N end Heat Exchanger
  49  PX    497.33  $ Inner Heat Exchanger N
  50  PX    601.47  $ Heat Exchanger TubeSheet N
  51  PX   1082.55  $ Heat Exchanger TubeSheet S
  52  PX   1186.69  $ Inner Heat Exchanger S
  53  PX   1191.26  $ S end Heat Exchanger
  54  PX    614.68  $ N end Chiller
  55  PX    619.76  $ Inner Chiller
  56  PX   1013.46  $ Inner Chiller
  57  PX   1018.54  $ S end Chiller
c Elevator Pit Walls
  58  PX    256.54  $ Gate N
  59  PX    347.98  $ Gate S
  60  PX    408.94  $ Inner Wall S
  61  PX    454.66  $ South Wall Inner
c South Pit Walls
  62  PX   1262.38  $ Weasel Curb N Outer
  63  PX   1292.86  $ Weasel Pit N Wall
  64  PX   1320.80  $ Weasel Gate N
  65  PX   1417.32  $ Weasel Gate S
  66  PX   1460.50  $ Weasel Pit S Wall
  67  PX   1496.06  $ Viewing Pit N Wall
  68  PX   1521.46  $ N Gate to Viewing Pit N
  69  PX   1617.98  $ N Gate to Viewing Pit S
  70  PX   1658.62  $ Gate Divider N
  71  PX   1694.18  $ Gate Divider S
  72  PX   1734.82  $ S Gate to Viewing Pit N
  73  PX   1831.34  $ S Gate to Viewing Pit S
  74  PX   1856.74  $ Viewing Pit S Wall
  75  PX   1887.22  $ Viewing Curb Outer S
c Reactor Discharge
  76  PX   2131.06  $ Gate Indent
  77  PX   2260.60  $ S Island
  78  PX   2557.78  $ Reactor N Face
  79  PX   2672.08  $ Reactor N
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c    Y Coordinates
  80  PY      0.00  $ Column 16             0.00 Column 16
c Concrete Columns - S Wall               593.09 Column 15
  81  PY   2291.08  $ Col 12.2 W          1172.21 Column 14
  82  PY   2336.80  $ Col 12.2 E          1751.33 Column 13
  83  PY   2397.76  $ Col 12.2 Pb         2391.41 Column 12
  84  PY   2879.09  $ Col 11.2 W          3031.49 Column 10.9
  85  PY   2924.81  $ Col 11.2 E          3694.43 Column 10
  86  PY   3458.21  $ Col 10.4 W          4357.37 Column 8.9
  87  PY   3732.53  $ Col 9.5 Pb          4989.83 Column 8
  88  PY   3991.61  $ Col 9.5 W           5622.29 Column 7.1
  89  PY   4037.33  $ Col 9.5 E           5927.09 Column 6
  90  PY   4098.29  $ Col 9.5 Pb          6292.85 Column 5
  91  PY   4570.73  $ Col 8.6 W           6656.07 Column 4
  92  PY   4616.45  $ Col 8.6 E           7039.61 Column 3
  93  PY   5149.85  $ Col 7.7 E           7245.35 Column 2.3
  94  PY   5210.81  $ Col 7.7 Pb          7832.09 Column 1.5
  95  PY   8324.85  $ Column 1            8324.85 Column 1
c Washing Pit & IX Modules
  96  PY    687.07  $ West Wall, Outer
  97  PY    707.39  $ West Wall, Inner
  98  PY   1215.39  $ East Wall, Inner
  99  PY    778.51  $ IX Box W Wall Outer
 100  PY    824.23  $ Cell #3 West Wall
 101  PY    915.67  $ Cell #3 East Wall
 102  PY    961.39  $ Cell #2 West Wall
 103  PY   1052.83  $ Cell #2 East Wall
 104  PY   1098.55  $ Cell #1 West Wall
 105  PY   1189.99  $ Cell #1 East Wall
 106  PY    793.75  $ Lead Cave W Outer
 107  PY    798.83  $ Lead Cave W Inner
 108  PY   1215.39  $ Lead Cave E Inner
 109  PY   1220.47  $ Lead Cave E Outer
 110  PY    831.85  $ IX Module #2 W Outer
 111  PY    880.11  $ IX Module #2 W Inner
 112  PY    961.39  $ IX Module #2 E Inner
 113  PY   1009.65  $ IX Module #2 E Outer
 114  PY   1070.61  $ IX Module #1 W Outer
 115  PY   1118.87  $ IX Module #1 W Inner
 116  PY   1200.15  $ IX Module #1 E Inner
 117  PY   1248.41  $ IX Module #1 E Outer
c Loadout Pits Details
 118  PY   1235.71  $ West Wall, Outer
 119  PY   1280.80  $ West Wall, Inner
 120  PY   1560.83  $ East Wall, Inner
 121  PY   1601.47  $ East Wall, Outer
c Sand Filter Walls
 122  PY   1240.79  $ West Wall, Outer
 123  PY   1271.27  $ West Wall, Inner
 124  P     1.5652   -1.0000    0.0000  -580.69  $ Slanted Wall Outer
 125  P     1.5652   -1.0000    0.0000  -637.30  $ Slanted Wall Inner
 126  PY   1499.87  $ East Wall, Inner
 127  PY   1515.11  $ Pipe Gap
 128  PY   1530.35  $ East Wall, Outer
c Pool Walls
 129  PY   1785.62  $ West Wall of Pool
 130  PY   1842.77  $ Lead Boundary
 131  PY   2957.83  $ Lead Boundary
 132  PY   3001.01  $ Inner Wall West
 133  PY   3021.33  $ Gate S Indent
 134  PY   3031.49  $ West Wall Center
 135  PY   3041.65  $ Gate N Indent
 136  PY   3061.97  $ Inner Wall West
 137  PY   3105.15  $ Lead Boundary
 138  PY   3503.93  $ Discharge W Inner
 139  PY   3521.71  $ Indent
 140  PY   3542.03  $ Gate W
 141  PY   3638.55  $ Island W
 142  PY   3658.87  $ Indent
 143  P     1.0000   -1.0000    0.0000 -1416.05  $ SW Slant Line
 144  PY   4283.71  $ Lead Boundary
 145  PY   4326.89  $ Inner Wall East
 146  PY   4347.21  $ Gate S Indent
 147  PY   4357.37  $ East Wall Center
 148  PY   4367.53  $ Gate N Indent
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 149  PY    4387.85  $ Inner Wall East
 150  PY    4431.03  $ Lead Boundary
 151  P     -1.0000   -1.0000    0.0000 -7146.29  $ SE Slant Line
 152  PY    4903.47  $ Indent
 153  PY    4923.79  $ Island E
 154  PY    5020.31  $ Gate E
 155  PY    5040.63  $ Indent
 156  PY    5104.13  $ Discharge E Inner
 157  PY    5543.55  $ Lead Boundary
 158  PY    5599.43  $ East Wall W
 159  PY    5645.15  $ East Wall E
c Elevator Pit Walls
 160  PY    5911.85  $ Corner W Wall
 161  PY    6257.29  $ East Wall Inner
c South Pit Walls
 162  PY    5919.47  $ Gate to Pits
 163  PY    5944.87  $ Pit West Wall
 164  PY    6290.31  $ Viewing Dam W
 165  PY    6320.79  $ Viewing Dam E
 166  PY    6503.67  $ West Edge Platform
 167  PY    6640.83  $ Pit East Wall
 168  PY    6671.31  $ Pit Curb Outer
c Pipe Elbows (diagonal planes)
 169  P      0.0000   -1.0000   -1.0000 -1824.99  $ W SF/Riser 13B
 170  P     -1.0000    0.0000   -1.0000  -714.38  $ W Riser/Ovrhd SF
 171  P     -1.0000   -1.0000    0.0000 -3013.71  $ Corner to 13D Riser
 172  P      0.0000    1.0000   -1.0000  1517.65  $ Knee of 13D Riser
 173  P      1.0000   -1.0000    0.0000  -115.57  $ S Corner W Ovrhd
 174  P      0.0000   -1.0000   -1.0000 -1752.60  $ S Loadout Riser
 175  P      0.0000    1.0000   -1.0000  1818.64  $ W Riser/Pump Upper
 176  P     -1.0000    0.0000   -1.0000  -296.55  $ W Riser/Pipe
 177  P      1.0000   -1.0000    0.0000 -1765.30  $ NW Corner
 178  P      1.0000    0.0000   -1.0000   -25.40  $ N Valves
 179  P     -1.0000   -1.0000    0.0000 -5637.53  $ NE Corner
 180  P      0.0000   -1.0000   -1.0000 -5584.19  $ E Riser/Pumps
 181  P      0.0000   -1.0000   -1.0000 -5863.59  $ E Pump/Riser
 182  P     -1.0000    0.0000   -1.0000  -930.91  $ Riser/Ovrhd to View
 183  P     -1.0000   -1.0000    0.0000 -6986.27  $ Corner by Pump #3
 184  P     -1.0000   -1.0000    0.0000 -7321.55  $ Corner N of #3
 185  P      1.0000    0.0000   -1.0000  1299.21  $ Tech View #3
 186  P      1.0000    0.0000   -1.0000  1277.62  $ Tech View #2
 187  P      1.0000   -1.0000    0.0000 -5510.53  $ Corner N of #2
 188  P     -1.0000   -1.0000    0.0000 -7103.11  $ Corner N of HX
 189  P      1.0000   -1.0000    0.0000 -5419.09  $ Corner S of HX
 190  P      1.0000   -1.0000    0.0000 -4608.83  $ East Corner to HX
 191  P      1.0000   -1.0000    0.0000 -3623.31  $ SE Corner Ovrhd
 192  P     -1.0000   -1.0000    0.0000 -3620.77  $ SW Corner Ovrhd
 193  P     -1.0000   -1.0000    0.0000 -2932.43  $ Corner to IXM
 194  P     -1.0000    0.0000   -1.0000  -891.54  $ W Riser/Ovrhd IX
 195  P      0.0000   -1.0000   -1.0000 -1687.83  $ N Loadout/Riser
 196  P      1.0000   -1.0000    0.0000  -633.73  $ Outlet/N Loadout
 197  P      1.0000   -1.0000    0.0000  -523.24  $ IX Box Outlet
 198  P      0.0000   -1.0000   -1.0000 -1808.48  $ SF Pipe 1 & Pipe 2
 199  P      1.0000   -1.0000    0.0000  -967.74  $ SF Pipe 3 & Pipe 4
 200  P      0.0000   -1.0000   -1.0000 -1818.64  $ SF Pipe 4 & Pipe 5
c   Z Coordinates
 201  PZ     609.60  $ Roof
 202  PZ     304.80  $ Overhead Pipe
 203  PZ     283.21  $ Height of Lower Overhead
 204  PZ     274.32  $ Sand Filter & IX Box Top
 205  PZ     259.08  $ Sand Filter Ceiling
 206  PZ     228.60  $ Sand Filter Vessel Top
 207  PZ     227.97  $ Sand Filter Vessel Top
 208  PZ     187.96  $ Lead Cave Upper
 209  PZ     182.88  $ Lead Cave Inner
 210  PZ     203.20  $ Top of IX Modules
 211  PZ     154.94  $ IX Modules Ceiling
 212  PZ      91.44  $ Sand Filter Opening
 213  PZ      60.96  $ Loadout Pit Curbs
 214  PZ      48.26  $ IX Module Floor
 215  PZ      15.88  $ Sand Filter Vessel Inner
 216  PZ      15.24  $ Sand Filter Vessel Bottom
 217  PZ      10.16  $ Washing Pit Curb
 218  PZ       1.27  $ Top of Lead Flooring
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 219  PZ      0.00  $ Top of Grating
 220  PZ     -3.18  $ Bottom of Grating
 221  PZ    -25.40  $ Top of Pool Inner Walls
 222  PZ    -35.56  $ Washing Pit Floor
 223  PZ    -45.72  $ Piping Under Grate
 224  PZ    -91.44  $ Top of Dam
 225  PZ   -152.40  $ Viewing Platform Upper
 226  PZ   -119.86  $ Water Level is 16'10"
 227  PZ   -304.80  $ Viewing Pit Lower
 228  PZ   -541.02  $ Top of Fuel
 229  PZ   -632.46  $ Bottom of Pool
 230  PZ   -779.78  $ Bottom of Loadout Pits
c Cylinders Along X (NS)
 231 C/X   1831.34   -45.72    10.16  $ W Wall Upper
 232 C/X   1831.34   -45.72     9.53  $ W Wall Upper
 233 C/X   2391.41    91.44    10.16  $ N Wall Valve 12
 234 C/X   2391.41    91.44     9.53  $ N Wall Valve 12
 235 C/X   3694.43    91.44    10.16  $ N Wall Valve 10
 236 C/X   3694.43    91.44     9.53  $ N Wall Valve 10
 237 C/X   4989.83    91.44    10.16  $ N Wall Valve 8
 238 C/X   4989.83    91.44     9.53  $ N Wall Valve 8
 239 C/X   5571.49   -45.72    10.16  $ Along E Wall
 240 C/X   5571.49   -45.72     9.53  $ Along E Wall
 241 C/X   1630.68   283.21    10.16  $ SF Loop Part 3
 242 C/X   1630.68   283.21     9.53  $ SF Loop Part 3
 243 C/X   1220.47   106.68    10.16  $ W to IX Box
 244 C/X   1220.47   106.68     9.53  $ W to IX Box
 245 C/X   1581.15   304.80    10.16  $ W Overhead - IX
 246 C/X   1581.15   304.80     9.53  $ W Overhead - IX
 247 C/X   1705.61   283.21    10.16  $ W Overhead - SF
 248 C/X   1705.61   283.21     9.53  $ W Overhead - SF
 249 C/X   5662.93   304.80    10.16  $ E Side Overhead
 250 C/X   5662.93   304.80     9.53  $ E Side Overhead
 251 C/X   6320.79    53.34    38.10  $ Chiller
 252 C/X   6320.79    53.34    37.15  $ Chiller
 253 C/X   6473.19    73.66    48.26  $ Heat Exchanger
 254 C/X   6473.19    73.66    47.31  $ Heat Exchanger
 255 C/X   6473.19    73.66    49.53  $ Heat Exchanger Pb
 256 C/X   6473.19   304.80    10.16  $ Pipe Over Heat Ex
 257 C/X   6473.19   304.80     9.53  $ Pipe Over Heat Ex
 258 C/X   6140.45   304.80    10.16  $ E Overhead - View #2
 259 C/X   6140.45   304.80     9.53  $ E Overhead - View #2
 260 C/X   6186.17   283.21    10.16  $ E Overhead - View #3
 261 C/X   6186.17   283.21     9.53  $ E Overhead - View #3
 262 C/X   5850.89   283.21    10.16  $ E Overhead - Pumps
 263 C/X   5850.89   283.21     9.53  $ E Overhead - Pumps
 264 C/X   1611.63   304.80     5.08  $ PVC Overhead, West Side
c Cylinders Along Y (EW)
 265 C/Y     66.04   -45.72    10.16  $ N Wall Upper
 266 C/Y     66.04   -45.72     9.53  $ N Wall Upper
 267 C/Y    431.17   177.80    10.16  $ SF Loop Part 1
 268 C/Y    431.17   177.80     9.53  $ SF Loop Part 1
 269 C/Y    662.94   283.21    10.16  $ SF Loop Part 4
 270 C/Y    662.94   283.21     9.53  $ SF Loop Part 4
 271 C/Y    342.27    12.70    10.16  $ Pipe to Sand Filter
 272 C/Y    342.27    12.70     9.53  $ Pipe to Sand Filter
 273 C/Y    586.74   106.68    10.16  $ North of N Loadout
 274 C/Y    586.74   106.68     9.53  $ North of N Loadout
 275 C/Y    697.23   106.68    10.16  $ North of IX Box
 276 C/Y    697.23   106.68     9.53  $ North of IX Box
 277 C/Y    723.90   -45.72    10.16  $ N Loadout Below Floor
 278 C/Y    723.90   -45.72     9.53  $ N Loadout Below Floor
 279 C/Y    431.17   119.38    10.16  $ From SF to Col 13B Riser
 280 C/Y    431.17   119.38     9.53  $ From SF to Col 13B Riser
 281 C/Y   1308.10   283.21    10.16  $ From Col 13D Riser
 282 C/Y   1308.10   283.21     9.53  $ From Col 13D Riser
 283 C/Y   1590.04   283.21    10.16  $ South of S Loadout
 284 C/Y   1590.04   283.21     9.53  $ South of S Loadout
 285 C/Y   1351.28   304.80    10.16  $ North of S Loadout
 286 C/Y   1351.28   304.80     9.53  $ North of S Loadout
 287 C/Y   2039.62   304.80    10.16  $ Pipe Above S Wall
 288 C/Y   2039.62   304.80     9.53  $ Pipe Above S Wall
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 291 C/Y     647.70     12.70     10.16  $ E Wall Pump #1
 292 C/Y     647.70     12.70      9.53  $ E Wall Pump #1
 293 C/Y     891.54     12.70     10.16  $ E Wall Pump #2
 294 C/Y     891.54     12.70      9.53  $ E Wall Pump #2
 295 C/Y    1135.38     12.70     10.16  $ E Wall Pump #3
 296 C/Y    1135.38     12.70      9.53  $ E Wall Pump #3
 289 C/Y    1135.38    283.21     10.16  $ E Overhead to Pump #3
 290 C/Y    1135.38    283.21      9.53  $ E Overhead to Pump #3
 297 C/Y    1054.10    304.80     10.16  $ OvrHd to Heat Exchanger
 298 C/Y    1054.10    304.80      9.53  $ OvrHd to Heat Exchanger
 299 C/Y     629.92    304.80     10.16  $ OvrHd from Heat Exch
 300 C/Y     629.92    304.80      9.53  $ OvrHd from Heat Exch
c Cylinders Along Z
 301 C/Z      30.48    684.53     10.16  $ NW Filter Media
 302 C/Z     815.34    854.71     22.86  $ IX Cell #3
 303 C/Z     815.34    991.87     22.86  $ IX Cell #2
 304 C/Z     815.34   1129.03     22.86  $ IX Cell #1
 305 C/Z     342.27   1385.57     98.11  $ Sand Filter Inner
 306 C/Z     342.27   1385.57     99.06  $ Sand Filter Outer
 307 C/Z     342.27   1831.34     10.16  $ Riser to Sand Filter
 308 C/Z     342.27   1831.34      9.53  $ Riser to Sand Filter
 309 C/Z      66.04   2391.41     10.16  $ N Wall Valve 12
 310 C/Z      66.04   2391.41      9.53  $ N Wall Valve 12
 311 C/Z      66.04   3694.43     10.16  $ N Wall Valve 10
 312 C/Z      66.04   3694.43      9.53  $ N Wall Valve 10
 313 C/Z      66.04   4989.83     10.16  $ N Wall Valve 8
 314 C/Z      66.04   4989.83      9.53  $ N Wall Valve 8
 315 C/Z     431.17   1630.68     10.16  $ SF Loop Part 2
 316 C/Z     431.17   1630.68      9.53  $ SF Loop Part 2
 317 C/Z     662.94   1535.43     10.16  $ SF Loop Part 5
 318 C/Z     662.94   1535.43      9.53  $ SF Loop Part 5
 319 C/Z     586.74   1581.15     10.16  $ W Riser - IX
 320 C/Z     586.74   1581.15      9.53  $ W Riser - IX
 321 C/Z     431.17   1705.61     10.16  $ Riser at Col 13B
 322 C/Z     431.17   1705.61      9.53  $ Riser at Col 13B
 323 C/Z    1308.10   1800.86     10.16  $ Col 13D Riser
 324 C/Z    1308.10   1800.86      9.53  $ Col 13D Riser
 325 C/Z    1590.04   1469.39     10.16  $ Riser in S Loadout
 326 C/Z    1590.04   1469.39      9.53  $ Riser in S Loadout
 327 C/Z    2090.42   2382.52     10.16  $ S Wall Col 12.2
 328 C/Z    2090.42   2382.52      9.53  $ S Wall Col 12.2
 329 C/Z    2090.42   4060.19     10.16  $ S Wall Col 9.5
 330 C/Z    2090.42   4060.19      9.53  $ S Wall Col 9.5
 331 C/Z    2090.42   5203.19     10.16  $ S Wall Col 7.7
 332 C/Z    2090.42   5203.19      9.53  $ S Wall Col 7.7
 333 C/Z     647.70   5571.49     10.16  $ E Wall Riser #1
 334 C/Z     647.70   5571.49      9.53  $ E Wall Riser #1
 335 C/Z     891.54   5571.49     10.16  $ E Wall Riser #2
 336 C/Z     891.54   5571.49      9.53  $ E Wall Riser #2
 337 C/Z    1135.38   5571.49     10.16  $ E Wall Riser #3
 338 C/Z    1135.38   5571.49      9.53  $ E Wall Riser #3
 339 C/Z     647.70   5850.89     10.16  $ E Pump/Ovrhd Riser #1
 340 C/Z     647.70   5850.89      9.53  $ E Pump/Ovrhd Riser #1
 341 C/Z     891.54   5850.89     10.16  $ E Pump/Ovrhd Riser #2
 342 C/Z     891.54   5850.89      9.53  $ E Pump/Ovrhd Riser #2
 343 C/Z    1308.10   6140.45     10.16  $ Riser U - West Leg
 344 C/Z    1308.10   6140.45      9.53  $ Riser U - West Leg
 345 C/Z    1308.10   6186.17     10.16  $ Riser U - East Leg
 346 C/Z    1308.10   6186.17      9.53  $ Riser U - East Leg
 347 C/Z    1582.42   6094.73     10.16  $ Riser #1 from View Pit
 348 C/Z    1582.42   6094.73      9.53  $ Riser #1 from View Pit
 349 C/Z    1582.42   6140.45     10.16  $ Riser #2 from View Pit
 350 C/Z    1582.42   6140.45      9.53  $ Riser #2 from View Pit
 351 C/Z    1582.42   6186.17     10.16  $ Riser #3 from View Pit
 352 C/Z    1582.42   6186.17      9.53  $ Riser #3 from View Pit
 353 C/Z    1054.10   6320.79     10.16  $ Riser from Chiller
 354 C/Z    1054.10   6320.79      9.53  $ Riser from Chiller
 355 C/Z     812.80   1550.67      5.08  $ PVC Riser from N Loadout
c Support Universes - X
 356  PX       0.00  $ origin
 357  PX       0.32  $ metal half thickness
 358  PX       2.86  $ inner grate
 359  PX       3.18  $ grate spacing
 360  PX       5.08  $ I-beam left
 361  PX     421.64  $ I-beam right
 362  PX     426.40  $ inner beam
 363  PX     426.72  $ beam spacing
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c Support Universes - Y
 364  PY      0.00  $ origin
 365  PY      0.32  $ metal half thickness
 366  PY      5.08  $ I-beam left
 367  PY    101.60  $ I-beam right
 368  PY    106.36  $ inner beam
 369  PY    106.68  $ beam spacing
c Support Universes - Z
 370  PZ      0.64  $ metal thickness
 371  PZ     21.59  $ inner upper

m1    $  Hanford Concrete
          1001.01p   -0.00310  $  Hydrogen
          8016.01p   -0.44070  $  Oxygen
         11023.01p   -0.01820  $  Sodium
         12000.01p   -0.03760  $  Magnesium
         13027.01p   -0.06070  $  Aluminum
         14000.01p   -0.21570  $  Silicon
         15031.01p   -0.00090  $  Phosphorus
         16032.01p   -0.00090  $  Sulfur
         20000.01p   -0.13060  $  Calcium
         22000.01p   -0.00490  $  Titanium
         25055.01p   -0.00130  $  Manganese
         26000.01p   -0.07880  $  Iron
         36000.01p   -0.00660  $  Krypton
m2    $  Air at 80°F and 20.0% Relative Humidity
          1001.01p   -0.00048  $  Hydrogen
          6012.01p   -0.00014  $  Carbon
          7014.01p   -0.75191  $  Nitrogen
          8016.01p   -0.23464  $  Oxygen
         18040.01p   -0.01282  $  Argon
m3    $ water
       1001.01p  0.66667   8016.01p  0.33333
m4    $ iron
       26000.01p  -1.0
m5    $ iron & air
       26000.01p  -1600.0    8016.01p  -0.21     7014.01p  -0.79
m6    $  Wet Sand (Working Media)
       1001.01p   2.5795E-01    $  H
       8016.01p   5.2496E-01    $  O
       9019.01p   6.8124E-05    $  F
      11023.01p   7.6730E-03    $  Na
      12000.01p   5.7802E-04    $  Mg
      13027.01p   2.1909E-02    $  Al
      14000.01p   1.7560E-01    $  Si
      16032.01p   1.6163E-04    $  S
      17000.01p   6.5711E-05    $  Cl
      19000.01p   8.7112E-03    $  K
      20000.01p   1.3155E-03    $  Ca
      26000.01p   9.8877E-04    $  Fe
      22000.01p   1.6199E-05    $  Ti
      92238.01p   4.2285E-04    $  U238
m7    $ stored fuel
       1001.01p  -0.03609  8016.01p  -0.28649  92238.01p  -0.67742
m8    $ lead
      82000.01p  -1.0
mode    p
print  40
prdmp   j  j  1
phys:p  j  1
idum    1
imp:p   0  1  243r
```

Appendix D. MCNP Source Descriptions and Detector Locations

Sources for Input to MCNP

```
nps     500000
sdef    erg=0.662  cel=d1  x=fcel d2  y=fcel d3  z=fcel d4  wgt=5.36E+11
        pos=fcel d5  ext=fcel d6  axs=fcel d7  rad=fcel d8
sc1  Cells with Sources (14.5 Ci Total)
   #   si1     sp1       sb1
        L       D         D    $   ID                    Volume   Concentration
       132  6.09E-02  15226   $ West Pool             5.08E+07  1.20 uCi/L
       133  6.34E-02  15846   $ Middle Pool           5.28E+07  1.20 uCi/L
       134  6.07E-02  15178   $ East Pool             5.06E+07  1.20 uCi/L
        24  4.27E-04    107   $ N loadout entry       3.55E+05  1.20 uCi/L
        22  1.43E-03    358   $ N loadout pit         1.19E+06  1.20 uCi/L
        33  4.27E-04    107   $ S loadout entry       3.55E+05  1.20 uCi/L
        31  1.43E-03    358   $ S loadout pit         1.19E+06  1.20 uCi/L
       222  2.63E-03    658   $ Elevator    .841      2.19E+06  1.20 uCi/L
       227  3.66E-03    915   $ Weasel Pit .874       3.05E+06  1.20 uCi/L
       231  5.45E-03   1364   $ Viewing     .912      4.55E+06  1.20 uCi/L
       164  1.22E-02   3060   $ Discharge  .747       1.02E+07  1.20 uCi/L
        64  6.08E-02   3040   $ West Wall - North     3.86E+04  1.00 uCi/cm2
        65  5.92E-02   2960   $ West Wall - Middle    3.76E+04  1.00 uCi/cm2
        66  5.05E-02   2526   $ West Wall - South     3.21E+04  1.00 uCi/cm2
       138  1.09E-01   5469   $ N Wall - West         6.95E+04  1.00 uCi/cm2
       138  1.14E-01   5692   $ N Wall - Middle       7.23E+04  1.00 uCi/cm2
       138  1.09E-01   5452   $ N Wall - East         6.92E+04  1.00 uCi/cm2
       161  1.56E-01   7812   $ S Wall - West         9.92E+04  1.00 uCi/cm2
       163  1.12E-01   5601   $ S Wall - Discharge    7.11E+04  1.00 uCi/cm2
       171  5.03E-02   2515   $ S Wall - East         3.19E+04  1.00 uCi/cm2
       236  2.13E-02   1063   $ E Wall - North        1.35E+04  1.00 uCi/cm2
       185  8.76E-02   4378   $ E Wall - Middle       5.56E+04  1.00 uCi/cm2
       229  9.37E-03    469   $ E Wall - Weasel       5.95E+03  1.00 uCi/cm2
       230  1.05E-02    526   $ E Wall - Tech View    6.68E+03  1.00 uCi/cm2
       186  2.49E-02   1246   $ E Wall - South        1.58E+04  1.00 uCi/cm2
        94  1.65E-01   8252   $ Inner W - West        1.05E+05  1.00 uCi/cm2
        94  1.65E-01   8252   $ Inner W - East        1.05E+05  1.00 uCi/cm2
       101  1.65E-01   8252   $ Inner E - West        1.05E+05  1.00 uCi/cm2
       101  1.65E-01   8252   $ Inner E - East        1.05E+05  1.00 uCi/cm2
       236  5.92E-02   2960   $ Elevator Pit - N      3.76E+04  1.00 uCi/cm2
       236  1.37E-02    686   $ Elevator Pit - E      8.71E+03  1.00 uCi/cm2
       236  3.11E-02   1554   $ Elevator Pit - SE     1.97E+04  1.00 uCi/cm2
       236  4.11E-03    206   $ Elevator Pit - E      2.61E+03  1.00 uCi/cm2
       236  2.40E-02   1200   $ Elevator Pit - S      1.52E+04  1.00 uCi/cm2
       185  9.60E-03    480   $ Elevator Pit - W      6.10E+03  1.00 uCi/cm2
       237  4.78E-02   1911   $ E Pump #2 Pedestal    4.78E+04  1.00 Ci/m3
        16  1.76E+00  10539   $ Lead Cave             1.76E+06  1.00 Ci/m3
        18  1.06E+00   6343   $ IXM #1 (west)         1.06E+06  1.00 Ci/m3
        20  1.06E+00   6343   $ IXM #2 (east)         1.06E+06  1.00 Ci/m3
        90  8.39E-03    336   $ S Load Drip W         8.39E+03  1.00 Ci/m3
        90  8.39E-03    336   $ S Load Drip Mid       8.39E+03  1.00 Ci/m3
        90  8.39E-03    336   $ S Load Drip E         8.39E+03  1.00 Ci/m3
       135  9.56E-02   3823   $ Sampler 10.9C         9.56E+04  1.00 Ci/m3
        25  1.96E-01   7833   $ PVC Pipes N Load      1.96E+05  1.00 Ci/m3
         2  3.65E+00  21922   $ Sand Filter           3.65E+06  1.00 Ci/m3
         9  2.82E-01   3386   $ IX #3 (west)          2.82E+05  1.00 Ci/m3
        10  2.82E-01   3386   $ IX #2 (middle)        2.82E+05  1.00 Ci/m3
        11  2.82E-01   3386   $ IX #1 (east)          2.82E+05  1.00 Ci/m3
       187  1.25E+00   7509   $ Chiller               1.25E+06  1.00 Ci/m3
       190  2.26E+00  13545   $ Heat Exchanger        2.26E+06  1.00 Ci/m3
        69  2.17E-02    391   $ NW Filter Media       2.17E+04  1.00 Ci/m3
        28  3.47E-03   1734   $ N Loadout Entry       1.27E+04   1.0 mCi/m
        47  1.75E-03    876   $ SF to 13B Riser       6.44E+03   1.0 mCi/m
        49  1.64E-03    819   $ Col 13B Riser         6.02E+03   1.0 mCi/m
        51  8.77E-03   4385   $ W 9.5' NS N           3.22E+04   1.0 mCi/m
        53  9.53E-04    476   $ W 9.5' EW N           3.50E+03   1.0 mCi/m
        55  3.48E-03   1742   $ Col 13D Riser         1.28E+04   1.0 mCi/m
        57  2.69E-03   1346   $ W 9.5' NS S           9.89E+03   1.0 mCi/m
        59  2.36E-03   1181   $ W 9.5' EW S           8.68E+03   1.0 mCi/m
        61  3.48E-03   1742   $ S Loadout Riser       1.28E+04   1.0 mCi/m
        72  3.96E-03   1981   $ IX Box Outlet         1.46E+04   1.0 mCi/m
        74  1.10E-03    552   $ IX Box NS             4.06E+03   1.0 mCi/m
        76  3.61E-03   1803   $ N Loadout Chest       1.33E+04   1.0 mCi/m
        78  1.98E-03    991   $ W Ovrhd Riser         7.28E+03   1.0 mCi/m
        80  3.05E-03   1524   $ W 10' NS N            1.12E+04   1.0 mCi/m
        82  6.65E-03   3327   $ W 10' to IXM          2.44E+04   1.0 mCi/m
        84  6.88E-03   3442   $ W 10' NS S            2.53E+04   1.0 mCi/m
       121  4.08E-02  20409   $ South Overhead        1.50E+05   1.0 mCi/m
       123  3.48E-03   1742   $ S Riser 12.2          1.28E+04   1.0 mCi/m
```

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          125  3.48E-03   1742  $ S Riser 9.5        1.28E+04   1.0 mCi/m
          127  3.48E-03   1742  $ S Riser 7.7        1.28E+04   1.0 mCi/m
          220  9.86E-03   4928  $ East Ovrhd NS      3.62E+04   1.0 mCi/m
          214  8.10E-03   4051  $ East Ovrhd EW S    2.98E+04   1.0 mCi/m
          216  4.24E-03   2121  $ East Over HX       1.56E+04   1.0 mCi/m
          218  3.33E-03   1664  $ East Ovrhd EW N    1.22E+04   1.0 mCi/m
          214  4.55E-03   2273  $ TV #2 NS N         1.67E+04   1.0 mCi/m
          214  4.93E-03   2464  $ TV #2 NS S         1.81E+04   1.0 mCi/m
          214  2.13E-03   1067  $ Chiller Riser      7.84E+03   1.0 mCi/m
          214  2.13E-03   1067  $ TV #2 Bypass       7.84E+03   1.0 mCi/m
          212  3.48E-03   1742  $ TV Riser #2        1.28E+04   1.0 mCi/m
          210  3.48E-03   1742  $ TV Riser #1        1.28E+04   1.0 mCi/m
          208  3.48E-03   1742  $ TV Riser #3        1.28E+04   1.0 mCi/m
          206  2.13E-03   1067  $ TV #3 Bypass       7.84E+03   1.0 mCi/m
          206  4.37E-03   2184  $ TV #3 NS           1.60E+04   1.0 mCi/m
          204  3.35E-03   1676  $ TV #3 EW           1.23E+04   1.0 mCi/m
          202  4.88E-03   2438  $ E Pumps Ovrhd      1.79E+04   1.0 mCi/m
          200  2.71E-03   1353  $ Ovrhd #1 East      9.94E+03   1.0 mCi/m
          194  2.79E-03   1397  $ Horiz #1 East      1.03E+04   1.0 mCi/m
          119  5.84E-04    876  $ Pool #1 East       2.15E+03   1.0 mCi/m
          202  2.71E-03   1353  $ Ovrhd #2 East      9.94E+03   1.0 mCi/m
          196  7.37E-04    368  $ Horiz #2 East      2.71E+03   1.0 mCi/m
          119  5.84E-04    876  $ Pool #2 East       2.15E+03   1.0 mCi/m
          119  5.74E-03   2870  $ E Wall Plenum      2.11E+04   1.0 mCi/m
          117  1.91E-03    952  $ E Wall North       7.00E+03   1.0 mCi/m
          109  3.74E-02  16831  $ North Wall         1.37E+05   1.0 mCi/m
          107  2.76E-03   2762  $ West Wall          1.01E+04   1.0 mCi/m
          109  1.37E-03    686  $ Riser N Col 12     5.04E+03   1.0 mCi/m
          109  1.37E-03    686  $ Riser N Col 10     5.04E+03   1.0 mCi/m
          109  1.37E-03    686  $ Riser N Col 8      5.04E+03   1.0 mCi/m
          111  9.14E-04    457  $ Horiz N Col 12     3.36E+03   1.0 mCi/m
          113  9.14E-04    457  $ Horiz N Col 10     3.36E+03   1.0 mCi/m
          115  9.14E-04    457  $ Horiz N Col 8      3.36E+03   1.0 mCi/m
          105  5.84E-04    876  $ Sand Fltr Riser    2.15E+03   1.0 mCi/m
           70  2.10E-03   1048  $ Sand Fltr Pump     7.70E+03   1.0 mCi/m
           86  2.74E-03   1372  $ PVC Riser in NL    5.21E+03   1.0 mCi/m
           89  1.00E+00    100  $ PVC Hot Spot       2.90E+02   1.0 Ci
           87  1.18E-02   5893  $ PVC NS in West     2.24E+04   1.0 mCi/m
           37  1.00E-03    502  $ SF Pipe #1         3.69E+03   1.0 mCi/m
           39  1.05E-03    527  $ SF Pipe #2         3.87E+03   1.0 mCi/m
           41  2.32E-03   1159  $ SF Pipe #3         8.51E+03   1.0 mCi/m
           43  9.53E-04    476  $ SF Pipe #4         3.50E+03   1.0 mCi/m
           45  4.03E-03   2015  $ SF Pipe #5         1.48E+04   1.0 mCi/m
c                       355495 Total Points
c            Integration Biasing                     Breakdown:
c            Pool Water   300 per m3                  53,177
c            Pool Walls   500 per m2                  88,845
c            Pipes:       500 per m                  122,149
c            IX/HeatX:   6000 per m3                  76,751
c            Misc Box:  40000 per m3                  14,574
sc2      X ranges
ds2      S     11    11    11    12    13    14    15    16    17    18    19    20
               21    22    23    23    23    24    24    24    25    26    27    28
               29    30    31    30    31    32    33    34    35    36    37    38
               39    40    40    41    41    41    42    43  0  0  0  0  0  0  0
             0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
             0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
             0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
si11   H    20.32 2108.20         $  width of pool NS
sp11           0       1
si12   H   695.96  792.48         $  N loadout entry
sp12           0       1
si13   H   637.54  850.90         $  N loadout pit
sp13           0       1
si14   H 1450.34 1546.86          $  S loadout entry
sp14           0       1
si15   H 1391.92 1605.28          $  S loadout pit
sp15           0       1
si16   H   256.54  454.66         $  elevator pit
sp16           0       1
si17   H 1292.86 1460.50          $  weasel pit
sp17           0       1
si18   H 1496.06 1856.74          $  viewing pit
sp18           0       1
si19   H 2131.06 2557.78          $  discharge chute
sp19           0       1
si20   H    20.32  695.96         $  wall contamination W
sp20           0       1
```

```
si21  H  792.48 1450.34        $  wall contamination W
sp21          0       1
si22  H 1546.86 2108.20        $  wall contamination W
sp22          0       1
si23  H   19.69   20.32        $  wall contamination N
sp23          0       1
si24  H 2108.20 2108.84        $  wall contamination S
sp24          0       1
si25  H   20.32  256.54        $  wall contamination E
sp25          0       1
si26  H  347.98 1320.80        $  wall contamination E   0.635 cm
sp26          0       1
si27  H 1417.32 1521.46        $  wall contamination E
sp27          0       1
si28  H 1617.98 1734.82        $  wall contamination E
sp28          0       1
si29  H 1831.34 2108.20        $  wall contamination E
sp29          0       1
si30  H  137.16 1971.04        $  wall contam. inner W
sp30          0       1
si31  H  157.48 1991.36        $  wall contam. inner E
sp31          0       1
si32  H  255.91  256.54        $  wall contam. elevator N
sp32          0       1
si33  H  256.54  408.94        $  wall contam. elevator E
sp33          0       1
si34  H  408.94  409.58        $  wall contam. elevator S
sp34          0       1
si35  H  408.94  454.66        $  wall contam. elevator E
sp35          0       1
si36  H  454.66  455.30        $  wall contam. elevator S
sp36          0       1
si37  H  347.98  454.66        $  wall contam. elevator W
sp37          0       1
si38  H  868.68  937.26        $  E Pump #2 Pedestal     45.72 cm
sp38          0       1
si39  H  901.70  957.58        $  lead cave              10.16 cm
sp39          0       1
si40  H 1036.32 1158.24        $  IXM #1 & #2
sp40          0       1
si41  H 1488.60 1508.92        $  S Loadout Drip Pan     20.32 cm
sp41          0       1
si42  H  828.04  873.76        $  Sampler at Col 10.9C   45.72 cm
sp42          0       1
si43  H  693.42  789.94        $  PVC in N Loadout
sp43          0       1
sc3     Y ranges
ds3   S    44    45    46    47    48    47    48    49    50    51    52    53
           53    53    44    45    46    54    55    56    57    57    57    57
           57    58    59    60    61    62    63    64    65    66    67    68
           69    70    71    72    73    74    75    76  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
si44  H 1785.62 3001.01        $  west bay
sp44          0       1
si45  H 3061.97 4326.89        $  middle bay
sp45          0       1
si46  H 4387.85 5599.43        $  east bay
sp46          0       1
si47  H 1601.47 1785.62        $  loadout entry
sp47          0       1
si48  H 1280.80 1560.83        $  loadout pit
sp48          0       1
si49  H 5599.43 6257.29        $  elevator pit
sp49          0       1
si50  H 5599.43 6640.83        $  weasel pit
sp50          0       1
si51  H 5599.43 6290.31        $  viewing pit
sp51          0       1
si52  H 3503.93 5104.13        $  discharge chute
sp52          0       1
si53  H 1784.99 1785.62        $  wall contamination W
sp53          0       1
si54  H 1785.62 3521.71        $  wall contamination S
sp54          0       1
si55  H 3658.87 4903.47        $  wall contamination S
sp55          0       1
```

```
si56  H 5040.63 5599.43         $  wall contamination S
sp56          0       1
si57  H 5599.43 5600.07         $  wall contamination E
sp57          0       1
si58  H 3001.01 3001.65         $  wall contam. inner W
sp58          0       1
si59  H 3061.34 3061.97         $  wall contam. inner W
sp59          0       1
si60  H 4326.89 4327.53         $  wall contam. inner E
sp60          0       1
si61  H 4387.22 4387.85         $  wall contam. inner E
sp61          0       1
si62  H 5599.43 6257.29         $  wall contam. elevator N
sp62          0       1
si63  H 6257.29 6257.93         $  wall contam. elevator E
sp63          0       1
si64  H 5911.85 6257.29         $  wall contam. elevator S
sp64          0       1
si65  H 5911.85 5912.49         $  wall contam. elevator E
sp65          0       1
si66  H 5645.15 5911.85         $  wall contam. elevator S
sp66          0       1
si67  H 5644.52 5645.15         $  wall contam. elevator W
sp67          0       1
si68  H 5706.11 5751.83         $  E Pump #2 Pedestal
sp68          0       1
si69  H  859.79 1154.43         $  lead cave      60.96 cm
sp69          0       1
si70  H  880.11  961.39         $  IXM #1
sp70          0       1
si71  H 1118.87 1200.15         $  IXM #2
sp71          0       1
si72  H  666.75  687.07         $  S Loadout Drip Pan
sp72          0       1
si73  H  941.07  961.39         $  S Loadout Drip Pan
sp73          0       1
si74  H 1154.43 1174.75         $  S Loadout Drip Pan
sp74          0       1
si75  H 2955.29 3001.01         $  Sampler at Col 10.9C
sp75          0       1
si76  H 1380.80 1558.29         $  PVC in N Loadout
sp76          0       1
sc4     Z ranges
ds4   S     77    77    77    77    77    77    77    77    77    77    77    78
            78    78    78    78    78    78    78    78    78    78    78    78
            78    78    78    78    78    78    78    78    78    78    78    79
            80    80    80    81    81    81    82    83   0   0   0   0   0   0   0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
si77  H -139.86 -119.86         $  20 cm below water surface
sp77          0       1
si78  H -234.78 -144.78         $  wall contam from 16'0" downward
sp78          0       1
si79  H   10.16   25.40         $  E Pump #2 Pedestal
sp79          0       1
si80  H   48.26  154.94         $  Lead Cave and IXM #1 & #2
sp80          0       1
si81  H  154.94  175.26         $  S Loadout Drip Pan
sp81          0       1
si82  H  -71.12  -25.40         $  Sampler at Col 10.9C
sp82          0       1
si83  H  -10.16    1.27         $  PVC in N Loadout
sp83          0       1
sc5   POS ranges
ds5   S   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0    84    85    86    87    88    89    90    91    92    93    94
            95    96    97    98    99   100   101   101   102   103   104   105
           106   107   108   109   110   110   111   112   112   113   114   115
           116   117   118   119   120   121   122   123   124   125   126   127
           128   129   130   131   131   132   133   134   135   136   137   138
           139   140   141   142   143   144   145   146   147
si84  L  342.27 1385.57  121.92   $  sand filter
sp84  D        1
si85  L  815.34  854.71    0.00   $  IX #3
sp85  D        1
si86  L  815.34  991.87    0.00   $  IX #2
```

```
sp86  D        1
si87  L   815.34 1129.03    0.00   $  IX #1
sp87  D        1
si88  L   647.70 6320.79   53.34   $  chiller                  2.54 cm
sp88  D        1
si89  L   604.01 6473.19   73.66   $  heat exchanger
sp89  D        1
si90  L    30.48  684.53   30.48   $  NW hot filter media
sp90  D        1
si91  L   723.90 1438.91  -45.72   $  N Loadout Entry
sp91  D        1
si92  L   431.17 1530.35  119.38   $  from SF to 13B riser
sp92  D        1
si93  L   431.17 1705.61  119.38   $  col 13B riser
sp93  D        1
si94  L   431.17 1705.61  283.21   $  W overhead at 9.5' NS north
sp94  D        1
si95  L  1308.10 1705.61  283.21   $  W overhead to Col 13D riser
sp95  D        1
si96  L  1308.10 1800.86 -119.86   $  riser at column 13D
sp96  D        1
si97  L  1320.80 1705.61  283.21   $  W overhead at 9.5' NS south
sp97  D        1
si98  L  1590.04 1469.39  283.21   $  W overhead at 9.5' EW
sp98  D        1
si99  L  1590.04 1469.39 -119.86   $  riser in S Loadout
sp99  D        1
si100 L   697.23  824.23  106.68   $  from IX box
sp100 D        1
si101 L   586.74 1220.47  106.68   $  NW corner N loadout
sp101 D        1
si102 L   586.74 1581.15  106.68   $  west overhead riser
sp102 D        1
si103 L   586.74 1581.15  304.80   $  NS overhead - north
sp103 D        1
si104 L  1351.28  915.67  304.80   $  EW to IXM
sp104 D        1
si105 L  1351.28 1581.15  304.80   $  NS overhead - south
sp105 D        1
si106 L  2039.62 1581.15  304.80   $  south overhead
sp106 D        1
si107 L  2090.42 2382.52 -119.86   $  south riser at col 12.2
sp107 D        1
si108 L  2090.42 4060.19 -119.86   $  south riser at col 9.5
sp108 D        1
si109 L  2090.42 5203.19 -119.86   $  south riser at col 7.7
sp109 D        1
si110 L  1054.10 5662.93  304.80   $  east overhead NS-EW corner
sp110 D        1
si111 L   629.92 6473.19  304.80   $  10' level - over heat exchanger
sp111 D        1
si112 L   629.92 6140.45  304.80   $  HX to TV #2 corner
sp112 D        1
si113 L  1089.66 6140.45  304.80   $  TV #2 NS (south piece)
sp113 D        1
si114 L  1054.10 6320.79   91.44   $  chiller riser
sp114 D        1
si115 L  1308.10 6140.45   30.48   $  tech view #2 bypass
sp115 D        1
si116 L  1582.42 6140.45 -119.86   $  tech view riser #2
sp116 D        1
si117 L  1582.42 6094.73 -119.86   $  tech view riser #1
sp117 D        1
si118 L  1582.42 6186.17 -119.86   $  tech view riser #3
sp118 D        1
si119 L  1308.10 6186.17   30.48   $  tech view #3 bypass
sp119 D        1
si120 L  1145.54 6186.17  283.21   $  tech view #3 NS
sp120 D        1
si121 L  1135.38 5850.89  283.21   $  tech view #3 EW to pumps
sp121 D        1
si122 L   647.70 5850.89  283.21   $  east pumps overhead
sp122 D        1
si123 L   647.70 5850.89   12.70   $  riser from pump #1
sp123 D        1
si124 L   647.70 5571.49   12.70   $  pump #1 - E wall
sp124 D        1
si125 L   647.70 5571.49  -45.72   $  riser #1 - E wall
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sp125 D       1
si126 L  891.54 5850.89   12.70   $  riser from pump #2
sp126 D       1
si127 L  891.54 5571.49   12.70   $  pump #2 - E wall
sp127 D       1
si128 L  891.54 5571.49  -45.72   $  riser #2 - E wall
sp128 D       1
si129 L  347.98 5571.49  -45.72   $  pump plenum - E wall
sp129 D       1
si130 L   66.04 5571.49  -45.72   $  north pipe E wall
sp130 D       1
si131 L   66.04 1831.34  -45.72   $  corner for N and W wall pipes
sp131 D       1
si132 L   66.04 2391.41  -45.72   $  riser N wall
sp132 D       1
si133 L   66.04 3694.43  -45.72   $  riser N wall
sp133 D       1
si134 L   66.04 4989.83  -45.72   $  riser N wall
sp134 D       1
si135 L  -25.40 2391.41   91.44   $  valve N wall
sp135 D       1
si136 L  -25.40 3694.43   91.44   $  valve N wall
sp136 D       1
si137 L  -25.40 4989.83   91.44   $  valve N wall
sp137 D       1
si138 L  342.27 1831.34  -45.72   $  sand filter riser
sp138 D       1
si139 L  342.27 1621.79   12.70   $  sand filter pump
sp139 D       1
si140 L  812.80 1550.67    0.00   $  PVC riser in N Loadout
sp140 D       1
si141 L  812.80 1596.39  274.32   $  PVC hot spot
sp141 D       1
si142 L  812.80 1611.63  304.80   $  PVC NS overhead - W side
sp142 D       1
si143 L  431.17 1530.35  177.80   $  SF Pipe #1
sp143 D       1
si144 L  431.17 1630.68  177.80   $  SF Pipe #2
sp144 D       1
si145 L  431.17 1630.68  283.21   $  SF Pipe #3
sp145 D       1
si146 L  662.94 1535.43  283.21   $  SF Pipe #4
sp146 D       1
si147 L  662.94 1535.43 -119.86   $  SF Pipe #5
sp147 D       1
sc6    EXT ranges
ds6    S    0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
            0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
            0   0  148  149  149  149  150  151  152  153  154  155  156
            157  158  159  160  158  161  162  163  164  165  166  167
            168  169  169  169  170  171  172  173  174  175  176  176
            158  158  158  176  177  178  179  180  181  182  180  183
            182  184  185  186  187  188  188  188  189  189  189  182
            190  191  192  193  194  195  196  197  198
si148 L  -80.65    80.65   $  sand filter
si149 L    0.00   187.96   $  IX in box
si150 L    0.00   363.22   $  chiller
si151 L    0.00   476.00   $  heat exchanger
si152 L    0.00    76.20   $  NW hot filter media
si153 L    0.00   346.71   $  N Loadout Entry
si154 L    0.00   175.26   $  from SF to 13B riser
si155 L    0.00   163.83   $  col 13B riser
si156 L    0.00   876.94   $  W overhead at 9.5' NS north
si157 L    0.00    95.25   $  W overhead to Col 13D riser
si158 L    0.00   348.46   $  risers from water level to 7.5'
si159 L    0.00   269.24   $  W overhead at 9.5' NS south
si160 L    0.00   236.22   $  W overhead at 9.5' EW
si161 L    0.00   396.24   $  from IX box
si162 L    0.00   110.49   $  NW corner N loadout
si163 L    0.00   360.68   $  N edge of N loadout
si164 L    0.00   198.12   $  west overhead riser
si165 L    0.00   304.80   $  NS overhead - north
si166 L    0.00   665.48   $  EW to IXM
si167 L    0.00   688.34   $  NS overhead - south
si168 L    0.00  4081.78   $  south overhead
si169 L    0.00   323.06   $  risers along south wall
si170 L    0.00   985.52   $  east overhead NS
si171 L    0.00   810.26   $  east overhead EW
```

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si172 L    0.00  424.18   $  10' level - over heat exchanger
si173 L    0.00  332.74   $  HX to TV #2 corner
si174 L    0.00  454.66   $  TV #2 NS (north piece)
si175 L    0.00  492.76   $  TV #2 NS (south piece)
si176 L    0.00  213.36   $  chiller riser and bypass loop
si177 L    0.00  436.88   $  tech view #3 NS
si178 L    0.00  335.28   $  tech view #3 EW to pumps
si179 L    0.00  487.68   $  east pumps overhead
si180 L    0.00  270.51   $  risers from pumps
si181 L    0.00  279.40   $  pump #1 - E wall
si182 L    0.00   58.42   $  risers from below grate to knee
si183 L    0.00   73.66   $  pump #2 - E wall
si184 L    0.00  574.04   $  pump plenum - E wall
si185 L    0.00  190.50   $  north pipe E wall
si186 L    0.00 3740.15   $  pipe along N wall
si187 L    0.00  276.23   $  pipe along W wall
si188 L    0.00  137.16   $  riser N wall
si189 L    0.00   91.44   $  valve N wall
si190 L    0.00  209.55   $  sand filter pump
si191 L    0.00  274.32   $  PVC riser in N Loadout
si192 L    0.00   15.24   $  PVC hot spot
si193 L    0.00 1178.56   $  PVC NS overhead - W side
si194 L    0.00  100.33   $  SF Pipe #1
si195 L    0.00  105.41   $  SF Pipe #2
si196 L    0.00  231.78   $  SF Pipe #3
si197 L    0.00   95.25   $  SF Pipe #4
si198 L    0.00  403.07   $  SF Pipe #5
sc7   AXS ranges
ds7   S   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  201  201  201  201  199  199  201  200  200  201  199
          200  201  199  200  201  200  199  200  201  199  200  199
          200  201  201  201  199  200  199  200  199  199  201  201
          201  201  201  201  199  200  199  201  200  201  201  200
          201  199  199  200  199  201  201  201  199  199  199  201
          200  201  200  199  200  201  199  200  201
si199 L    1.00     0.00     0.00     $  X axis
sp199 D       1
si200 L    0.00     1.00     0.00     $  Y axis
sp200 D       1
si201 L    0.00     0.00     1.00     $  Z axis
sp201 D       1
sc8   RAD ranges
ds8   S   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
          0  0  202  203  203  203  204  205  206  207  207  207  207
          207  207  207  207  207  207  207  207  207  207  207  207
          207  207  207  207  207  207  207  207  207  207  207  207
          207  207  207  207  207  207  207  207  207  207  207  207
          207  207  207  207  207  207  207  207  207  207  207  207
          207  208  208  208  207  207  207  207  207
si202 L   47.11    97.11   $  sand filter
sp202 D     -21        1
si203 L    0.00    21.86   $  IX in box
sp203 D     -21        1
si204 L   16.83    37.15   $  chiller              20.32 cm
sp204 D     -21        1
si205 L   26.99    47.31   $  heat exchanger
sp205 D     -21        1
si206 L    0.00     9.53   $  8 inch filter
sp206 D     -21        1
si207 L    8.89     9.53   $  8 inch pipes         0.635 cm
sp207 D     -21        1
si208 L    4.45     5.08   $  4 inch PVC pipes
sp208 D     -21        1
```

Near Source Detector Locations

```
fc5     Dose Points Near Sources
f5:p     271.78 5778.50   60.96      1.0 $ Over Elevator Pit NW      15
         332.74 6242.05   60.96      1.0 $ Over Elevator Pit E       15
         439.42 5778.50   60.96      1.0 $ Over Elevator Pit SW      15
         902.97 5728.97   40.64      1.0 $ Pump #2 Pedestal          60
        1137.92  797.55  129.54      1.0 $ IXM #1 (G10) Chest       2.2
        1137.92 1272.52  129.54      1.0 $ IXM #2 (K10) Chest         6
        1498.76 1164.59  139.70      1.0 $ Drip Pan - Pit End       250
        1498.76  951.23  139.70      1.0 $ Drip Pan - Middle        100
        1498.76  676.91  139.70      1.0 $ Drip Pan - Door End       50
         850.90 2978.15   15.24      1.0 $ Sampler at Col 10.9C       8
         741.68 1543.05   15.24      1.0 $ PVC in N Loadout         150
         741.68 1573.53    2.54      1.0 $ PVC in N Loadout - E      35
         167.01 1385.57  121.92      1.0 $ SF North Wall              6
         167.01 1210.31  121.92      1.0 $ SF Northwest Corner        6
         342.27 1210.31  121.92      1.0 $ SF West Wall               6
         681.99  854.71  106.68      1.0 $ Pipe Along IX Box - #3    40
         681.99  923.29  106.68      1.0 $ Pipe Along IX Box         45
         681.99  991.87  106.68      1.0 $ Pipe Along IX Box - #2    50
         681.99 1060.45  106.68      1.0 $ Pipe Along IX Box         45
         681.99 1129.03  106.68      1.0 $ Pipe Along IX Box - #1    40
         586.74 6396.99   91.44      1.0 $ Between HX/Chiller - N    20
        1010.92 6396.99   91.44      1.0 $ Between HX/Chiller - S    15
         842.01 6553.20   91.44      1.0 $ E Side HX                  7
          45.72  684.53   68.58      1.0 $ NW Filter Media          120
          71.12  684.53   68.58      1.0 $ NW Filter Media at 1ft    30
         723.90 1560.83   15.24      1.0 $ N Loadout Entry - Pit     50
         723.90 1665.61   15.24      1.0 $ N Loadout Entry           30
         723.90 1770.38   15.24      1.0 $ N Loadout Entry - Pool    20
         431.17 1705.61  104.14      1.0 $ SF Pipes, lower E        110
         431.17 1690.37  134.62      1.0 $ SF Pipes, upper E        120
         446.41 1545.59  119.38      1.0 $ SF Pipes, lower W         60
         424.18 1766.57   27.94      1.0 $ Beam at Col 13B           25
        1308.10 1816.10  121.92      1.0 $ Column 13D                15
        1308.10 1816.10  213.36      1.0 $ Col 13D - Above Head      25
        1513.84 1720.85  283.21      1.0 $ 9.5' W Ovrhd - SE         70
        1605.28 1644.65  283.21      1.0 $ 9.5' W Ovrhd - SE         50
        1605.28 1469.39  106.68      1.0 $ S Loadout Riser          100
         571.50 1235.71  106.68      1.0 $ Pipe Along N Load, W      35
         571.50 1408.43  106.68      1.0 $ Pipe Along N Load, Mid    40
         571.50 1581.15  106.68      1.0 $ Elbow - N Loadout - N     60
         586.74 1596.39  106.68      1.0 $ Elbow - N Load - Outer    60
         586.74 1565.91  119.38      1.0 $ Elbow - N Load - Inner    60
        2075.18 2382.52   91.44      1.0 $ S Wall Col 12.2           13
        2075.18 4060.19   91.44      1.0 $ S Wall Col 9.5            16
        2075.18 5203.19   91.44      1.0 $ S Wall Col 7.7            25
        1546.86 5647.69  304.80      1.0 $ E 10' NS Middle           15
         857.25 6125.21  304.80      1.0 $ E 10' NS N Piece          45
        1336.04 6140.45  365.76      1.0 $ E 10' NS S Piece @ 2'     32
        1567.18 6079.49  152.40      1.0 $ View Pit Riser #1         50
        1567.18 6140.45  152.40      1.0 $ View Pit Riser #2         40
        1567.18 6201.41  152.40      1.0 $ View Pit Riser #3         30
        1536.70 6140.45  152.40      1.0 $ View Pit Risers - 1 ft    20
        1308.10 6163.31  121.92      1.0 $ Bypass Loop - Inner       40
        1308.10 6201.41  121.92      1.0 $ Bypass Loop - East        40
        1308.10 6163.31  289.56      1.0 $ Bypass Loop - Above      100
        1069.34 6320.79  182.88      1.0 $ Valve - S End Chiller     35
         769.62 5835.65  283.21      1.0 $ Pump Overhead             45
         647.70 5835.65  252.73      1.0 $ Pump #1 Riser             35
         647.70 5571.49   27.94      1.0 $ Pump #1 Knee              12
         891.54 5571.49   27.94      1.0 $ Pump #2 Knee               7
          81.28 2391.41   91.44      1.0 $ N Wall Valve at Col 12     8
          81.28 3694.43   91.44      1.0 $ N Wall Valve at Col 10     6
          81.28 4989.83   91.44      1.0 $ N Wall Valve at Col 8      6
         342.27 1831.34   27.94      1.0 $ SF Pump Knee              50
         342.27 1846.58   12.70      1.0 $ SF Pump Knee              50
         342.27 1637.03   27.94      1.0 $ SF Pump                   20
         812.80 1565.91  152.40      1.0 $ PVC Pipe Riser - NL       27
         812.80 1565.91  274.32      1.0 $ PVC Pipe - W Elbow       250
         812.80 1604.01  259.08      1.0 $ PVC Hot Spot - Contact  1200
         812.80 1604.01  243.84      1.0 $ PVC Hot Spot - 6 in      250
         812.80 1604.01  228.60      1.0 $ PVC Hot Spot - 1 ft      130
         995.68 1611.63  320.04      1.0 $ PVC Pipe - 6 ft           45
        1991.36 1611.63  320.04      1.0 $ PVC Pipe - S Elbow        20
```

Principle X and Y Coordinates of the KE-Basin Dose Rate Grid

ID	X Coordinates West	Pool	East	
1	5.08	47.06	81.00	(for valves along N wall of pool)
2	147.32	181.74		
3	299.72	316.43		
4	421.64	424.18		
5	541.02	558.87	546.10	
6	693.42	693.55	668.02	
7	802.64	801.30	789.94	
8	911.86	909.05		
9	1003.30	1043.74	1033.78	
10	1137.92	1151.49	1155.70	
11	1272.54	1286.18	1277.62	
12	1409.70	1420.86	1399.54	
13	1546.86	1528.61	1521.46	
14	1656.08	1663.30	1643.38	
15	1778.00	1771.05	1765.30	
16	1894.84	1905.74	1887.22	
17	2014.22	2013.48	2009.14	
18	2133.60	2131.06		
19	2255.52	2252.98		
20	2377.44	2374.90		

ID	Y Coordinate		ID	Y Coordinate		ID	Y Coordinate	
A	not used		T	2366.39		AM	4713.35	
B	196.85		U	2518.41		AN	4820.03	
C	318.77		V	2625.09		AO	4926.71	
D	440.69		W	2731.77		AP	5033.39	
E	560.07		X	2889.25		AQ	5185.41	
F	678.81		Y	2980.00		AR	5292.09	
G	797.55		Z	3112.77		AS	5437.11	
H	916.29		AA	3219.45		AT	5542.00	(5540.00)
I	1035.04		AB	3387.47	(3356.99)	AU	5663.92	(5633.44)
J	1153.78		AC	3494.15	(3524.63)	AV	5816.32	
K	1272.52		AD	3600.83	(3631.31)	AW	5968.72	
L	1391.26		AE	3707.51	(3737.99)	AX	6121.12	(6090.64)
M	1510.00		AF	3859.53	(3890.01)	AY	6273.52	
N	1648.92		AG	3966.21	(3996.69)	AZ	6380.20	
O	1767.84		AH	4072.89		BA	6486.88	
P	1875.79		AI	4240.91		BB	6593.56	
Q	2046.35		AJ	4355.00		BC	6700.24	
R	2153.03		AK	4438.65		BD	6806.92	
S	2259.71		AL	4545.33				

Note: AB to AG differences occur between the south pool wall and the reactor.

Detector Points Used for Chest Level Results
(Knee Level Uses Z-coordinate of 53.34 cm)

```
fc5   Dose Points at Chest Level - 4.25 ft
f5:p     299.72  196.85 129.54   1  $ B3  Chest Level - 4.25 ft
         421.64  196.85 129.54   1  $ B4
         541.02  196.85 129.54   1  $ B5
         693.42  196.85 129.54   1  $ B6
         802.64  196.85 129.54   1  $ B7
         911.86  196.85 129.54   1  $ B8
        1003.30  196.85 129.54   1  $ B9
        1137.92  196.85 129.54   1  $ B10
        1272.54  196.85 129.54   1  $ B11
        1409.70  196.85 129.54   1  $ B12
        1546.86  196.85 129.54   1  $ B13
        1656.08  196.85 129.54   1  $ B14
        1778.00  196.85 129.54   1  $ B15
        1894.84  196.85 129.54   1  $ B16
        2014.22  196.85 129.54   1  $ B17
        2133.60  196.85 129.54   1  $ B18
        2255.52  196.85 129.54   1  $ B19
        2377.44  196.85 129.54   1  $ B20
         147.32  318.77 129.54   1  $ C2  Chest Level - 4.25 ft
         299.72  318.77 129.54   1  $ C3
         421.64  318.77 129.54   1  $ C4
         541.02  318.77 129.54   1  $ C5
         693.42  318.77 129.54   1  $ C6
         802.64  318.77 129.54   1  $ C7
         911.86  318.77 129.54   1  $ C8
        1003.30  318.77 129.54   1  $ C9
        1137.92  318.77 129.54   1  $ C10
        1272.54  318.77 129.54   1  $ C11
        1409.70  318.77 129.54   1  $ C12
        1546.86  318.77 129.54   1  $ C13
        1656.08  318.77 129.54   1  $ C14
        1778.00  318.77 129.54   1  $ C15
        1894.84  318.77 129.54   1  $ C16
        2014.22  318.77 129.54   1  $ C17
        2133.60  318.77 129.54   1  $ C18
        2255.52  318.77 129.54   1  $ C19
        2377.44  318.77 129.54   1  $ C20
           5.08  440.69 129.54   1  $ D1  Chest Level - 4.25 ft
         147.32  440.69 129.54   1  $ D2
         299.72  440.69 129.54   1  $ D3
         421.64  440.69 129.54   1  $ D4
         541.02  440.69 129.54   1  $ D5
         693.42  440.69 129.54   1  $ D6
         802.64  440.69 129.54   1  $ D7
         911.86  440.69 129.54   1  $ D8
        1003.30  440.69 129.54   1  $ D9
        1137.92  440.69 129.54   1  $ D10
        1272.54  440.69 129.54   1  $ D11
        1409.70  440.69 129.54   1  $ D12
        1546.86  440.69 129.54   1  $ D13
        1656.08  440.69 129.54   1  $ D14
        1778.00  440.69 129.54   1  $ D15
        1894.84  440.69 129.54   1  $ D16
        2014.22  440.69 129.54   1  $ D17
        2133.60  440.69 129.54   1  $ D18
        2255.52  440.69 129.54   1  $ D19
        2377.44  440.69 129.54   1  $ D20
           5.08  560.07 129.54   1  $ E1  Chest Level - 4.25 ft
         147.32  560.07 129.54   1  $ E2
         299.72  560.07 129.54   1  $ E3
         421.64  560.07 129.54   1  $ E4
         541.02  560.07 129.54   1  $ E5
         693.42  560.07 129.54   1  $ E6
         802.64  560.07 129.54   1  $ E7
         911.86  560.07 129.54   1  $ E8
        1003.30  560.07 129.54   1  $ E9
        1137.92  560.07 129.54   1  $ E10
        1272.54  560.07 129.54   1  $ E11
        1409.70  560.07 129.54   1  $ E12
        1546.86  560.07 129.54   1  $ E13
        1656.08  560.07 129.54   1  $ E14
        1778.00  560.07 129.54   1  $ E15
        1894.84  560.07 129.54   1  $ E16
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2014.22	560.07	129.54	1	$	E17	
2133.60	560.07	129.54	1	$	E18	
2255.52	560.07	129.54	1	$	E19	
2377.44	560.07	129.54	1	$	E20	
5.08	678.81	129.54	1	$	F1	Chest Level - 4.25 ft
147.32	678.81	129.54	1	$	F2	
299.72	678.81	129.54	1	$	F3	
421.64	678.81	129.54	1	$	F4	
541.02	678.81	129.54	1	$	F5	
693.42	678.81	129.54	1	$	F6	
802.64	678.81	129.54	1	$	F7	
911.86	678.81	129.54	1	$	F8	
1003.30	678.81	129.54	1	$	F9	
1137.92	678.81	129.54	1	$	F10	
1272.54	678.81	129.54	1	$	F11	
1409.70	678.81	129.54	1	$	F12	
1546.86	678.81	129.54	1	$	F13	
1656.08	678.81	129.54	1	$	F14	
1778.00	678.81	129.54	1	$	F15	
1894.84	678.81	129.54	1	$	F16	
2014.22	678.81	129.54	1	$	F17	
2133.60	678.81	129.54	1	$	F18	
2255.52	678.81	129.54	1	$	F19	
2377.44	678.81	129.54	1	$	F20	
5.08	797.55	129.54	1	$	G1	Chest Level - 4.25 ft
147.32	797.55	129.54	1	$	G2	
299.72	797.55	129.54	1	$	G3	
421.64	797.55	129.54	1	$	G4	
541.02	797.55	129.54	1	$	G5	
693.42	797.55	129.54	1	$	G6	
1003.30	797.55	129.54	1	$	G9	
1137.92	797.55	129.54	1	$	G10	
1272.54	797.55	129.54	1	$	G11	
1409.70	797.55	129.54	1	$	G12	
1546.86	797.55	129.54	1	$	G13	
1656.08	797.55	129.54	1	$	G14	
1778.00	797.55	129.54	1	$	G15	
1894.84	797.55	129.54	1	$	G16	
2014.22	797.55	129.54	1	$	G17	
2133.60	797.55	129.54	1	$	G18	
2255.52	797.55	129.54	1	$	G19	
2377.44	797.55	129.54	1	$	G20	
5.08	916.29	129.54	1	$	H1	Chest Level - 4.25 ft
147.32	916.29	129.54	1	$	H2	
299.72	916.29	129.54	1	$	H3	
421.64	916.29	129.54	1	$	H4	
541.02	916.29	129.54	1	$	H5	
693.42	916.29	129.54	1	$	H6	
1272.54	916.29	129.54	1	$	H11	
1409.70	916.29	129.54	1	$	H12	
1546.86	916.29	129.54	1	$	H13	
1656.08	916.29	129.54	1	$	H14	
1778.00	916.29	129.54	1	$	H15	
1894.84	916.29	129.54	1	$	H16	
2014.22	916.29	129.54	1	$	H17	
2133.60	916.29	129.54	1	$	H18	
2255.52	916.29	129.54	1	$	H19	
2377.44	916.29	129.54	1	$	H20	
5.08	1035.04	129.54	1	$	I1	Chest Level - 4.25 ft
147.32	1035.04	129.54	1	$	I2	
299.72	1035.04	129.54	1	$	I3	
421.64	1035.04	129.54	1	$	I4	
541.02	1035.04	129.54	1	$	I5	
693.42	1035.04	129.54	1	$	I6	
1272.54	1035.04	129.54	1	$	I11	
1409.70	1035.04	129.54	1	$	I12	
1546.86	1035.04	129.54	1	$	I13	
1656.08	1035.04	129.54	1	$	I14	
1778.00	1035.04	129.54	1	$	I15	
1894.84	1035.04	129.54	1	$	I16	
2014.22	1035.04	129.54	1	$	I17	
2133.60	1035.04	129.54	1	$	I18	
2255.52	1035.04	129.54	1	$	I19	
2377.44	1035.04	129.54	1	$	I20	
5.08	1153.78	129.54	1	$	J1	Chest Level - 4.25 ft
147.32	1153.78	129.54	1	$	J2	
299.72	1153.78	129.54	1	$	J3	
421.64	1153.78	129.54	1	$	J4	

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 541.02 1153.78 129.54   1  $ J5
 693.42 1153.78 129.54   1  $ J6
1272.54 1153.78 129.54   1  $ J11
1409.70 1153.78 129.54   1  $ J12
1546.86 1153.78 129.54   1  $ J13
1656.08 1153.78 129.54   1  $ J14
1778.00 1153.78 129.54   1  $ J15
1894.84 1153.78 129.54   1  $ J16
2014.22 1153.78 129.54   1  $ J17
2133.60 1153.78 129.54   1  $ J18
2377.44 1153.78 129.54   1  $ J20
   5.08 1272.52 129.54   1  $ K1  Chest Level - 4.25 ft
 147.32 1272.52 129.54   1  $ K2
 541.02 1272.52 129.54   1  $ K5
 911.86 1272.52 129.54   1  $ K8
1003.30 1272.52 129.54   1  $ K9
1137.92 1272.52 129.54   1  $ K10
1272.54 1272.52 129.54   1  $ K11
1778.00 1272.52 129.54   1  $ K15
1894.84 1272.52 129.54   1  $ K16
2014.22 1272.52 129.54   1  $ K17
2133.60 1272.52 129.54   1  $ K18
2255.52 1272.52 129.54   1  $ K19
2377.44 1272.52 129.54   1  $ K20
   5.08 1391.26 129.54   1  $ L1  Chest Level - 4.25 ft
 147.32 1391.26 129.54   1  $ L2
 541.02 1391.26 129.54   1  $ L5
 911.86 1391.26 129.54   1  $ L8
1003.30 1391.26 129.54   1  $ L9
1137.92 1391.26 129.54   1  $ L10
1272.54 1391.26 129.54   1  $ L11
1778.00 1391.26 129.54   1  $ L15
1894.84 1391.26 129.54   1  $ L16
2014.22 1391.26 129.54   1  $ L17
2133.60 1391.26 129.54   1  $ L18
2255.52 1391.26 129.54   1  $ L19
2377.44 1391.26 129.54   1  $ L20
   5.08 1510.00 129.54   1  $ M1  Chest Level - 4.25 ft
 147.32 1510.00 129.54   1  $ M2
 541.02 1510.00 129.54   1  $ M5
 911.86 1510.00 129.54   1  $ M8
1003.30 1510.00 129.54   1  $ M9
1137.92 1510.00 129.54   1  $ M10
1272.54 1510.00 129.54   1  $ M11
1778.00 1510.00 129.54   1  $ M15
1894.84 1510.00 129.54   1  $ M16
2014.22 1510.00 129.54   1  $ M17
2133.60 1510.00 129.54   1  $ M18
2255.52 1510.00 129.54   1  $ M19
2377.44 1510.00 129.54   1  $ M20
   5.08 1648.92 129.54   1  $ N1  Chest Level - 4.25 ft
 147.32 1648.92 129.54   1  $ N2
 299.72 1648.92 129.54   1  $ N3
 421.64 1648.92 129.54   1  $ N4
 541.02 1648.92 129.54   1  $ N5
 693.42 1648.92 129.54   1  $ N6
 802.64 1648.92 129.54   1  $ N7
 911.86 1648.92 129.54   1  $ N8
1003.30 1648.92 129.54   1  $ N9
1137.92 1648.92 129.54   1  $ N10
1272.54 1648.92 129.54   1  $ N11
1409.70 1648.92 129.54   1  $ N12
1546.86 1648.92 129.54   1  $ N13
1656.08 1648.92 129.54   1  $ N14
1778.00 1648.92 129.54   1  $ N15
1894.84 1648.92 129.54   1  $ N16
2014.22 1648.92 129.54   1  $ N17
2133.60 1648.92 129.54   1  $ N18
2255.52 1648.92 129.54   1  $ N19
2377.44 1648.92 129.54   1  $ N20
  47.06 1767.84 129.54   1  $ O1  Chest Level - 4.25 ft
 181.74 1767.84 129.54   1  $ O2
 316.43 1767.84 129.54   1  $ O3
 424.18 1767.84 129.54   1  $ O4
 558.87 1767.84 129.54   1  $ O5
 693.55 1767.84 129.54   1  $ O6
 801.30 1767.84 129.54   1  $ O7
 909.05 1767.84 129.54   1  $ O8
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1043.74 1767.84 129.54   1  $ O9
1151.49 1767.84 129.54   1  $ O10
1286.18 1767.84 129.54   1  $ O11
1420.86 1767.84 129.54   1  $ O12
1528.61 1767.84 129.54   1  $ O13
1663.30 1767.84 129.54   1  $ O14
1771.05 1767.84 129.54   1  $ O15
1905.74 1767.84 129.54   1  $ O16
2013.48 1767.84 129.54   1  $ O17
2131.06 1767.84 129.54   1  $ O18
2252.98 1767.84 129.54   1  $ O19
2374.90 1767.84 129.54   1  $ O20
  47.06 1875.79 129.54   1  $ P1  Chest Level - 4.25 ft
 181.74 1875.79 129.54   1  $ P2
 316.43 1875.79 129.54   1  $ P3
 424.18 1875.79 129.54   1  $ P4
 558.87 1875.79 129.54   1  $ P5
 693.55 1875.79 129.54   1  $ P6
 801.30 1875.79 129.54   1  $ P7
 909.05 1875.79 129.54   1  $ P8
1043.74 1875.79 129.54   1  $ P9
1151.49 1875.79 129.54   1  $ P10
1286.18 1875.79 129.54   1  $ P11
1420.86 1875.79 129.54   1  $ P12
1528.61 1875.79 129.54   1  $ P13
1663.30 1875.79 129.54   1  $ P14
1771.05 1875.79 129.54   1  $ P15
1905.74 1875.79 129.54   1  $ P16
2013.48 1875.79 129.54   1  $ P17
2131.06 1875.79 129.54   1  $ P18
2252.98 1875.79 129.54   1  $ P19
2374.90 1875.79 129.54   1  $ P20
  47.06 2046.35 129.54   1  $ Q1  Chest Level - 4.25 ft
 181.74 2046.35 129.54   1  $ Q2
 316.43 2046.35 129.54   1  $ Q3
 424.18 2046.35 129.54   1  $ Q4
 558.87 2046.35 129.54   1  $ Q5
 693.55 2046.35 129.54   1  $ Q6
 801.30 2046.35 129.54   1  $ Q7
 909.05 2046.35 129.54   1  $ Q8
1043.74 2046.35 129.54   1  $ Q9
1151.49 2046.35 129.54   1  $ Q10
1286.18 2046.35 129.54   1  $ Q11
1420.86 2046.35 129.54   1  $ Q12
1528.61 2046.35 129.54   1  $ Q13
1663.30 2046.35 129.54   1  $ Q14
1771.05 2046.35 129.54   1  $ Q15
1905.74 2046.35 129.54   1  $ Q16
2013.48 2046.35 129.54   1  $ Q17
2131.06 2046.35 129.54   1  $ Q18
2252.98 2046.35 129.54   1  $ Q19
2374.90 2046.35 129.54   1  $ Q20
  47.06 2153.03 129.54   1  $ R1  Chest Level - 4.25 ft
 181.74 2153.03 129.54   1  $ R2
 316.43 2153.03 129.54   1  $ R3
 424.18 2153.03 129.54   1  $ R4
 558.87 2153.03 129.54   1  $ R5
 693.55 2153.03 129.54   1  $ R6
 801.30 2153.03 129.54   1  $ R7
 909.05 2153.03 129.54   1  $ R8
1043.74 2153.03 129.54   1  $ R9
1151.49 2153.03 129.54   1  $ R10
1286.18 2153.03 129.54   1  $ R11
1420.86 2153.03 129.54   1  $ R12
1528.61 2153.03 129.54   1  $ R13
1663.30 2153.03 129.54   1  $ R14
1771.05 2153.03 129.54   1  $ R15
1905.74 2153.03 129.54   1  $ R16
2013.48 2153.03 129.54   1  $ R17
2131.06 2153.03 129.54   1  $ R18
2252.98 2153.03 129.54   1  $ R19
2374.90 2153.03 129.54   1  $ R20
  47.06 2259.71 129.54   1  $ S1  Chest Level - 4.25 ft
 181.74 2259.71 129.54   1  $ S2
 316.43 2259.71 129.54   1  $ S3
 424.18 2259.71 129.54   1  $ S4
 558.87 2259.71 129.54   1  $ S5
 693.55 2259.71 129.54   1  $ S6
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 801.30 2259.71 129.54   1  $ S7
 909.05 2259.71 129.54   1  $ S8
1043.74 2259.71 129.54   1  $ S9
1151.49 2259.71 129.54   1  $ S10
1286.18 2259.71 129.54   1  $ S11
1420.86 2259.71 129.54   1  $ S12
1528.61 2259.71 129.54   1  $ S13
1663.30 2259.71 129.54   1  $ S14
1771.05 2259.71 129.54   1  $ S15
1905.74 2259.71 129.54   1  $ S16
2013.48 2259.71 129.54   1  $ S17
2131.06 2259.71 129.54   1  $ S18
2252.98 2259.71 129.54   1  $ S19
2374.90 2259.71 129.54   1  $ S20
  81.00 2366.39 129.54   1  $ T1  Chest Level - 4.25 ft
 181.74 2366.39 129.54   1  $ T2
 316.43 2366.39 129.54   1  $ T3
 424.18 2366.39 129.54   1  $ T4
 558.87 2366.39 129.54   1  $ T5
 693.55 2366.39 129.54   1  $ T6
 801.30 2366.39 129.54   1  $ T7
 909.05 2366.39 129.54   1  $ T8
1043.74 2366.39 129.54   1  $ T9
1151.49 2366.39 129.54   1  $ T10
1286.18 2366.39 129.54   1  $ T11
1420.86 2366.39 129.54   1  $ T12
1528.61 2366.39 129.54   1  $ T13
1663.30 2366.39 129.54   1  $ T14
1771.05 2366.39 129.54   1  $ T15
1905.74 2366.39 129.54   1  $ T16
2013.48 2366.39 129.54   1  $ T17
2131.06 2366.39 129.54   1  $ T18
2252.98 2366.39 129.54   1  $ T19
  47.06 2518.41 129.54   1  $ U1  Chest Level - 4.25 ft
 181.74 2518.41 129.54   1  $ U2
 316.43 2518.41 129.54   1  $ U3
 424.18 2518.41 129.54   1  $ U4
 558.87 2518.41 129.54   1  $ U5
 693.55 2518.41 129.54   1  $ U6
 801.30 2518.41 129.54   1  $ U7
 909.05 2518.41 129.54   1  $ U8
1043.74 2518.41 129.54   1  $ U9
1151.49 2518.41 129.54   1  $ U10
1286.18 2518.41 129.54   1  $ U11
1420.86 2518.41 129.54   1  $ U12
1528.61 2518.41 129.54   1  $ U13
1663.30 2518.41 129.54   1  $ U14
1771.05 2518.41 129.54   1  $ U15
1905.74 2518.41 129.54   1  $ U16
2013.48 2518.41 129.54   1  $ U17
2131.06 2518.41 129.54   1  $ U18
2252.98 2518.41 129.54   1  $ U19
  47.06 2625.09 129.54   1  $ V1  Chest Level - 4.25 ft
 181.74 2625.09 129.54   1  $ V2
 316.43 2625.09 129.54   1  $ V3
 424.18 2625.09 129.54   1  $ V4
 558.87 2625.09 129.54   1  $ V5
 693.55 2625.09 129.54   1  $ V6
 801.30 2625.09 129.54   1  $ V7
 909.05 2625.09 129.54   1  $ V8
1043.74 2625.09 129.54   1  $ V9
1151.49 2625.09 129.54   1  $ V10
1286.18 2625.09 129.54   1  $ V11
1420.86 2625.09 129.54   1  $ V12
1528.61 2625.09 129.54   1  $ V13
1663.30 2625.09 129.54   1  $ V14
1771.05 2625.09 129.54   1  $ V15
1905.74 2625.09 129.54   1  $ V16
2013.48 2625.09 129.54   1  $ V17
2131.06 2625.09 129.54   1  $ V18
2252.98 2625.09 129.54   1  $ V19
  47.06 2731.77 129.54   1  $ W1  Chest Level - 4.25 ft
 181.74 2731.77 129.54   1  $ W2
 316.43 2731.77 129.54   1  $ W3
 424.18 2731.77 129.54   1  $ W4
 558.87 2731.77 129.54   1  $ W5
 693.55 2731.77 129.54   1  $ W6
 801.30 2731.77 129.54   1  $ W7
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 909.05 2731.77 129.54   1  $ W8
1043.74 2731.77 129.54   1  $ W9
1151.49 2731.77 129.54   1  $ W10
1286.18 2731.77 129.54   1  $ W11
1420.86 2731.77 129.54   1  $ W12
1528.61 2731.77 129.54   1  $ W13
1663.30 2731.77 129.54   1  $ W14
1771.05 2731.77 129.54   1  $ W15
1905.74 2731.77 129.54   1  $ W16
2013.48 2731.77 129.54   1  $ W17
2131.06 2731.77 129.54   1  $ W18
2252.98 2731.77 129.54   1  $ W19
  47.06 2889.25 129.54   1  $ X1  Chest Level - 4.25 ft
 181.74 2889.25 129.54   1  $ X2
 316.43 2889.25 129.54   1  $ X3
 424.18 2889.25 129.54   1  $ X4
 558.87 2889.25 129.54   1  $ X5
 693.55 2889.25 129.54   1  $ X6
 801.30 2889.25 129.54   1  $ X7
 909.05 2889.25 129.54   1  $ X8
1043.74 2889.25 129.54   1  $ X9
1151.49 2889.25 129.54   1  $ X10
1286.18 2889.25 129.54   1  $ X11
1420.86 2889.25 129.54   1  $ X12
1528.61 2889.25 129.54   1  $ X13
1663.30 2889.25 129.54   1  $ X14
1771.05 2889.25 129.54   1  $ X15
1905.74 2889.25 129.54   1  $ X16
2013.48 2889.25 129.54   1  $ X17
2131.06 2889.25 129.54   1  $ X18
2252.98 2889.25 129.54   1  $ X19
2374.90 2889.25 129.54   1  $ X20
  47.06 2980.00 129.54   1  $ Y1  Chest Level - 4.25 ft
 181.74 2980.00 129.54   1  $ Y2
 316.43 2980.00 129.54   1  $ Y3
 424.18 2980.00 129.54   1  $ Y4
 558.87 2980.00 129.54   1  $ Y5
 693.55 2980.00 129.54   1  $ Y6
 801.30 2980.00 129.54   1  $ Y7
 909.05 2980.00 129.54   1  $ Y8
1043.74 2980.00 129.54   1  $ Y9
1151.49 2980.00 129.54   1  $ Y10
1286.18 2980.00 129.54   1  $ Y11
1420.86 2980.00 129.54   1  $ Y12
1528.61 2980.00 129.54   1  $ Y13
1663.30 2980.00 129.54   1  $ Y14
1771.05 2980.00 129.54   1  $ Y15
1905.74 2980.00 129.54   1  $ Y16
2013.48 2980.00 129.54   1  $ Y17
2131.06 2980.00 129.54   1  $ Y18
2252.98 2980.00 129.54   1  $ Y19
2374.90 2980.00 129.54   1  $ Y20
  47.06 3112.77 129.54   1  $ Z1  Chest Level - 4.25 ft
 181.74 3112.77 129.54   1  $ Z2
 316.43 3112.77 129.54   1  $ Z3
 424.18 3112.77 129.54   1  $ Z4
 558.87 3112.77 129.54   1  $ Z5
 693.55 3112.77 129.54   1  $ Z6
 801.30 3112.77 129.54   1  $ Z7
 909.05 3112.77 129.54   1  $ Z8
1043.74 3112.77 129.54   1  $ Z9
1151.49 3112.77 129.54   1  $ Z10
1286.18 3112.77 129.54   1  $ Z11
1420.86 3112.77 129.54   1  $ Z12
1528.61 3112.77 129.54   1  $ Z13
1663.30 3112.77 129.54   1  $ Z14
1771.05 3112.77 129.54   1  $ Z15
1905.74 3112.77 129.54   1  $ Z16
2013.48 3112.77 129.54   1  $ Z17
2131.06 3112.77 129.54   1  $ Z18
2252.98 3112.77 129.54   1  $ Z19
2374.90 3112.77 129.54   1  $ Z20
  47.06 3219.45 129.54   1  $ AA1 Chest Level - 4.25 ft
 181.74 3219.45 129.54   1  $ AA2
 316.43 3219.45 129.54   1  $ AA3
 424.18 3219.45 129.54   1  $ AA4
 558.87 3219.45 129.54   1  $ AA5
 693.55 3219.45 129.54   1  $ AA6
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 801.30 3219.45 129.54   1  $ AA7
 909.05 3219.45 129.54   1  $ AA8
1043.74 3219.45 129.54   1  $ AA9
1151.49 3219.45 129.54   1  $ AA10
1286.18 3219.45 129.54   1  $ AA11
1420.86 3219.45 129.54   1  $ AA12
1528.61 3219.45 129.54   1  $ AA13
1663.30 3219.45 129.54   1  $ AA14
1771.05 3219.45 129.54   1  $ AA15
1905.74 3219.45 129.54   1  $ AA16
2013.48 3219.45 129.54   1  $ AA17
2131.06 3219.45 129.54   1  $ AA18
2252.98 3219.45 129.54   1  $ AA19
2374.90 3219.45 129.54   1  $ AA20
  47.06 3387.47 129.54   1  $ AB1 Chest Level - 4.25 ft
 181.74 3387.47 129.54   1  $ AB2
 316.43 3387.47 129.54   1  $ AB3
 424.18 3387.47 129.54   1  $ AB4
 558.87 3387.47 129.54   1  $ AB5
 693.55 3387.47 129.54   1  $ AB6
 801.30 3387.47 129.54   1  $ AB7
 909.05 3387.47 129.54   1  $ AB8
1043.74 3387.47 129.54   1  $ AB9
1151.49 3387.47 129.54   1  $ AB10
1286.18 3387.47 129.54   1  $ AB11
1420.86 3387.47 129.54   1  $ AB12
1528.61 3387.47 129.54   1  $ AB13
1663.30 3387.47 129.54   1  $ AB14
1771.05 3387.47 129.54   1  $ AB15
1905.74 3387.47 129.54   1  $ AB16
2013.48 3387.47 129.54   1  $ AB17
2131.06 3356.99 129.54   1  $ AB18
2252.98 3356.99 129.54   1  $ AB19
2374.90 3356.99 129.54   1  $ AB20
  47.06 3494.15 129.54   1  $ AC1 Chest Level - 4.25 ft
 181.74 3494.15 129.54   1  $ AC2
 316.43 3494.15 129.54   1  $ AC3
 424.18 3494.15 129.54   1  $ AC4
 558.87 3494.15 129.54   1  $ AC5
 693.55 3494.15 129.54   1  $ AC6
 801.30 3494.15 129.54   1  $ AC7
 909.05 3494.15 129.54   1  $ AC8
1043.74 3494.15 129.54   1  $ AC9
1151.49 3494.15 129.54   1  $ AC10
1286.18 3494.15 129.54   1  $ AC11
1420.86 3494.15 129.54   1  $ AC12
1528.61 3494.15 129.54   1  $ AC13
1663.30 3494.15 129.54   1  $ AC14
1771.05 3494.15 129.54   1  $ AC15
1905.74 3494.15 129.54   1  $ AC16
2013.48 3494.15 129.54   1  $ AC17
2131.06 3524.63 129.54   1  $ AC18
2252.98 3524.63 129.54   1  $ AC19
2374.90 3524.63 129.54   1  $ AC20
  47.06 3600.83 129.54   1  $ AD1 Chest Level - 4.25 ft
 181.74 3600.83 129.54   1  $ AD2
 316.43 3600.83 129.54   1  $ AD3
 424.18 3600.83 129.54   1  $ AD4
 558.87 3600.83 129.54   1  $ AD5
 693.55 3600.83 129.54   1  $ AD6
 801.30 3600.83 129.54   1  $ AD7
 909.05 3600.83 129.54   1  $ AD8
1043.74 3600.83 129.54   1  $ AD9
1151.49 3600.83 129.54   1  $ AD10
1286.18 3600.83 129.54   1  $ AD11
1420.86 3600.83 129.54   1  $ AD12
1528.61 3600.83 129.54   1  $ AD13
1663.30 3600.83 129.54   1  $ AD14
1771.05 3600.83 129.54   1  $ AD15
1905.74 3600.83 129.54   1  $ AD16
2013.48 3600.83 129.54   1  $ AD17
2131.06 3631.31 129.54   1  $ AD18
2252.98 3631.31 129.54   1  $ AD19
  47.06 3707.51 129.54   1  $ AE1 Chest Level - 4.25 ft
 181.74 3707.51 129.54   1  $ AE2
 316.43 3707.51 129.54   1  $ AE3
 424.18 3707.51 129.54   1  $ AE4
 558.87 3707.51 129.54   1  $ AE5
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 693.55 3707.51 129.54   1  $ AE6
 801.30 3707.51 129.54   1  $ AE7
1286.18 3707.51 129.54   1  $ AE11
1420.86 3707.51 129.54   1  $ AE12
1528.61 3707.51 129.54   1  $ AE13
1663.30 3707.51 129.54   1  $ AE14
1771.05 3707.51 129.54   1  $ AE15
1905.74 3707.51 129.54   1  $ AE16
2013.48 3707.51 129.54   1  $ AE17
2131.06 3737.99 129.54   1  $ AE18
2252.98 3737.99 129.54   1  $ AE19
  47.06 3859.53 129.54   1  $ AF1 Chest Level - 4.25 ft
 181.74 3859.53 129.54   1  $ AF2
 316.43 3859.53 129.54   1  $ AF3
 424.18 3859.53 129.54   1  $ AF4
 558.87 3859.53 129.54   1  $ AF5
 693.55 3859.53 129.54   1  $ AF6
 801.30 3859.53 129.54   1  $ AF7
 909.05 3859.53 129.54   1  $ AF8
1043.74 3859.53 129.54   1  $ AF9
1151.49 3859.53 129.54   1  $ AF10
1286.18 3859.53 129.54   1  $ AF11
1420.86 3859.53 129.54   1  $ AF12
1528.61 3859.53 129.54   1  $ AF13
1663.30 3859.53 129.54   1  $ AF14
1771.05 3859.53 129.54   1  $ AF15
1905.74 3859.53 129.54   1  $ AF16
2013.48 3859.53 129.54   1  $ AF17
2131.06 3890.01 129.54   1  $ AF18
2252.98 3890.01 129.54   1  $ AF19
  47.06 3966.21 129.54   1  $ AG1 Chest Level - 4.25 ft
 181.74 3966.21 129.54   1  $ AG2
 316.43 3966.21 129.54   1  $ AG3
 424.18 3966.21 129.54   1  $ AG4
 558.87 3966.21 129.54   1  $ AG5
 693.55 3966.21 129.54   1  $ AG6
 801.30 3966.21 129.54   1  $ AG7
 909.05 3966.21 129.54   1  $ AG8
1043.74 3966.21 129.54   1  $ AG9
1151.49 3966.21 129.54   1  $ AG10
1286.18 3966.21 129.54   1  $ AG11
1420.86 3966.21 129.54   1  $ AG12
1528.61 3966.21 129.54   1  $ AG13
1663.30 3966.21 129.54   1  $ AG14
1771.05 3966.21 129.54   1  $ AG15
1905.74 3966.21 129.54   1  $ AG16
2013.48 3966.21 129.54   1  $ AG17
2252.98 3996.69 129.54   1  $ AG19
  47.06 4072.89 129.54   1  $ AH1 Chest Level - 4.25 ft
 181.74 4072.89 129.54   1  $ AH2
 316.43 4072.89 129.54   1  $ AH3
 424.18 4072.89 129.54   1  $ AH4
 558.87 4072.89 129.54   1  $ AH5
 693.55 4072.89 129.54   1  $ AH6
 801.30 4072.89 129.54   1  $ AH7
 909.05 4072.89 129.54   1  $ AH8
1043.74 4072.89 129.54   1  $ AH9
1151.49 4072.89 129.54   1  $ AH10
1286.18 4072.89 129.54   1  $ AH11
1420.86 4072.89 129.54   1  $ AH12
1528.61 4072.89 129.54   1  $ AH13
1663.30 4072.89 129.54   1  $ AH14
1771.05 4072.89 129.54   1  $ AH15
1905.74 4072.89 129.54   1  $ AH16
2013.48 4072.89 129.54   1  $ AH17
2131.06 4072.89 129.54   1  $ AH18
2252.98 4072.89 129.54   1  $ AH19
  47.06 4240.91 129.54   1  $ AI1 Chest Level - 4.25 ft
 181.74 4240.91 129.54   1  $ AI2
 316.43 4240.91 129.54   1  $ AI3
 424.18 4240.91 129.54   1  $ AI4
 558.87 4240.91 129.54   1  $ AI5
 693.55 4240.91 129.54   1  $ AI6
 801.30 4240.91 129.54   1  $ AI7
 909.05 4240.91 129.54   1  $ AI8
1043.74 4240.91 129.54   1  $ AI9
1151.49 4240.91 129.54   1  $ AI10
1286.18 4240.91 129.54   1  $ AI11
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1420.86 4240.91 129.54   1  $ AI12
1528.61 4240.91 129.54   1  $ AI13
1663.30 4240.91 129.54   1  $ AI14
1771.05 4240.91 129.54   1  $ AI15
1905.74 4240.91 129.54   1  $ AI16
2013.48 4240.91 129.54   1  $ AI17
2131.06 4240.91 129.54   1  $ AI18
2252.98 4240.91 129.54   1  $ AI19
  47.06 4355.00 129.54   1  $ AJ1 Chest Level - 4.25 ft
 181.74 4355.00 129.54   1  $ AJ2
 316.43 4355.00 129.54   1  $ AJ3
 424.18 4355.00 129.54   1  $ AJ4
 558.87 4355.00 129.54   1  $ AJ5
 693.55 4355.00 129.54   1  $ AJ6
 801.30 4355.00 129.54   1  $ AJ7
 909.05 4355.00 129.54   1  $ AJ8
1043.74 4355.00 129.54   1  $ AJ9
1151.49 4355.00 129.54   1  $ AJ10
1286.18 4355.00 129.54   1  $ AJ11
1420.86 4355.00 129.54   1  $ AJ12
1528.61 4355.00 129.54   1  $ AJ13
1663.30 4355.00 129.54   1  $ AJ14
1771.05 4355.00 129.54   1  $ AJ15
1905.74 4355.00 129.54   1  $ AJ16
2013.48 4355.00 129.54   1  $ AJ17
2131.06 4355.00 129.54   1  $ AJ18
2252.98 4355.00 129.54   1  $ AJ19
  47.06 4438.65 129.54   1  $ AK1 Chest Level - 4.25 ft
 181.74 4438.65 129.54   1  $ AK2
 316.43 4438.65 129.54   1  $ AK3
 424.18 4438.65 129.54   1  $ AK4
 558.87 4438.65 129.54   1  $ AK5
 693.55 4438.65 129.54   1  $ AK6
 801.30 4438.65 129.54   1  $ AK7
 909.05 4438.65 129.54   1  $ AK8
1043.74 4438.65 129.54   1  $ AK9
1151.49 4438.65 129.54   1  $ AK10
1286.18 4438.65 129.54   1  $ AK11
1420.86 4438.65 129.54   1  $ AK12
1528.61 4438.65 129.54   1  $ AK13
1663.30 4438.65 129.54   1  $ AK14
1771.05 4438.65 129.54   1  $ AK15
1905.74 4438.65 129.54   1  $ AK16
2013.48 4438.65 129.54   1  $ AK17
2131.06 4438.65 129.54   1  $ AK18
2252.98 4438.65 129.54   1  $ AK19
  47.06 4545.33 129.54   1  $ AL1 Chest Level - 4.25 ft
 181.74 4545.33 129.54   1  $ AL2
 316.43 4545.33 129.54   1  $ AL3
 424.18 4545.33 129.54   1  $ AL4
 558.87 4545.33 129.54   1  $ AL5
 693.55 4545.33 129.54   1  $ AL6
 801.30 4545.33 129.54   1  $ AL7
 909.05 4545.33 129.54   1  $ AL8
1043.74 4545.33 129.54   1  $ AL9
1151.49 4545.33 129.54   1  $ AL10
1286.18 4545.33 129.54   1  $ AL11
1420.86 4545.33 129.54   1  $ AL12
1528.61 4545.33 129.54   1  $ AL13
1663.30 4545.33 129.54   1  $ AL14
1771.05 4545.33 129.54   1  $ AL15
1905.74 4545.33 129.54   1  $ AL16
2013.48 4545.33 129.54   1  $ AL17
2131.06 4545.33 129.54   1  $ AL18
2252.98 4545.33 129.54   1  $ AL19
  47.06 4713.35 129.54   1  $ AM1 Chest Level - 4.25 ft
 181.74 4713.35 129.54   1  $ AM2
 316.43 4713.35 129.54   1  $ AM3
 424.18 4713.35 129.54   1  $ AM4
 558.87 4713.35 129.54   1  $ AM5
 693.55 4713.35 129.54   1  $ AM6
 801.30 4713.35 129.54   1  $ AM7
 909.05 4713.35 129.54   1  $ AM8
1043.74 4713.35 129.54   1  $ AM9
1151.49 4713.35 129.54   1  $ AM10
1286.18 4713.35 129.54   1  $ AM11
1420.86 4713.35 129.54   1  $ AM12
1528.61 4713.35 129.54   1  $ AM13
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1663.30 4713.35 129.54   1  $ AM14
1771.05 4713.35 129.54   1  $ AM15
1905.74 4713.35 129.54   1  $ AM16
2013.48 4713.35 129.54   1  $ AM17
2131.06 4713.35 129.54   1  $ AM18
2252.98 4713.35 129.54   1  $ AM19
  47.06 4820.03 129.54   1  $ AN1 Chest Level - 4.25 ft
 181.74 4820.03 129.54   1  $ AN2
 316.43 4820.03 129.54   1  $ AN3
 424.18 4820.03 129.54   1  $ AN4
 558.87 4820.03 129.54   1  $ AN5
 693.55 4820.03 129.54   1  $ AN6
 801.30 4820.03 129.54   1  $ AN7
 909.05 4820.03 129.54   1  $ AN8
1043.74 4820.03 129.54   1  $ AN9
1151.49 4820.03 129.54   1  $ AN10
1286.18 4820.03 129.54   1  $ AN11
1420.86 4820.03 129.54   1  $ AN12
1528.61 4820.03 129.54   1  $ AN13
1663.30 4820.03 129.54   1  $ AN14
1771.05 4820.03 129.54   1  $ AN15
1905.74 4820.03 129.54   1  $ AN16
2013.48 4820.03 129.54   1  $ AN17
2131.06 4820.03 129.54   1  $ AN18
2252.98 4820.03 129.54   1  $ AN19
  47.06 4926.71 129.54   1  $ AO1
 181.74 4926.71 129.54   1  $ AO2 Chest Level - 4.25 ft
 316.43 4926.71 129.54   1  $ AO3
 424.18 4926.71 129.54   1  $ AO4
 558.87 4926.71 129.54   1  $ AO5
 693.55 4926.71 129.54   1  $ AO6
 801.30 4926.71 129.54   1  $ AO7
 909.05 4926.71 129.54   1  $ AO8
1043.74 4926.71 129.54   1  $ AO9
1151.49 4926.71 129.54   1  $ AO10
1286.18 4926.71 129.54   1  $ AO11
1420.86 4926.71 129.54   1  $ AO12
1528.61 4926.71 129.54   1  $ AO13
1663.30 4926.71 129.54   1  $ AO14
1771.05 4926.71 129.54   1  $ AO15
1905.74 4926.71 129.54   1  $ AO16
2013.48 4926.71 129.54   1  $ AO17
2374.90 4926.71 129.54   1  $ AO20
  47.06 5033.39 129.54   1  $ AP1 Chest Level - 4.25 ft
 181.74 5033.39 129.54   1  $ AP2
 316.43 5033.39 129.54   1  $ AP3
 424.18 5033.39 129.54   1  $ AP4
 558.87 5033.39 129.54   1  $ AP5
 693.55 5033.39 129.54   1  $ AP6
 801.30 5033.39 129.54   1  $ AP7
 909.05 5033.39 129.54   1  $ AP8
1043.74 5033.39 129.54   1  $ AP9
1151.49 5033.39 129.54   1  $ AP10
1286.18 5033.39 129.54   1  $ AP11
1420.86 5033.39 129.54   1  $ AP12
1528.61 5033.39 129.54   1  $ AP13
1663.30 5033.39 129.54   1  $ AP14
1771.05 5033.39 129.54   1  $ AP15
1905.74 5033.39 129.54   1  $ AP16
2013.48 5033.39 129.54   1  $ AP17
2131.06 5033.39 129.54   1  $ AP18
2252.98 5033.39 129.54   1  $ AP19
2374.90 5033.39 129.54   1  $ AP20
  47.06 5185.41 129.54   1  $ AQ1 Chest Level - 4.25 ft
 181.74 5185.41 129.54   1  $ AQ2
 316.43 5185.41 129.54   1  $ AQ3
 424.18 5185.41 129.54   1  $ AQ4
 558.87 5185.41 129.54   1  $ AQ5
 693.55 5185.41 129.54   1  $ AQ6
 801.30 5185.41 129.54   1  $ AQ7
 909.05 5185.41 129.54   1  $ AQ8
1043.74 5185.41 129.54   1  $ AQ9
1151.49 5185.41 129.54   1  $ AQ10
1286.18 5185.41 129.54   1  $ AQ11
1420.86 5185.41 129.54   1  $ AQ12
1528.61 5185.41 129.54   1  $ AQ13
1663.30 5185.41 129.54   1  $ AQ14
1771.05 5185.41 129.54   1  $ AQ15
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1905.74 5185.41 129.54   1  $ AQ16
2013.48 5185.41 129.54   1  $ AQ17
2252.98 5185.41 129.54   1  $ AQ19
2374.90 5185.41 129.54   1  $ AQ20
  47.06 5292.09 129.54   1  $ AR1 Chest Level - 4.25 ft
 181.74 5292.09 129.54   1  $ AR2
 316.43 5292.09 129.54   1  $ AR3
 424.18 5292.09 129.54   1  $ AR4
 558.87 5292.09 129.54   1  $ AR5
 693.55 5292.09 129.54   1  $ AR6
 801.30 5292.09 129.54   1  $ AR7
 909.05 5292.09 129.54   1  $ AR8
1043.74 5292.09 129.54   1  $ AR9
1151.49 5292.09 129.54   1  $ AR10
1286.18 5292.09 129.54   1  $ AR11
1420.86 5292.09 129.54   1  $ AR12
1528.61 5292.09 129.54   1  $ AR13
1663.30 5292.09 129.54   1  $ AR14
1771.05 5292.09 129.54   1  $ AR15
1905.74 5292.09 129.54   1  $ AR16
2013.48 5292.09 129.54   1  $ AR17
2131.06 5292.09 129.54   1  $ AR18
2252.98 5292.09 129.54   1  $ AR19
2374.90 5292.09 129.54   1  $ AR20
  47.06 5437.11 129.54   1  $ AS1 Chest Level - 4.25 ft
 181.74 5437.11 129.54   1  $ AS2
 316.43 5437.11 129.54   1  $ AS3
 424.18 5437.11 129.54   1  $ AS4
 558.87 5437.11 129.54   1  $ AS5
 693.55 5437.11 129.54   1  $ AS6
 801.30 5437.11 129.54   1  $ AS7
 909.05 5437.11 129.54   1  $ AS8
1043.74 5437.11 129.54   1  $ AS9
1151.49 5437.11 129.54   1  $ AS10
1286.18 5437.11 129.54   1  $ AS11
1420.86 5437.11 129.54   1  $ AS12
1528.61 5437.11 129.54   1  $ AS13
1663.30 5437.11 129.54   1  $ AS14
1771.05 5437.11 129.54   1  $ AS15
1905.74 5437.11 129.54   1  $ AS16
2013.48 5437.11 129.54   1  $ AS17
2131.06 5437.11 129.54   1  $ AS18
2252.98 5437.11 129.54   1  $ AS19
2374.90 5437.11 129.54   1  $ AS20
  47.06 5542.00 129.54   1  $ AT1 Chest Level - 4.25 ft
 181.74 5542.00 129.54   1  $ AT2
 316.43 5542.00 129.54   1  $ AT3
 424.18 5540.00 129.54   1  $ AT4
 558.87 5542.00 129.54   1  $ AT5
 693.55 5542.00 129.54   1  $ AT6
 801.30 5542.00 129.54   1  $ AT7
 909.05 5542.00 129.54   1  $ AT8
1043.74 5542.00 129.54   1  $ AT9
1151.49 5542.00 129.54   1  $ AT10
1286.18 5540.00 129.54   1  $ AT11
1420.86 5542.00 129.54   1  $ AT12
1528.61 5542.00 129.54   1  $ AT13
1663.30 5542.00 129.54   1  $ AT14
1771.05 5542.00 129.54   1  $ AT15
1905.74 5542.00 129.54   1  $ AT16
2013.48 5542.00 129.54   1  $ AT17
2131.06 5542.00 129.54   1  $ AT18
2252.98 5542.00 129.54   1  $ AT19
2374.90 5542.00 129.54   1  $ AT20
   5.08 5663.92 129.54   1  $ AU1 Chest Level - 4.25 ft
 147.32 5663.92 129.54   1  $ AU2
 424.18 5663.92 129.54   1  $ AU4
 546.10 5663.92 129.54   1  $ AU5
 668.02 5663.92 129.54   1  $ AU6
 789.94 5663.92 129.54   1  $ AU7
 911.86 5663.92 129.54   1  $ AU8
1033.78 5663.92 129.54   1  $ AU9
1155.70 5663.92 129.54   1  $ AU10
1277.62 5663.92 129.54   1  $ AU11
1399.54 5663.92 129.54   1  $ AU12
1521.46 5663.92 129.54   1  $ AU13
1643.38 5663.92 129.54   1  $ AU14
1765.30 5663.92 129.54   1  $ AU15
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1887.22 5663.92 129.54    1  $ AU16
2009.14 5633.44 129.54    1  $ AU17
2131.06 5663.92 129.54    1  $ AU18
2252.98 5663.92 129.54    1  $ AU19
2374.90 5663.92 129.54    1  $ AU20
   5.08 5816.32 129.54    1  $ AV1 Chest Level - 4.25 ft
 147.32 5816.32 129.54    1  $ AV2
 424.18 5816.32 129.54    1  $ AV4
 546.10 5816.32 129.54    1  $ AV5
 668.02 5816.32 129.54    1  $ AV6
 789.94 5816.32 129.54    1  $ AV7
 911.86 5816.32 129.54    1  $ AV8
1033.78 5816.32 129.54    1  $ AV9
1155.70 5816.32 129.54    1  $ AV10
1277.62 5816.32 129.54    1  $ AV11
1399.54 5816.32 129.54    1  $ AV12
1521.46 5816.32 129.54    1  $ AV13
1643.38 5816.32 129.54    1  $ AV14
1765.30 5816.32 129.54    1  $ AV15
2009.14 5816.32 129.54    1  $ AV17
2131.06 5816.32 129.54    1  $ AV18
2252.98 5816.32 129.54    1  $ AV19
2374.90 5816.32 129.54    1  $ AV20
 424.18 5968.72 129.54    1  $ AW4 Chest Level - 4.25 ft
 546.10 5968.72 129.54    1  $ AW5
 668.02 5968.72 129.54    1  $ AW6
 789.94 5968.72 129.54    1  $ AW7
 911.86 5968.72 129.54    1  $ AW8
1033.78 5968.72 129.54    1  $ AW9
1155.70 5968.72 129.54    1  $ AW10
1277.62 5968.72 129.54    1  $ AW11
1399.54 5968.72 129.54    1  $ AW12
1521.46 5968.72 129.54    1  $ AW13
1643.38 5968.72 129.54    1  $ AW14
1765.30 5968.72 129.54    1  $ AW15
2009.14 5968.72 129.54    1  $ AW17
2131.06 5968.72 129.54    1  $ AW18
2374.90 5968.72 129.54    1  $ AW20
 424.18 6090.64 129.54    1  $ AX4 Chest Level - 4.25 ft
 546.10 6121.12 129.54    1  $ AX5
 668.02 6121.12 129.54    1  $ AX6
 789.94 6121.12 129.54    1  $ AX7
 911.86 6121.12 129.54    1  $ AX8
1033.78 6121.12 129.54    1  $ AX9
1155.70 6121.12 129.54    1  $ AX10
1277.62 6121.12 129.54    1  $ AX11
1399.54 6121.12 129.54    1  $ AX12
1521.46 6121.12 129.54    1  $ AX13
1765.30 6121.12 129.54    1  $ AX15
2009.14 6121.12 129.54    1  $ AX17
2131.06 6121.12 129.54    1  $ AX18
2252.98 6121.12 129.54    1  $ AX19
2374.90 6121.12 129.54    1  $ AX20
   5.08 6273.52 129.54    1  $ AY1 Chest Level - 4.25 ft
 147.32 6273.52 129.54    1  $ AY2
 299.72 6273.52 129.54    1  $ AY3
 424.18 6273.52 129.54    1  $ AY4
 546.10 6273.52 129.54    1  $ AY5
1033.78 6273.52 129.54    1  $ AY9
1155.70 6273.52 129.54    1  $ AY10
1277.62 6273.52 129.54    1  $ AY11
1399.54 6273.52 129.54    1  $ AY12
1521.46 6273.52 129.54    1  $ AY13
1765.30 6273.52 129.54    1  $ AY15
2009.14 6273.52 129.54    1  $ AY17
2131.06 6273.52 129.54    1  $ AY18
2252.98 6273.52 129.54    1  $ AY19
2374.90 6273.52 129.54    1  $ AY20
   5.08 6380.20 129.54    1  $ AZ1 Chest Level - 4.25 ft
 147.32 6380.20 129.54    1  $ AZ2
 299.72 6380.20 129.54    1  $ AZ3
 424.18 6380.20 129.54    1  $ AZ4
 546.10 6380.20 129.54    1  $ AZ5
1155.70 6380.20 129.54    1  $ AZ10
1277.62 6380.20 129.54    1  $ AZ11
1521.46 6380.20 129.54    1  $ AZ13
1765.30 6380.20 129.54    1  $ AZ15
1887.22 6380.20 129.54    1  $ AZ16
```

```
2009.14 6380.20 129.54   1  $ AZ17
2131.06 6380.20 129.54   1  $ AZ18
2252.98 6380.20 129.54   1  $ AZ19
2374.90 6380.20 129.54   1  $ AZ20
 147.32 6486.88 129.54   1  $ BA2 Chest Level - 4.25 ft
 299.72 6486.88 129.54   1  $ BA3
1155.70 6486.88 129.54   1  $ BA10
1277.62 6486.88 129.54   1  $ BA11
1521.46 6486.88 129.54   1  $ BA13
1765.30 6486.88 129.54   1  $ BA15
1887.22 6486.88 129.54   1  $ BA16
 147.32 6593.56 129.54   1  $ BB2 Chest Level - 4.25 ft
 299.72 6593.56 129.54   1  $ BB3
 424.18 6593.56 129.54   1  $ BB4
 546.10 6593.56 129.54   1  $ BB5
 668.02 6593.56 129.54   1  $ BB6
1277.62 6593.56 129.54   1  $ BB11
1399.54 6593.56 129.54   1  $ BB12
1521.46 6593.56 129.54   1  $ BB13
1643.38 6593.56 129.54   1  $ BB14
1765.30 6593.56 129.54   1  $ BB15
1887.22 6593.56 129.54   1  $ BB16
 668.02 6700.24 129.54   1  $ BC6 Chest Level - 4.25 ft
 789.94 6700.24 129.54   1  $ BC7
 911.86 6700.24 129.54   1  $ BC8
1155.70 6700.24 129.54   1  $ BC10
1277.62 6700.24 129.54   1  $ BC11
1765.30 6700.24 129.54   1  $ BC15
1887.22 6700.24 129.54   1  $ BC16
 668.02 6806.92 129.54   1  $ BD6 Chest Level - 4.25 ft
 789.94 6806.92 129.54   1  $ BD7
 911.86 6806.92 129.54   1  $ BD8
1033.78 6806.92 129.54   1  $ BD9
1155.70 6806.92 129.54   1  $ BD10
1277.62 6806.92 129.54   1  $ BD11
```

Appendix E. Software to Generate MCNP Input

KE-GEOM.PAS Software Listing

```
Program Convert_KEGeom;
{ Author:   Paul D. Rittmann, PhD CHP
  Purpose:  Reads the KE-GEOM.WQ1 output text file and creates the 3 MCNP
            input file pieces: geometry (cells & surfaces with material lines)
            sources, and near source points.  This also breaks the
            source block into individual source pieces.
  Input:    Text file from the KE-GEOM.WQ1 spreadsheet.
}

Uses  Crt, DOS*, Objects, Utility;

Const  Version = 'KE-GEOM Version 1.1   April 10, 1997';
  SrcMax = 180; { limit on the number of distinct radiation sources }
  FileDrive = 'D:\'; { where the files are found '}
  EffFile = 'KE-GEOM.EFF';{ MCNP efficiency file list from GREP on output }
  SSFile = 'KE-GEOM.PRN';{ KE-GEOM.WQ1 text file }
  Gfile = 'GEOM'; { geometry surfaces and cells }
  Sfile = 'S-ALL'; { all the source info }
  Pfile = 'PT-NEAR'; { near source locations }
  LstFile = 'SORTSRC';{ list of sources 2 ways }
  MaxLine = 4000; { limit on the number of lines in the input file }
  Gnum = 50; { number of lines of extra geometry information }
  GeomInfo : Array[1..Gnum] of ST66 = (
'm1   $  Hanford Concrete',
'          1001.01p   -0.00310  $  Hydrogen',
'          8016.01p   -0.44070  $  Oxygen',
'         11023.01p   -0.01820  $  Sodium',
'         12000.01p   -0.03760  $  Magnesium',
'         13027.01p   -0.06070  $  Aluminum',
'         14000.01p   -0.21570  $  Silicon',
'         15031.01p   -0.00090  $  Phosphorus',
'         16032.01p   -0.00090  $  Sulfur',
'         20000.01p   -0.13060  $  Calcium',
'         22000.01p   -0.00490  $  Titanium',
'         25055.01p   -0.00130  $  Manganese',
'         26000.01p   -0.07880  $  Iron',
'         36000.01p   -0.00660  $  Krypton',
'm2   $  Air at 80°F and 20.0% Relative Humidity',
'          1001.01p   -0.00048  $  Hydrogen',
'          6012.01p   -0.00014  $  Carbon',
'          7014.01p   -0.75191  $  Nitrogen',
'          8016.01p   -0.23464  $  Oxygen',
'         18040.01p   -0.01282  $  Argon',
'm3   $ water',
'       1001.01p  0.66667   8016.01p  0.33333',
'm4   $ iron',
'       26000.01p  -1.0',
'm5   $ iron & air',
'       26000.01p  -1600.0    8016.01p  -0.21     7014.01p  -0.79',
'm6   $  Wet Sand (Working Media)',
'       1001.01p   2.5795E-01   $  H ',
'       8016.01p   5.2496E-01   $  O ',
'       9019.01p   6.8124E-05   $  F ',
'      11023.01p   7.6730E-03   $  Na',
'      12000.01p   5.7802E-04   $  Mg',
'      13027.01p   2.1909E-02   $  Al',
'      14000.01p   1.7560E-01   $  Si',
'      16032.01p   1.6163E-04   $  S ',
'      17000.01p   6.5711E-05   $  Cl',
'      19000.01p   8.7112E-03   $  K ',
'      20000.01p   1.3155E-03   $  Ca',
'      26000.01p   9.8877E-04   $  Fe',
'      22000.01p   1.6199E-05   $  Ti',
'      92238.01p   4.2285E-04   $  U238',
'm7   $ stored fuel',
'       1001.01p  -0.03609  8016.01p  -0.28649  92238.01p  -0.67742',
'm8   $ lead',
'      82000.01p  -1.0',
'mode    p',
'print  40',
'prdmp   j  j  1',
'phys:p  j  1',
'idum    1');
```

*DOS - MS-DOS is a trademark of Microsoft Corporation.

```
Type
  SrcSpecPtr = ^SrcSpecType;
  SrcSpecType = Record { 160+32+640+120+8 = 960 bytes }
    Title   : ST25;    { title of source }
    ConcAmt : ST19;    { concentration and units }
    Fname,             { source file name }
    Effic   : ST7;     { efficiency from MCNP run }
    nps     : LongInt; { number of source points in this region }
    wgt     : Single;  { total source strength, Bq }
    cel     : Integer; { which cell the source region is in }
    Vx,six,spx : Array[1..4] of Integer;{ 1,2,3,4=X,Y,Z,0 or =POS,EXT,AXS,RAD }
           { Vx are values in the distribution fcel }
           { six,spx are indices to the AllTxt array }
    End;

Var
  fi,fo    : Text; { the KE-GEOM.WQ1 text file and output file }
  Nxyz,            { number of rectangular box sources }
  SpecNum,         { number of sources specified in the source block }
  PartD,           { index to current part being read }
  LineD    : Integer; { current line in the input file }
  SrcOrd : Array[1..SrcMax] of Integer; { sorted order for SrcSpec }
  SrcSpec  : Array[1..SrcMax] of SrcSpecPtr; { info about each source }
  AllTxt   : Array[1..MaxLine] of Pstring; { lines from the input file }
  TxtStrt,                  { holds the start and end index to each  }
  TxtFini  : Array[1..15] of Integer;{ block in the AllTxt array:
                                  1 = X surfaces
                                  2 = Y surfaces & slant planes
                                  3 = Z surfaces & cylinders
                                  4 = importances line
                                  5 = cell definitions
                                  6 = source list (cell ID, prob, and bias)
                                  7 = X coordinate range
                                  8 = POS coordinates
                                  9 = Y coordinate range
                                 10 = EXT coordinates
                                 11 = near source detector locations
                                 12 = Z coordinate range
                                 13 = AXS coordinates
                                 14 = RAD coordinates  }

Procedure New_Screen;
{ Clears the screen and places the distinctive header on the top line }
Begin
  TextAttr:= White;      ClrScr;
  TextAttr:= HelpTitle;  ClrEol;       Write(Space,Version);
  TextAttr:= HelpText;   Msg(78-Length(Author),1,Author);
  TextAttr:= TblColor;   Writeln;
  Writeln(' Converts KE-GEOM.WQ1 text output into MCNP input pieces.');
  TextAttr:= HiColor;    Writeln;
  Writeln(' The KE-GEOM.WQ1 text file is assumed to be named ',FileDrive,SSFile);
  TextAttr:= TblColor;   Writeln;
  Writeln(' The geometry (surface & cells) are placed in ',FileDrive,Gfile);
  Writeln(' The radiation sources are placed in ',FileDrive,Sfile);
  Writeln(' The near source dose points are placed in ',FileDrive,Pfile);
  Writeln;
  ScnLine:= 9;           TextAttr:= HdrColor;
End;


Procedure Show_Err(MsgST : ST79);
{ Displays error message and quits }
Begin
  If MsgST[0] > #0 Then Begin  { error message first }
    TextAttr:= ErrColor;    Inc(ScnLine,2);     Msg(1,ScnLine,MsgST);
    End;
  Halt;
End;
```

```
Procedure Initialize;
{ Opens the current input and summary files. }
Var   I : Integer;
Begin
  New_Screen;
  ST:= FileDrive + SSFile;
 { verify existance of the input file }
  Assign(fi,ST);      {$I-}  Reset(fi);  {$I+}
  If IOResult > 0 Then
    Show_Err('Oops!  The file '+ST+' could not be located!');
  For I:= 1 to SrcMax Do SrcOrd[I]:= I;
  LineD:= 0;    PartD:= 0;
End;


Procedure Read_Parts;
{ Reads the input file looking for line which begin with a character
  in the first column.  Other lines are skipped.  Once such a line is
  found, the lines are stored in memory until a blank line is encountered.
  SrcFlag catchs some format issues at the beginning of the source list. }
Var  K : Integer;      Found,SrcFlag : Boolean;
Procedure Show_Where;
Begin
  If PartD > 0 Then TxtFini[PartD]:= LineD;
  Inc(PartD);
  TxtStrt[PartD]:= Succ(LineD);
  Writeln(PartD:3,TxtStrt[PartD]:5,': ',Copy(ST,1,69));
End;
Begin
  ST:= '';
  Repeat
    Readln(fi,ST);
    Found:= (Length(ST) > 0) and (ST[1] <> Space);
  Until Eof(fi) or Found;
  SrcFlag:= Copy(ST,1,3) = 'sc1';
  Show_Where;
  Repeat
    Inc(LineD);               AllTxt[LineD]:= NewStr(ST);
    Readln(fi,ST);
    If SrcFlag Then Begin
      K:= Pos('sb1',ST);      Delete(ST,K+3,50);
      SrcFlag:= false;
      End   Else
    If (PartD = 13) and (Copy(ST,1,3) = 'sc8') Then Show_Where;
  Until (Length(ST) = 0) or (LineD > MaxLine) or Eof(fi);
End;


Procedure Dump_Block(Blk:Byte);
Var  J : Integer;
Begin
  For J:= TxtStrt[Blk] to TxtFini[Blk] Do Writeln(fo,AllTxt[J]^);
End;


Procedure Dump_MCNP_Geom;
Var  K : Integer;
Begin
  ST:= AllTxt[TxtStrt[5]]^;    TextAttr:= TblColor;
  If Pos('16',ST) > 0 Then CH:= '1'   Else CH:= '2';
  ST:= FileDrive + Gfile + CH + '.L3';
  Writeln(' Writing the file ',ST);
  Assign(fo,ST);      Rewrite(fo);
  Dump_Block(5); { cells }
  Writeln(fo);
  Dump_Block(1); { X surfaces }
  Dump_Block(2); { Y surfaces }
  Dump_Block(3); { Z surfaces }
  Writeln(fo);
  For K:= 1 to Gnum Do Writeln(fo,GeomInfo[K]);
  Writeln(fo,AllTxt[TxtStrt[4]]^); { importances }
  Close(fo);
End;
```

```
Procedure Dump_MCNP_Srcs;
Var  J,K : Integer;
Begin
  ST:= FileDrive + Sfile;       TextAttr:= TblColor;
  Writeln(' Writing the file ',ST);
  Assign(fo,ST);      Rewrite(fo);
  Writeln(fo,'nps    500000');
  ST:= AllTxt[TxtStrt[6]]^;            K:= Length(ST);
  While ST[K] =  Space Do Dec(K); { skip any trailing blanks }
  While ST[K] <> Space Do Dec(K); { skip over the photons/sec units }
  Dec(K);                              J:= K;
  While ST[K] <> Space Do Dec(K); { skip over the number }
  Writeln(fo,'sdef   erg=0.662  cel=d1  x=fcel d2  y=fcel d3  z=fcel d4  wgt=',
            Copy(ST,Succ(K),J-K));
  While ST[K] <> ')' Do Dec(K);        ST[0]:= Chr(K);
  AllTxt[TxtStrt[6]]^:= ST;
  Writeln(fo,'       pos=fcel d5  ext=fcel d6  axs=fcel d7  rad=fcel d8');
  Dump_Block( 6); { source ID }
  Dump_Block( 7); { X ranges }
  Dump_Block( 9); { Y ranges }
  Dump_Block(12); { Z ranges }
  Dump_Block( 8); { POS ranges }
  Dump_Block(10); { EXT ranges }
  Dump_Block(13); { AXS ranges }
  Dump_Block(14); { RAD ranges }
  Close(fo);
End;


Procedure Dump_MCNP_NrPt;
Begin
  ST:= FileDrive + Pfile;       TextAttr:= TblColor;
  Writeln(' Writing the file ',ST);
  Assign(fo,ST);      Rewrite(fo);
  Dump_Block(11);
  Close(fo);
End;


Procedure Check_Memory;
{ Displays the number of bytes available on the heap. }
Begin
  TextAttr:= White;        Writeln;
  Writeln(MaxAvail,' bytes available on heap');
  Writeln;
End;


Procedure Get_Source_Specs;
{ Interprets the fcel blocks and revises them to have the correct
  number of entries. }
Var   Err,Lng,Ia,Ib,J,Lno,LnA,LnB,Src,wrk : Integer;
Function Numeric_String : ST15;
{ Uses the global ST, Ia, Ib to return a numeric string }
Begin
  Ia:= Ib;   While ST[Ia] = Space Do Inc(Ia);  { skip leading spaces }
  Ib:= Ia;   While ST[Ib] <> Space Do Inc(Ib); { find end of number }
  Numeric_String:= Copy(ST,Ia,Ib-Ia);
End;
Procedure Identify_Specs(Blk,Coord,Jinit:Integer);
Var   N : Integer;    TmpST : ST25;    ZeroX : Boolean;
Begin
 { first, look through the pointer block to find Vx values }
  LnA:= Succ(TxtStrt[Blk]);       Src:= 0;
  If Jinit = 0 Then Lno:= LnA
             Else Lno:= Succ(LnA);{ cylinders have zeros for the first line }
  ST:= AllTxt[Lno]^ + Space;
  Repeat
    Lng:= Length(ST);        Ib:= 10;
    Repeat
      Val(Numeric_String,wrk,Err);
      If Err > 0 Then Show_Err('invalid: '+ST);
      If wrk > 0 Then Begin
        Inc(Src);            SrcSpec[Src+Jinit]^.Vx[Coord]:= wrk;
        End;
    Until Ib = Lng;
    Inc(Lno);                ST:= AllTxt[Lno]^ + Space;
```

```
  Until ST[1] = 's';
  Writeln('Block',Blk:3,':  ',Src,' sources');
  LnB:= Lno;                   If Blk = 7 Then Nxyz:= Src; { only for X ranges }
 { second, revise the fcel block to add any necessary zeros }
  Lno:= LnA;                   ST:= Copy(AllTxt[Lno]^,1,8);
  ZeroX:= Jinit > 0;           Lng:= Length(AllTxt[Lno]^);
  If ZeroX Then wrk:= Lng-3  Else wrk:= lng-5;
  For N:= 1 to SpecNum Do With SrcSpec[N]^ Do Begin
    If Length(ST) > wrk Then Begin
      AllTxt[Lno]^:= ST;    Inc(Lno);     ST:= '        ';
      End;
    If ZeroX Then TmpST:= '  0'    Else Str(Vx[Coord]:5,TmpST);
    ST:= ST + TmpST;
    If N = Nxyz Then Begin      ZeroX:= not ZeroX;
      If ZeroX Then wrk:= Lng-3    Else wrk:= Lng-5;
      End;
    End;
  AllTxt[Lno]^:= ST;           Inc(Lno);
 { third, rearrange pointers to eliminate the extra lines }
  Lng:= LnB - Lno;             Dec(TxtFini[Blk],Lng);
  For N:= Lno to TxtFini[Blk] Do AllTxt[N]:= AllTxt[N+Lng];
 { fourth, look at the distribution lines to locate six & spx }
  ST:= AllTxt[Lno]^;
  If ST[5] = Space Then Ib:= 2   Else Ib:= 3;
  Val(Copy(ST,3,Ib),wrk,Err);
  If Jinit = 0 Then Begin  Ia:= 1;            Ib:= Nxyz;     End
             Else Begin  Ia:= Succ(Nxyz);  Ib:= SpecNum;  End;
  For N:= Ia to Ib Do With SrcSpec[N]^ Do Begin
    Lng:= Vx[Coord] - wrk;
    If Blk = 10  { EXT has no SP lines }
      Then Begin six[Coord]:= Lno + Lng;   spx[Coord]:= 0                End
      Else Begin six[Coord]:= Lno + 2*Lng; spx[Coord]:= Succ(six[Coord])  End;
    End;
End;
Begin
 { first, create the SrcSpec array with source cell and weight information }
  Lno:= TxtStrt[6] + 3;      TextAttr:= HdrColor;
  ST:= AllTxt[Lno]^;          Src:= 0;
  Repeat
    Inc(Src);   Ib:= 1;      New(SrcSpec[Src]);
    With SrcSpec[Src]^ Do Begin
      Val(Numeric_String,cel,Err);
      If Err > 0 Then Show_Err('cel invalid: '+ST);
      Val(Numeric_String,wgt,Err);
      If Err > 0 Then Show_Err('wgt invalid: '+ST);
      Val(Numeric_String,nps,Err);
      If Err > 0 Then Show_Err('nps invalid: '+ST);
      wgt:= wgt * 3.7E+10;  { convert to Bq }
      Title:= Copy(ST,32,18);                Ib:= Length(Title);
      While Title[Ib] = Space Do Dec(Ib);    Title[0]:= Chr(Ib);
      Ia:= 60;    While ST[Ia] = Space Do Inc(Ia);
      ConcAmt:= Copy(ST,Ia,15);
      For Ia:= 1 to 4 Do
        Begin  Vx[Ia]:= 0;  six[Ia]:= 0;  spx[Ia]:= 0;  End;
      Fname:= ' --- ';       Effic:= Space;
    End;
    Inc(Lno);                 ST:= AllTxt[Lno]^;
  Until ST[1] = 'c';
  SpecNum:= Src;
  Identify_Specs( 7,1,0); { X coordinate ranges }
  Identify_Specs( 9,2,0); { Y coordinate ranges }
  Identify_Specs(12,3,0); { Z coordinate ranges }
  Identify_Specs( 8,1,Nxyz); { POS coordinates }
  Identify_Specs(10,2,Nxyz); { EXT coordinates }
  Identify_Specs(13,3,Nxyz); { AXS coordinates }
  Identify_Specs(14,4,Nxyz); { RAD coordinates }
End;


Procedure Read_MCNP_Eff;
Var  fe : Text;    Wrk,K : Integer;    WrkST : ST7;
Begin
  ST:= FileDrive + EffFile;
 { verify existance of the MCNP efficiency file }
  Assign(fe,ST);      {$I-}  Reset(fe);  {$I+}
  If IOResult > 0 Then
    Show_Err('Oops!  The file '+ST+' could not be located!');
  While not Eof(fe) Do Begin
```

```
    Readln(fe,ST);     WrkST:= Copy(ST,53,3);
    While WrkST[1] = Space Do Delete(WrkST,1,1);
    Val(WrkST,Wrk,K); { cell ID number }
    WrkST:= Copy(ST,34,7);
    For K:= 1 to SpecNum Do With SrcSpec[K]^ Do
      If cel = Wrk Then Effic:= WrkST;
    End;
  Close(fe);
End;


Procedure Create_Water_Src;
{ pool water only - one source file }
Var  J,K,Ka : Integer;       WrkST : ST33;
Begin
 { look through cell region title for water depth }
  ST:= AllTxt[TxtStrt[5]]^;
  If Pos('16',ST) > 0 Then CH:= '1'   Else CH:= '2';
  K:= Pos('Water',ST);        J:= Pos('"',ST);
  ST:= 'sc1   '+Copy(ST,K,Succ(J-K))+'  (20 cm Layer;  1.0 uCi/L)';
  WrkST:= FileDrive + 'S-WATER.' + CH;
  TextAttr:= TblColor;    Writeln(' Creating source file for pool water: ',WrkST);
  TextAttr:= HdrColor;
  Assign(fo,WrkST);    Rewrite(fo);
  Writeln(fo,'nps    40000');
  Writeln(fo,'sdef   erg=0.662  cel=d1  x=fcel d2  y=fcel d3  z=fcel d4  wgt=7.87E+09');
  Writeln(fo,ST);        Ka:= Succ(TxtStrt[6]);
  For J:= Ka to (Ka+12) Do Writeln(fo,AllTxt[J]^);
  For K:= 1 to 3 Do Begin
    If K = 1 Then Ka:= 7   Else
    If K = 2 Then Ka:= 9   Else Ka:= 12;
    Ka:= TxtStrt[Ka];
    Writeln(fo,AllTxt[Ka]^);
    Write(fo,Copy(AllTxt[Succ(Ka)]^,1,10));
    For J:= 1 to 11 Do Write(fo,SrcSpec[J]^.Vx[K]:5); { fcel info }
    Writeln(fo);        Ka:= Pred(SrcSpec[1]^.six[K]);
    For J:= 1 to 2*Succ(SrcSpec[11]^.Vx[K] - SrcSpec[1]^.Vx[K]) Do
      Writeln(fo,AllTxt[Ka+J]^);
    End;
  Close(fo);
End;


Procedure Create_Src_Files(Strt:Byte);
{ Skips the sources before Strt and prints all the rest }
Var  Src,K,Ka : Integer;      WrkST : ST19;
Begin
  TextAttr:= TblColor;
  Writeln(' Creating other source files:');   TextAttr:= HdrColor;
  For Src:= Strt to SpecNum Do With SrcSpec[Src]^ Do Begin
    If Src < 36 { 1-11 are the pool, 12-35 are the walls, 36-SpecNum are the rest }
      Then Begin  K:= Succ(Src-Strt);    CH:= 'W';   End
      Else Begin  K:= Src-35;            CH:= 'O';   End;
    Str(K:2,ST);
    If ST[1] = Space Then ST[1]:= Zero;
    Fname:= 'S-' + CH + ST;
    ST:= FileDrive + Fname;     Write(ST:10);
    Assign(fo,ST);   Rewrite(fo);
    Writeln(fo,'nps    ',nps);
    Str(cel,WrkST);     ST:= 'sdef   erg=0.662  cel=' + WrkST + '  ';
    WrkST:= Sci2(wgt);  WrkST[1]:= '=';
    WrkST:= '  wgt' + WrkST;
    If Vx[4] = 0
    Then Begin  Ka:= 3;
      Writeln(fo,ST,'x=d',Vx[1],'  y=d',Vx[2],'  z=d',Vx[3],WrkST)
      End
    Else Begin  Ka:= 4;
      Writeln(fo,ST,'pos=d',Vx[1],' ext=d',Vx[2],' axs=d',Vx[3],' rad=d',Vx[4],WrkST);
      End;
    Writeln(fo,'sc',Vx[1],'    ',Title,'   (',ConcAmt,')');
    For K:= 1 to Ka Do Begin
      Writeln(fo,AllTxt[six[K]]^);
      If spx[K] > 0 Then Writeln(fo,AllTxt[spx[K]]^);
      End;
    Close(fo);
    End;
End;
```

```
Procedure QuickSort(L, R: Integer);
{ Uses the QuickSort algorithm to sort the records by cel ID number }
Var
  I, J : Integer;
  X, Y : Integer;
Function Less(a,b:Integer) : Boolean;
Begin
  If SrcSpec[a]^.cel = SrcSpec[b]^.cel
    Then Less:= SrcSpec[a]^.Title < SrcSpec[b]^.Title
    Else Less:= SrcSpec[a]^.cel < SrcSpec[b]^.cel
End;
Begin
  I:= L;
  J:= R;
  X:= SrcOrd[(L + R) div 2];
  Repeat
    While Less(SrcOrd[I],X) Do Inc(I);
    While Less(X,SrcOrd[J]) Do Dec(J);
    If I <= J Then Begin
      Y:= SrcOrd[I];
      SrcOrd[I]:= SrcOrd[J];
      SrcOrd[J]:= Y;
      Inc(I);
      Dec(J);
      End;
  Until I > J;
  If L < J Then QuickSort(L, J);
  If I < R Then QuickSort(I, R);
End;


Procedure Write_Sorted;
Var  Src : Integer;
Begin
  QuickSort(1,SpecNum);
  Assign(fo,FileDrive+LstFile);   Rewrite(fo);
  Writeln(fo,'Sorted list of Sources in KE-Basin');
  Writeln(fo);
  For Src:= 1 to SpecNum Do With SrcSpec[SrcOrd[Src]]^ Do
    Writeln(fo,cel:4,Space,Effic,'  ',Title);
  Writeln(fo);
  Writeln(fo,'List of Sources by File Name');
  Writeln(fo);
  For Src:= 1 to SpecNum Do With SrcSpec[Src]^ Do Begin
    ST:= '  ' + Fname + '  ' + ConcAmt + '          ';
    ST[0]:= #23;
    Writeln(fo,Src:3,ST,Title);
    End;
  Close(fo);
End;


Begin
  Initialize;
  While not Eof(fi) Do Read_Parts;
  Check_Memory;
  Dump_MCNP_Geom;
  Dump_MCNP_NrPt;
  Get_Source_Specs;
  Dump_MCNP_Srcs;
  Read_MCNP_Eff;
  Check_Memory;
  Create_Water_Src;     { pool water only - one source file }
  Create_Src_Files(12); { all other sources - beginning with source no. 12 }
  Write_Sorted;
End.
```

MK-NEAR.BAT to Generate MCNP Input for Near Source Points

```
@Echo Off
:  creates near source input files
D:
CD \
MD T

:  pool water source
Copy Geoml.L2+Pt-NEAR+S-WATER \T\HW00

:  pool wall sources
For %%f in (1 2 3 4 5 6 7 8 9) Do Copy Geoml.L2+Pt-NEAR+S-W0%%f \T\HW0%%f
For %%f in (0 1 2 3 4 5 6 7 8 9) Do Copy Geoml.L2+Pt-NEAR+S-W1%%f \T\HW1%%f
For %%f in (0 1 2 3 4) Do Copy Geoml.L2+Pt-NEAR+S-W2%%f \T\HW2%%f
:  remove the trailing garbage
For %%f in (0 1 2 3 4 5 6 7 8 9) Do Trim \T\HW0%%f
For %%f in (0 1 2 3 4 5 6 7 8 9) Do Trim \T\HW1%%f
For %%f in (0 1 2 3 4) Do Trim \T\HW2%%f
Move \T\*. C:\MCNP\NEAR

:  sources using the entire grid - no lattices
For %%f in (1 2 3 4 5 6 7 9) Do Copy Geoml.X+Pt-NEAR+S-00%%f \T\H00%%f
For %%f in (0 1 2 3 4 5 6 8 9) Do Copy Geoml.X+Pt-NEAR+S-01%%f \T\H01%%f
For %%f in (0 1 3 4 5 6 7 8 9) Do Copy Geoml.X+Pt-NEAR+S-02%%f \T\H02%%f
For %%f in (0 1 2 3 7 8 9) Do Copy Geoml.X+Pt-NEAR+S-03%%f \T\H03%%f
:  remove the trailing garbage
For %%f in (1 2 3 4 5 6 7 9) Do Trim \T\H00%%f
For %%f in (0 1 2 3 4 5 6 8 9) Do Trim \T\H01%%f
For %%f in (0 1 3 4 5 6 7 8 9) Do Trim \T\H02%%f
For %%f in (0 1 2 3 7 8 9) Do Trim \T\H03%%f
Move \T\*. C:\MCNP\NEAR

:  sources using the entire grid - no lattices
For %%f in (0 1 2 3 4 8 9) Do Copy Geoml.X+Pt-NEAR+S-04%%f \T\H04%%f
For %%f in (0 1 2 3 5 6) Do Copy Geoml.X+Pt-NEAR+S-05%%f \T\H05%%f
For %%f in (5 6 7 9) Do Copy Geoml.X+Pt-NEAR+S-06%%f \T\H06%%f
For %%f in (0 1 2 3 4 5 6 7) Do Copy Geoml.X+Pt-NEAR+S-07%%f \T\H07%%f
:  remove the trailing garbage
For %%f in (0 1 2 3 4 8 9) Do Trim \T\H04%%f
For %%f in (0 1 2 3 5 6) Do Trim \T\H05%%f
For %%f in (5 6 7 9) Do Trim \T\H06%%f
For %%f in (0 1 2 3 4 5 6 7) Do Trim \T\H07%%f
Move \T\*. C:\MCNP\NEAR

:  sources using the entire grid - floor lattices
For %%f in (008 017 022 034 035 036) Do Copy Geoml.L2+Pt-NEAR+S-%%f \T\H%%f
For %%f in (045 046 047 054 057 058) Do Copy Geoml.L2+Pt-NEAR+S-%%f \T\H%%f
For %%f in (059 060 061 062 063 064 068) Do Copy Geoml.L2+Pt-NEAR+S-%%f
\T\H%%f
:  remove the trailing garbage
For %%f in (008 017 022 034 035 036) Do Trim \T\H%%f
For %%f in (045 046 047 054 057 058) Do Trim \T\H%%f
For %%f in (059 060 061 062 063 064 068) Do Trim \T\H%%f
Move \T\*. C:\MCNP\NEAR
```

UNIX Script File to Run MCNP Cases

```
#    USER=w67656
#    @$-r mcnp-hl
#    @$-e zerr.hl
#    @$-o zout.hl
#    @$-lT 3000:00
#    @$-lt 3000:00
#    @$-me
#    @$
 cd /t/‘hostname‘              # Change to the /t space on the machine
 mkdir pdrl                    # Create directory to run in
 cd pdrl                       # Change to the directory you created
 pwd

rm h001.t h001.sum             # Remove old files if they exist
rcp erpag2:/home/w67656/k-pool/h001 .
/apps/mcnp/mcnph inp=h001 outp=h001.t
rm runtpe
mv mctal h001.sum
rcp h001.t erpag2:/home/w67656/k-pool/h001.t
rcp h001.sum erpag2:/home/w67656/k-pool/h001.sum

rm h002.t h002.sum             # Remove old files if they exist
rcp erpag2:/home/w67656/k-pool/h002 .
/apps/mcnp/mcnph inp=h002 outp=h002.t
rm runtpe
mv mctal h002.sum
rcp h002.t erpag2:/home/w67656/k-pool/h002.t
rcp h002.sum erpag2:/home/w67656/k-pool/h002.sum

rm h003.t h003.sum             # Remove old files if they exist
rcp erpag2:/home/w67656/k-pool/h003 .
/apps/mcnp/mcnph inp=h003 outp=h003.t
rm runtpe
mv mctal h003.sum
rcp h003.t erpag2:/home/w67656/k-pool/h003.t
rcp h003.sum erpag2:/home/w67656/k-pool/h003.sum

rm h004.t h004.sum             # Remove old files if they exist
rcp erpag2:/home/w67656/k-pool/h004 .
/apps/mcnp/mcnph inp=h004 outp=h004.t
rm runtpe
mv mctal h004.sum
rcp h004.t erpag2:/home/w67656/k-pool/h004.t
rcp h004.sum erpag2:/home/w67656/k-pool/h004.sum

.
.
.

etc.
```

Appendix F. Post-processing of MCNP Output

MCTAL Summary File for the PVC Hot Spot Source (H071.SUM)

```
mcnph      4a     04/10/97 10:19:50    2        100           752
 KE Basin Geometry -- Water Level is 16'10" -- No Lattices
ntal     1
    5
tally    5    2
      Dose Points Near Sources
f        73
d        2
u        0
s        0
m        0
c        0
e        0
t        0
vals
  1.63276E-01 0.0302  1.14218E-01 0.0370  1.24526E-01 0.0363  8.21117E-02 0.0476
  1.64786E-01 0.0301  1.15420E-01 0.0370  1.84322E-01 0.0135  1.30821E-01 0.0202
  7.64363E-18 0.0596  4.02246E-21 0.0652  1.44501E+01 0.0016  1.39102E+01 0.0016
  4.99304E+00 0.0009  4.68056E+00 0.0009  3.27147E-01 0.0427  3.23790E-02 0.0597
  2.43358E-02 0.1238  1.43368E-03 0.1414  1.72811E+00 0.0006  1.54902E+00 0.0006
  4.52657E+01 0.0023  4.43008E+01 0.0023  4.30286E+01 0.0023  4.20881E+01 0.0023
  7.88742E-12 0.0139  1.83744E-14 0.0155  9.01865E-14 0.0146  1.25197E-16 0.0163
  4.97960E-07 0.0628  4.06648E-09 0.0700  9.64358E-15 0.0624  1.05157E-17 0.0681
  6.05282E-11 0.0584  1.77613E-13 0.0640  4.21358E-07 0.0542  3.36058E-09 0.0595
  3.09089E-03 0.0479  7.60395E-05 0.0546  7.35444E+00 0.0257  2.31378E+00 0.0489
  1.14260E-01 0.0368  7.25491E-02 0.0530  1.14324E-01 0.0368  7.25953E-02 0.0530
  3.82323E-07 0.0522  3.41925E-08 0.0547  2.29603E+00 0.0006  2.08786E+00 0.0007
  2.35773E+00 0.0006  2.14663E+00 0.0007  4.46943E+01 0.0023  4.37356E+01 0.0023
  4.36342E+01 0.0024  4.26871E+01 0.0025  3.34806E+01 0.0023  3.26525E+01 0.0024
  1.85717E+01 0.0017  1.79580E+01 0.0017  1.99022E+01 0.0017  1.92664E+01 0.0018
  2.10093E+01 0.0080  2.02398E+01 0.0120  1.44047E+01 0.0015  1.38657E+01 0.0015
  1.09018E+01 0.0013  1.04344E+01 0.0013  1.16276E+01 0.0013  1.11445E+01 0.0014
  2.20447E-04 0.0433  4.39955E-06 0.0487  2.10466E+00 0.0009  4.79548E-01 0.0009
  1.93531E+00 0.0009  4.40914E-01 0.0009  2.37355E+00 0.0062  4.09234E-01 0.0078
  7.70084E+00 0.0047  1.81705E+00 0.0056  1.15017E+01 0.0027  2.22949E+00 0.0032
  4.34304E+01 0.0024  4.24855E+01 0.0025  4.49600E+01 0.0025  4.39984E+01 0.0025
  1.51123E+00 0.0005  1.34448E+00 0.0005  4.32762E-01 0.0003  3.48519E-01 0.0003
  1.98915E-01 0.0312  1.43469E-01 0.0380  1.09945E-01 0.0515  5.38572E-02 0.1074
  9.23046E-02 0.0505  4.47767E-02 0.1040  8.12652E-02 0.0529  3.53493E-02 0.1194
  1.13218E-01 0.0457  6.77231E-02 0.0714  1.08961E-01 0.0465  6.47709E-02 0.0730
  1.05417E-01 0.0471  6.24378E-02 0.0738  1.09240E-01 0.0464  6.49501E-02 0.0729
  3.89320E-02 0.0496  7.44772E-03 0.0589  8.45244E-03 0.0524  8.26026E-04 0.0590
  2.66614E-02 0.0753  4.64316E-03 0.0985  1.02891E-01 0.0449  5.96415E-02 0.0745
  1.09713E-01 0.0520  5.76619E-02 0.0986  1.16962E-01 0.0487  6.41877E-02 0.0894
  2.05847E-01 0.0002  1.50797E-01 0.0003  2.06127E-01 0.0002  1.51032E-01 0.0003
  2.85914E+00 0.0007  2.62552E+00 0.0008  6.76721E-01 0.0004  5.68757E-01 0.0004
  2.55472E-01 0.0225  1.91262E-01 0.0281  1.02628E+01 0.0013  9.80968E+00 0.0013
  9.82197E+00 0.0013  9.37893E+00 0.0013  1.21023E+01 0.0013  1.16091E+01 0.0014
  2.10616E+02 0.0050  2.08521E+02 0.0050  2.38632E+03 0.0221  2.37928E+03 0.0221
  1.47202E+04 0.0414  1.47030E+04 0.0414  3.70573E+03 0.0210  3.69695E+03 0.0210
  1.64744E+03 0.0140  1.64157E+03 0.0140  9.62653E+01 0.0037  9.48527E+01 0.0038
  2.43579E+00 0.0006  2.22104E+00 0.0006
tfc    1       1       1       1       1       1       1       1       1
       100  1.63276E-01  3.02022E-02  7.93453E+03
```

ALLTBL.PAS Summary File for the PVC Hot Spot Source (H071.TBL)

KE Basin Geometry -- Water Level is 16'10" -- No Lattices
Dose Points Near Sources
PVC Hot Spot (1.0 Ci)
04/10/97 Source Points: 100

X	Y	Z	Dose Rate	RelErr %	Comment
271.78	5778.50	60.96	1.633E-01	3.020E+00	Over Elevator Pit NW
332.74	6242.05	60.96	1.245E-01	3.630E+00	Over Elevator Pit E
439.42	5778.50	60.96	1.648E-01	3.010E+00	Over Elevator Pit SW
902.97	5728.97	40.64	1.843E-01	1.350E+00	Pump #2 Pedestal
1137.92	797.55	129.54	7.644E-18	5.960E+00	IXM #1 (G10) Chest
1137.92	1272.52	129.54	1.445E+01	1.600E-01	IXM #2 (K10) Chest

1498.76	1164.59	139.70	4.993E+00	9.000E-02	Drip Pan - Pit End
1498.76	951.23	139.70	3.271E-01	4.270E+00	Drip Pan - Middle
1498.76	676.91	139.70	2.434E-02	1.238E+01	Drip Pan - Door End
850.90	2978.15	15.24	1.728E+00	6.000E-02	Sampler at Col 10.9C
741.68	1543.05	15.24	4.527E+01	2.300E-01	PVC in N Loadout
741.68	1573.53	2.54	4.303E+01	2.300E-01	PVC in N Loadout - E
167.01	1385.57	121.92	7.887E-12	1.390E+00	SF North Wall
167.01	1210.31	121.92	9.019E-14	1.460E+00	SF Northwest Corner
342.27	1210.31	121.92	4.980E-07	6.280E+00	SF West Wall
681.99	854.71	106.68	9.644E-15	6.240E+00	Pipe Along IX Box - #3
681.99	923.29	106.68	6.053E-11	5.840E+00	Pipe Along IX Box
681.99	991.87	106.68	4.214E-07	5.420E+00	Pipe Along IX Box - #2
681.99	1060.45	106.68	3.091E-03	4.790E+00	Pipe Along IX Box
681.99	1129.03	106.68	7.354E+00	2.570E+00	Pipe Along IX Box - #1
586.74	6396.99	91.44	1.143E-01	3.680E+00	Between HX/Chiller - N
1010.92	6396.99	91.44	1.143E-01	3.680E+00	Between HX/Chiller - S
842.01	6553.20	91.44	3.823E-07	5.220E+00	E Side HX
45.72	684.53	68.58	2.296E+00	6.000E-02	NW Filter Media
71.12	684.53	68.58	2.358E+00	6.000E-02	NW Filter Media at 1ft
723.90	1560.83	15.24	4.469E+01	2.300E-01	N Loadout Entry - Pit
723.90	1665.61	15.24	4.363E+01	2.400E-01	N Loadout Entry
723.90	1770.38	15.24	3.348E+01	2.300E-01	N Loadout Entry - Pool
431.17	1705.61	104.14	1.857E+01	1.700E-01	SF Pipes, lower E
431.17	1690.37	134.62	1.990E+01	1.700E-01	SF Pipes, upper E
446.41	1545.59	119.38	2.101E+01	8.000E-01	SF Pipes, lower W
424.18	1766.57	27.94	1.440E+01	1.500E-01	Beam at Col 13B
1308.10	1816.10	121.92	1.090E+01	1.300E-01	Column 13D
1308.10	1816.10	213.36	1.163E+01	1.300E-01	Col 13D - Above Head
1513.84	1720.85	283.21	2.204E-04	4.330E+00	9.5' W Ovrhd - SE
1605.28	1644.65	283.21	2.105E+00	9.000E-02	9.5' W Ovrhd - SE
1605.28	1469.39	106.68	1.935E+00	9.000E-02	S Loadout Riser
571.50	1235.71	106.68	2.374E+00	6.200E-01	Pipe Along N Load, W
571.50	1408.43	106.68	7.701E+00	4.700E-01	Pipe Along N Load, Mid
571.50	1581.15	106.68	1.150E+01	2.700E-01	Elbow - N Loadout - N
586.74	1596.39	106.68	4.343E+01	2.400E-01	Elbow - N Load - Outer
586.74	1565.91	119.38	4.496E+01	2.500E-01	Elbow - N Load - Inner
2075.18	2382.52	91.44	1.511E+00	5.000E-02	S Wall Col 12.2
2075.18	4060.19	91.44	4.328E-01	3.000E-02	S Wall Col 9.5
2075.18	5203.19	91.44	1.989E-01	3.120E+00	S Wall Col 7.7
1546.86	5647.69	304.80	1.099E-01	5.150E+00	E 10' NS Middle
857.25	6125.21	304.80	9.230E-02	5.050E+00	E 10' NS N Piece
1336.04	6140.45	365.76	8.127E-02	5.290E+00	E 10' NS S Piece @ 2'
1567.18	6079.49	152.40	1.132E-01	4.570E+00	View Pit Riser #1
1567.18	6140.45	152.40	1.090E-01	4.650E+00	View Pit Riser #2
1567.18	6201.41	152.40	1.054E-01	4.710E+00	View Pit Riser #3
1536.70	6140.45	152.40	1.092E-01	4.640E+00	View Pit Risers - 1 ft
1308.10	6163.31	121.92	3.893E-02	4.960E+00	Bypass Loop - Inner
1308.10	6201.41	121.92	8.452E-03	5.240E+00	Bypass Loop - East
1308.10	6163.31	289.56	2.666E-02	7.530E+00	Bypass Loop - Above
1069.34	6320.79	182.88	1.029E-01	4.490E+00	Valve - S End Chiller
769.62	5835.65	283.21	1.097E-01	5.200E+00	Pump Overhead
647.70	5835.65	252.73	1.170E-01	4.870E+00	Pump #1 Riser
647.70	5571.49	27.94	2.058E-01	2.000E-02	Pump #1 Knee
891.54	5571.49	27.94	2.061E-01	2.000E-02	Pump #2 Knee
81.28	2391.41	91.44	2.859E+00	7.000E-02	N Wall Valve at Col 12
81.28	3694.43	91.44	6.767E-01	4.000E-02	N Wall Valve at Col 10
81.28	4989.83	91.44	2.555E-01	2.250E+00	N Wall Valve at Col 8
342.27	1831.34	27.94	1.026E+01	1.300E-01	SF Pump Knee
342.27	1846.58	12.70	9.822E+00	1.300E-01	SF Pump Knee
342.27	1637.03	27.94	1.210E+01	1.300E-01	SF Pump
812.80	1565.91	152.40	2.106E+02	5.000E-01	PVC Pipe Riser - NL
812.80	1565.91	274.32	2.386E+03	2.210E+00	PVC Pipe - W Elbow
812.80	1604.01	259.08	1.472E+04	4.140E+00	PVC Hot Spot - Contact
812.80	1604.01	243.84	3.706E+03	2.100E+00	PVC Hot Spot - 6 in
812.80	1604.01	228.60	1.647E+03	1.400E+00	PVC Hot Spot - 1 ft
995.68	1611.63	320.04	9.627E+01	3.700E-01	PVC Pipe - 6 ft
1991.36	1611.63	320.04	2.436E+00	6.000E-02	PVC Pipe - S Elbow

ALLTBL.PAS Software Listing

```
Program Convert_MCTAL;
{ Author:   Paul D. Rittmann, PhD CHP
  Purpose:  Reads all the MCNPH input files and MCTAL summary files, then
            arranges the MCNPH output into a usable table, and writes a
            binary files with the source information and detector points.
            Also produces text files for spreadsheet input, and various
            text files (geometry, detector point titles, source titles).
  Input:    The MCNPH input files in the user input subdirectory.
}

Uses  Crt, DOS;

Const  Space = ' ';   Zero = '0';   Bslash = '\';
  Ntop = 40;    { number of highest DR indices }
  PtMax = 90;   { number of near source dose rate points }
  SrcMax = 200; { number of distinct radiation sources }
 { These are the filename extensions.  The file names used for the summaries
   is the same as the subdirectory name. }
  SrcFile = '-S.BIN';   SsFile = '.SS';    PtFile = '-P.BIN';
  FileG = '.G';    FileP = '.P';    FileS = '.S';    FileD = '.D';
  MCTALext = '.SUM';  { extension characteristic of MCTAL summary files }
  IntChar : Array[0..15] of Char = '0123456789ABCDEF';

Type
  Str79 = String[79];
  Str19 = String[19];
  Str15 = String[15];
  PtPtr = ^PtDataType;
  PtDataType = Record  { 100 bytes }
    DeTitle : Str79;  { location description }
    QA,Totl,          { measured readings (mR/h) and computed sum (mrem/h) }
    X,Y,Z   : Single; { X,Y,Z coordinates }
    End;
  DRarray = Array[1..PtMax] of Single; { 360 bytes }
  SrcPtr = ^SrcDataType;
  SrcDataType = Record { 160+32+720+80+8 = 1000 bytes }
    SrcID,               { title of source }
    GeomSt  : Str79;     { title of geometry file }
    FileID,              { which input file }
    Units   : Str15;     { original amount units }
    NearDR,              { near source dose rates for Amt=1 }
    RelErr  : DRarray;   { relative error in NearDR }
    TopN    : Array[1..Ntop] of Integer; { indices to highest NearDR values }
    nps     : LongInt;   { number of source particles used }
    Conc    : Single;    { original concentration used in the MCNP run }
    End;

Var
  MCfile  : Array[1..200] of Str19;  { names of MCNPH input file (XXX), and
                                       MCTAL summary file (XXX.SUM)   }
  SubDir,          { subdirectory with input & summary files }
  OutFile,         { used for output summary file names }
  InFile,          { MCNPH input file }
  SumFile : Str15; { MCTAL file }
  Title1,Title2,Title3, { geometry, dose points and source title lines }
  RunInfo : Str79;
  HtStr   : String[5];
  fg,fp,fs,fd,
  fi,fsum : Text;
  Nsrc,       { number of sources = number of input files }
  Src,Pt,
  Npts,
  Ks,Ns   : Integer;
  Xg,Yg,           { coordinates of detector point }
  PtData  : Array[1..Ptmax] of PtPtr;
  SrcData : Array[1..SrcMax] of SrcPtr;
  First   : Boolean;
  SScol   : Array[1..PtMax] of String[2];
  LineStr : String[89];


Function Sci3( r:Single )  : Str79;
{ Returns an 11 character string with r in the format '  1.234E+04'  }
Var  ST : String[12];
Begin
  Str(r:12,ST);
```

```
  Delete(ST,9,2);
  Sci3:= '  ' + ST;
End;

Function Sci4( r:Single )  : Str79;
{ Returns an 11 character string with r in the format ' 1.2345E+04'  }
Var  ST : String[13];
Begin
  Str(r:13,ST);
  Delete(ST,10,2);
  Sci4:= ' ' + ST;
End;

Procedure Show_How(Msg : String);
Begin
  If Msg[0] > #0 Then Begin  { error message first }
    TextAttr:= LightMagenta;    Writeln;
    Writeln(Msg);
    End;
  TextAttr:= White;          Writeln;
  Write('ALLTBL.EXE');       TextAttr:= LightCyan;
  Writeln(' - Converts all MCNP input and MCTAL summaries into readable tables.');
  Writeln('              by Paul D. Rittmann, PhD CHP         13-Feb-97');
  TextAttr:= LightGreen;     Writeln;
  Writeln('Execution requires both a subdirectory name and the first characters');
  Writeln('   of the input file names on the command line.  Other characters are');
  Writeln('   assumed to be sequential numbers.');
  Writeln('For example,  ALLTBL  NEAR  H  HW   will look for H000 H001 etc. and');
  Writeln('   HW00 HW01 etc. in the NEAR subdirectory.');
  TextAttr:= Lightcyan;      Writeln;
  Writeln('The dose rate summary tables are written to the .TBL files.');
  Writeln('Titles used in each MCNPH run are listed in ',FileG,', ',FileP,', and ',FileS,'.');
  Writeln('Binary files have source (',SrcFile,') and detector (',PtFile,') information.');
  Halt;
End;

Procedure Make_Input_File_List(Fstr:String);
{ Looks for input files 4 characters long which begin with Fstr. }
Var  WrkName : Str19;        fx : Text;
     N,Lng,MaxNum,GrpCount : Integer;
Begin
  Lng:= Length(Fstr);        Writeln;
  For N:= 1 to Lng Do Fstr[N]:= UpCase(Fstr[N]);
  Fstr:= Fstr + '000';       Fstr[0]:= #4;
  If Lng = 1 Then MaxNum:= 999   Else MaxNum:= 99;
  GrpCount:= 0;
  Repeat
    Fstr[4]:= IntChar[GrpCount mod 10];
    If GrpCount > 9  Then Fstr[3]:= IntChar[(GrpCount div 10) mod 10];
    If GrpCount > 99 Then Fstr[2]:= IntChar[GrpCount div 100];
    InFile:= SubDir + Fstr;
    Assign(fx,InFile);       {$I-}  Reset(fx);  {$I+}
    If IOResult = 0
      Then Begin  Close(fx);
        Inc(Nsrc);           MCfile[Nsrc]:= Fstr;
        WrkName:= InFile + MCTALext;
        Assign(fx,WrkName);  {$I-}  Reset(fx);  {$I+}
        If IOResult > 0 Then
          Show_How('Oops!  The file '+WrkName+' could not be located!');
        Close(fx);
        End
      Else Begin
        If GrpCount > 0 Then Exit;
        End;
    Write(Fstr,'    ');
    Inc(GrpCount);
  Until GrpCount = MaxNum;
End;

Procedure Initialize;
Var    L,K : Integer;
Begin
  TextAttr:= White;        ClrScr;       Writeln;
  Writeln('ALLTBL by Paul D. Rittmann, PhD CHP');    Writeln;
 { read the command line subdirectory name }
  SubDir:= ParamStr(1);      L:= Length(SubDir);
  For K:= 1 to L Do SubDir[K]:= UpCase(SubDir[K]);
  If SubDir[L] <> Bslash Then SubDir:= SubDir + Bslash;
```

```
   TextAttr:= Yellow;         Writeln('Using ',SubDir);
   OutFile:= Copy(SubDir,1,Pred(Length(SubDir)));
   For K:= 1 to 89 Do LineStr[K]:= #196;
  { prepare the list of input files to process }
   Nsrc:= 0;                  TextAttr:= LightCyan;
   For K:= 2 to ParamCount Do Make_Input_File_List(ParamStr(K));
   Writeln;
   TextAttr:= Yellow;         Writeln('FileCount: ',Nsrc);
   Writeln;
  { open text summary files }
   Assign(fg,OutFile+FileG);  Rewrite(fg); { geometry titles }
   Writeln(fg,'Titles of the Geometries');           Writeln(fg);
   Writeln(fg);
   Writeln(fg,'  #  File   Title of Geometry Block');
   LineStr[0]:= #72;    Writeln(fg,LineStr);
   Assign(fp,OutFile+FileP);  Rewrite(fp); { detector point titles }
   Writeln(fp,'Titles of the Detector Points');      Writeln(fp);
   Writeln(fp);
   Writeln(fp,'  #  File   Title of Detector Block');
   Writeln(fp,LineStr);
   Assign(fs,OutFile+FileS);  Rewrite(fs); { source ID titles }
   Writeln(fs,'Titles of the Radiation Sources');    Writeln(fs);
   Writeln(fs);
   Writeln(fs,'  #  File    nps   Orig Conc   Source Location');
   Writeln(fs,LineStr);
  { create the spreadsheet column ID letters }
   For K:= 1 to PtMax Do Begin
     SScol[K]:= '  ';
     SScol[K][2]:= Chr(65+(Pred(K) mod 26));
     If K > 26 Then SScol[K][1]:= Chr(64+(Pred(K) div 26));
     End;
   SScol[PtMax]:= '  ';
 End;

 Procedure Read_MCNPH_Values;
 { Reads the two input files and matches them. }
 Var  I,J,a,Err : Integer;        Zcoord : Single;
      ReadSum,More : Boolean;
      LineI,LineS  : String;
 Procedure Write_Source_Item(Var f : Text);
 { Writes one line (LineI) to the specified text file }
 Begin
   Writeln(f,Src:3,'  ',MCfile[Src],'  ',LineI);
 End;
 Procedure Show_Titles(Hdr:Str79);
 { Displays title lines in LineI and LineS on the screen }
 Var  Lng : Integer;
 Begin
   While LineI[1] = Space Do Delete(LineI,1,1);
   While LineS[1] = Space Do Delete(LineS,1,1);
   Lng:= Length(LineS);   While LineS[Lng] = Space Do Dec(Lng);
   LineS[0]:= Chr(Lng);
   If LineI <> LineS Then Begin   TextAttr:= LightMagenta;
     Writeln;    Write(' ***>>> ',Hdr,' Don''t Match!!!');
     End;
 End;
 Procedure Get_Coord(Var Strt:Integer; Var NewVal:Single;  Msg:Str79);
 { Reads a real number in LineI beginning at Strt.  If the string to real con-
   version is valid then NewVal is the number, and Strt is at the first blank.
   Otherwise, Show_How is called with the Msg string.  }
 Var   Fini : Integer;
 Begin
   While LineI[Strt] = Space Do Inc(Strt);    { start of X-coordinate }
   Fini:= Succ(Strt);
   While LineI[Fini] <> Space Do Inc(Fini);   { end of number }
   Val(Copy(LineI,Strt,Fini-Strt),NewVal,Err);
   If Err > 0 then Show_How('Invalid '+Msg+': '+Copy(LineI,Strt,Fini-Strt));
   Strt:= Fini;
 End;
 Procedure Get_The_Info(Indx:Integer);
 { Reads a single dose rate and relative error from the MCTAL file }
 Var  Tmp : Single;    Found : Boolean;    Ka,Kb : Integer;
 Begin
   With PtData[Indx]^ Do Begin
    { read the MCNPH dose rate at this point }
     If ReadSum Then Begin Readln(fsum,LineS);  a:= 3;  End
                Else a:= 43;
    ReadSum:= not ReadSum;
```

```
    Val(Copy(LineS,a,11),Tmp,Err);
    If Err > 0 Then Show_How('Invalid MCNPH Dose Rate: '+Copy(LineS,a,11));
    With SrcData[Src]^ Do Begin
      NearDR[Indx]:= Tmp;      { add dose rate to SrcData record }
     { insert in the TopN sorting array }
      Ka:= 0;
      Repeat   Inc(Ka);
        Found:= (Tmp > NearDR[TopN[Ka]]);
      Until Found or (Ka = Ntop);
      If Found Then Begin
        For Kb:= Ntop downto Succ(Ka) Do TopN[Kb]:= TopN[Pred(Kb)];
        TopN[Ka]:= Indx;
        End;
      End;
   { read the MCNPH relative error }   a:= a + 13;
    Val(Zero+Copy(LineS,a,5),Tmp,Err);
    If Err > 0 Then Show_How('Invalid MCNPH Relative Error: '+Copy(LineS,a,5));
    SrcData[Src]^.RelErr[Indx]:= 100.0*Tmp;
    End;
End;
Procedure Get_nps;
Var  K : Integer;
Begin
  Delete(LineI,1,5);
  RunInfo:= RunInfo + '     Source Points: ' + LineI;
  While LineI[1] = Space Do Delete(LineI,1,1); { remove leading blanks }
  K:= Length(LineI);          While LineI[K] = Space Do Dec(K);
  LineI[0]:= Chr(K);          Val(LineI,SrcData[Src]^.nps,K);
End;
Procedure First_File;
{ Initializes the PtData array using the first input file }
Var  N : Integer;
Begin
  N:= 0;                      First:= false;
  Repeat   { loop over dose points in the input file }
    Readln(fi,LineI);   More:= Copy(LineI,1,5) = '     ';
    If Copy(LineI,1,4) = 'f5:p' Then More:= true;
    If More Then Begin
      Inc(N);   New(PtData[N]);
      With PtData[N]^ Do Begin
        FillChar(DeTitle,SizeOf(DeTitle),Space);
        QA:= 0;  Totl:= 0;  X:= 0;  Y:= 0;  Z:= 0;
       { store the title of this detector point }
        I:= Pos('$',LineI);  Inc(I);  While LineI[I] = Space Do Inc(I);
        J:= Length(LineI);            While LineI[J] = Space Do Dec(J);
        DeTitle:= Copy(LineI,I,Succ(J-I));
       { find the measured dose rate at this point, mR/h }
        J:= Length(DeTitle);
        While DeTitle[J] <> Space Do Dec(J);
        Val(Copy(DeTitle,Succ(J),4),QA,Err);
        If Err > 0 then Show_How('Invalid measured DR: '+DeTitle);
        While DeTitle[J] = Space Do Dec(J);
        DeTitle[0]:= Chr(J);
       { find the coordinates of this detector point }
        I:= 6;
        Get_Coord(I,X,'X-coordinate');
        Get_Coord(I,Y,'Y-coordinate');
        Get_Coord(I,Z,'Z-coordinate');
        End;
      Get_The_Info(N);
      End;
  Until not More;
  Npts:= N;
 { read the number of points }
  If Copy(LineI,1,3) = 'nps' Then Get_nps;
End;
Procedure Later_Files;
Var  N : Integer;
Begin
  For N:= 1 to Npts Do Get_The_Info(N);
 { read the number of points }
  Repeat    Readln(fi,LineI);
  Until Copy(LineI,1,3) = 'nps';
  Get_nps;
End;
Begin  { Read_MCNPH_Values }
  InFile:= SubDir + MCfile[Src];   Assign(fi,InFile);     Reset(fi);
  SumFile:= InFile + MCTALext;     Assign(fsum,SumFile);  Reset(fsum);
```

```
  New(SrcData[Src]);
  With SrcData[Src]^ Do Begin
    FillChar(SrcID, SizeOf(SrcID), Space);
    FillChar(GeomSt,SizeOf(GeomSt),Space);
    FillChar(FileID,SizeOf(FileID),Space);       FileID:= MCfile[Src];
    FillChar(Units, SizeOf(Units), Space);
    FillChar(NearDR,SizeOf(NearDR), 0);
    FillChar(RelErr,SizeOf(RelErr), 0);
    For I:= 1 to Ntop Do TopN[I]:= PtMax;
    Conc:= 0;       nps:= 0;
    End;
  TextAttr:= Yellow;    Write('Processing ',InFile,' and ',SumFile,'.  ');
 { read run title lines }
  Readln(fi,LineI);   { input file title }
  Readln(fsum,RunInfo);  Delete(RunInfo,1,18);   Delete(RunInfo,9,40);
  Readln(fsum,LineS);
  Show_Titles('Main Titles');                    Title1:= LineI;
  SrcData[Src]^.GeomSt:= Title1;                 Write_Source_Item(fg);
 { read detector title line }
  Repeat    Readln(fi,LineI);
  Until Copy(LineI,1,3) = 'fc5';
  Delete(LineI,1,5);
  For I:= 1 to 3 Do Readln(fsum);                Read(fsum,LineS);
  Show_Titles('Detector Titles');                Title2:= LineI;
 { read and store the MCNPH dose rates }         Write_Source_Item(fp);
  Repeat    Readln(fsum,LineS);
  Until Copy(LineS,1,4) = 'vals';
  ReadSum:= true;
  If First Then First_File
           Else Later_Files;
 { read the source comment line }
  Repeat    Readln(fi,LineI);
  Until Copy(LineI,1,2) = 'sc';
  Delete(LineI,1,5);
  While LineI[1] = Space Do Delete(LineI,1,1);
  J:= Length(LineI);   While LineI[J] = Space Do Dec(J);
 { locate the units for the original activity concentration }
  I:= Pred(J);          Title3:= LineI;
  If LineI[I] = '2' Then LineI[I]:= '²';
  While LineI[I] <> Space Do Dec(I);
  With SrcData[Src]^ Do Begin
    Units:= Copy(LineI,Succ(I),Pred(J-I));
    If Units[1] = 'u' Then Units[1]:= 'µ';
    End;
 { find the original amount of the activity concentration }
  Dec(I);   J:= I;
  While (LineI[J] <> '(') and (LineI[J] <> Space) Do Dec(J);
  Val(Copy(LineI,Succ(J),I-J),SrcData[Src]^.Conc,Err);
  If Err > 0 then Show_How('Invalid original conc: '+LineI);
  Dec(J);
  While LineI[J] = Space Do Dec(J);
  If LineI[J] = ';' Then LineI[J]:= ')';
  With SrcData[Src]^ Do Begin
    SrcID:= Copy(LineI,1,J);
    Str(nps:6,LineI);    Str(Conc:3:0,LineS);
    LineI:= LineI + LineS + Space + Units + '        ';   LineI[0]:= #19;
    LineI:= LineI + SrcID;
    End;
  Write_Source_Item(fs);
  Close(fi);    Close(fsum);
End;

Procedure Write_Table;
{ Creates and writes output tables. }
Var    J : Integer;      FileName : Str79;
Begin
 { open output files }
  FileName:= InFile + '.TBL';
  Assign(fi,FileName);   Rewrite(fi);
  TextAttr:= LightCyan;  Writeln('Writing ',FileName);
  Writeln(fi,Title1);    Writeln(fi,Title2);   Writeln(fi,Title3);
  Writeln(fi,RunInfo);   Writeln(fi);
  Writeln(fi,'     X        Y        Z      Dose Rate   RelErr %    Comment');
  Writeln(fi,' ──────────────────────────────────────────────────────────────');
  For J:= 1 to Npts Do With PtData[J]^ Do With SrcData[Src]^ Do
    Writeln(fi,X:9:2,Y:9:2,Z:9:2,Sci3(NearDR[J]),Sci3(RelErr[J]),'   ',DeTitle);
  Writeln(fi,' ──────────────────────────────────────────────────────────────');
  Close(fi);
```

```
End;

Procedure Dump_Extra_Files;
{ Creates the two binary files.  Additional text files are also output.
  Fpt has the detector information.  Fsrc has the source information.  }
Var  fpt : File of PtDataType;      K,R,Nt : Integer;
    fsrc : File of SrcDataType;     WrkSt : String;
Procedure Dump_Block(A,B:Integer);
Var  Ka,Kb : Integer;
Begin
  Writeln(fs);
  For Ka:= 1 to Src Do With SrcData[Ka]^ Do Begin
    Str(Ka:3,WrkSt);        WrkSt:= WrkSt + Space;
    For Kb:= A to B Do WrkSt:= WrkSt + Sci4(NearDR[Kb]);
    Writeln(fs,WrkSt);
    End;
End;
Begin
  LineStr[0]:= #72;
  Writeln(fg,LineStr);       Close(fg);
  Writeln(fp,LineStr);       Close(fp);
  Writeln(fs,LineStr);       Close(fs);
  TextAttr:= White;          Writeln;
  Writeln(Src,' radiation sources were used.  Source titles: ',
              OutFile+FileS,'   Data: ',OutFile+SrcFile);
  Assign(fsrc,OutFile+SrcFile);      Rewrite(fsrc);
  For R:= 1 to Nsrc Do Write(fsrc,SrcData[R]^);
  Close(fsrc);
  Writeln(Npts,' detector points were used.  Detector titles: ',
              OutFile+FileP,'   Data: ',OutFile+PtFile);
  Assign(fpt,OutFile+PtFile);     Rewrite(fpt );
  For R:= 1 to Npts Do Write(fpt,PtData[R]^);
  Close(fpt);
  TextAttr:= Yellow;
  Writeln('Generating a list of detectors: ',OutFile+FileD);
  Assign(fd,OutFile+FileD);  Rewrite(fd);
  Writeln(fd,'List of Detectors with Spreadsheet Column ID');
  Writeln(fd);               LineStr[0]:= #58;
  Writeln(fd,'Col  Xcoord  Ycoord  Zcoord  mR/h  Detector Location');
{            AA  1234.56 1234.56 1234.56   100  12345678901234567890123  }
  Writeln(fd,LineStr);       WrkSt:= '     ';
  For R:= 1 to Npts Do With PtData[R]^ Do
    Writeln(fd,SScol[R],X:9:2,Y:8:2,Z:8:2,QA:6:0,'  ',DeTitle);
  Writeln(fd,LineStr);       Close(fd);
  Writeln('Generating a list of useful spreadsheet information: ',SsFile);
  Assign(fs,OutFile+SsFile);        Rewrite(fs);
  Writeln(fs,'List of Dose Rates from Each Source');
  K:= -19;   R:= 0;
  Repeat
    Inc(K,20);    Inc(R,20);
    If R > Npts Then R:= Npts;
    Dump_Block(K,R);
  Until R = Npts;
  If Npts > 20 Then Nt:= 20    Else Nt:= Npts;
  Writeln(fs);               Writeln(fs);
  Writeln(fs,'List of Main Targets (highest ',Nt,') for Each Source');
  Writeln(fs);
  For R:= 1 to Nsrc Do With SrcData[R]^ Do Begin
    Str(R:3,WrkSt);          WrkSt:= WrkSt + Space;
    For K:= 1 to Nt Do WrkSt:= WrkSt+'  '+SScol[TopN[K]];
    Writeln(fs,WrkSt);
    End;
  Close(fs);
End;

Begin
  If ParamCount < 2  Then Show_How('');
  Initialize;
  First:= true;
  For Src:= 1 to Nsrc Do Begin
    Read_MCNPH_Values;
    Write_Table;
    End;
  Dump_Extra_Files;
End.
```

Appendix G. Program to Convert MCTAL Files for the Grid into Binary

```
Program Convert_MCTAL;
{ Author:   Paul D. Rittmann, PhD CHP
  Purpose:  Reads the MCNPH input file and MCTAL summary file and arranges
            the MCNPH output to match the standard grid.  Dose rates are
            stored in the binary file.  The first two records of the binary
            file contain the X and Y coordinates of the grid.
  Input:    MCNPH input file, MCTAL summary output file, binary file.
            Command line parameters are the names of the input files.
            There are 4 binary files, KNEE & CHST at 2 depths.
  Output:   Text file with MCNPH dose rates in the standard grid order (.2D),
            text file suitable for import into a spreadsheet (transposed),
            the updated binary file.
}

Uses  Crt, DOS;

Const  Space = ' ';   Zero = '0';   Colon = ':';   Bslash = '\';
  Xmax = 20;  { number of points in the NS direction }
  Ymax = 56;  { number of points in the EW direction }
  MCTALext = '.SUM';  { extension characteristic of MCTAL summary files }

Type
  StdGrid = Array[1..Xmax,1..Ymax] of Single; { 4480 bytes }
  Str79 = String[79];
  Str19 = String[19];
  Str15 = String[15];
  DRrec = Record    { 4576 bytes per record }
    Title : Str79;
    FileN : Str15;
    DR    : StdGrid;
    End;

Var
  MCfile  : Array[1..200] of Str19;  { names of MCNPH input file (XXX), and
                                       MCTAL summary file (XXX.SUM)   }
  MCshrt  : Array[1..200] of Str15;  { MCfile without path information }
  BinFile,         { name of binary file (KNEE1, KNEE2, CHST1, or CHST2) }
  Title1,Title2,Title3,
  RunInfo : Str79;
  HtStr   : String[5];
  FileCount,
  F       : Integer;
  fb      : File of DRrec;  { binary file }
  Xg,Yg,              { coordinates of detector point }
  DR,RE   : StdGrid; { Dose Rate and Relative Error from MCNPH }
  OneRec  : DRrec;
  Hdr1,Hdr2 : String;


Procedure Show_How(Msg : String);
Begin
  If Msg[0] > #0 Then Begin  { error message first }
    TextAttr:= LightMagenta;    Writeln;
    Writeln(Msg);
    End;
  TextAttr:= White;        Writeln;
  Write('BINCALI.EXE');       TextAttr:= LightCyan;
  Writeln(' - Converts one or more MCTAL output summary files.');
  Writeln('             by Paul D. Rittmann, PhD CHP    April 21, 1997');
  TextAttr:= LightGreen;   Writeln;
  Writeln('Command line should have the binary file name followed by one');
  Writeln('or more input file names.  If the number is omitted, then all');
  Writeln('input & MCTAL files with that name will be processed.');
  Writeln;
  Writeln('Binary files are either KNEEn or CHSTn, where n is the depth');
  Writeln('   of the water in the pool (1=16''10" and 2=17''2")');
  Writeln('Output files are .2D with standard grid, .2DO for spreadsheet');
  Writeln('   input (transposed), and an updated binary file.');
  Halt;
End;
```

```
Procedure Make_Input_File_List;
{ Reads the command line and prepares a list of file names to use }
Var  WrkName, GrpN : Str19;           MoreFiles : Boolean;
     N,K,Lng,GrpCount : Integer;
Procedure Verify_Files(Flg:Integer);
{ Looks for WrkName.  If WrkName and WrkName.SUM are found then
  FileCount is incremented and MCfile[FileCount]:= WrkName.
  Otherwise what happens depends on Flg.  If Flg=0 the program ends
  with an error message.  Otherwise MoreFiles is made false.  }
Var  fx : Text;
Begin
  Assign(fx,WrkName);     {$I-}  Reset(fx);  {$I+}
  If IOResult > 0 Then Begin
    If Flg = 0 Then Show_How('Oops!  The file '+WrkName+' could not be located!')
               Else Begin  MoreFiles:= false;   Exit    End
    End;
  Inc(FileCount);
  MCfile[FileCount]:= WrkName;
  Close(fx);
  WrkName:= WrkName + MCTALext;
  Assign(fx,WrkName);     {$I-}  Reset(fx);  {$I+}
  If IOResult > 0 Then Begin
    If Flg = 0 Then Show_How('Oops!  The file '+WrkName+' could not be located!')
               Else Begin  MoreFiles:= false;   Dec(FileCount);   Exit   End
    End;
  Close(fx);
 { store the simple file name without path information }
  Flg:= Lng;
  While (WrkName[Flg] <> Bslash) and (WrkName[Flg] <> Colon) and (Flg > 0) Do Dec(Flg);
  If Flg = 0 Then MCshrt[FileCount]:= MCfile[FileCount]
             Else MCshrt[FileCount]:= Copy(MCfile[FileCount],Succ(Flg),15);
End;
Begin
  BinFile:= ParamStr(1);
  For K:= 1 to Length(BinFile) Do BinFile[K]:= UpCase(BinFile[K]);
 { find binary file and read the X & Y coordinates }
  Assign(fb,BinFile);     {$I-} Reset(fb);  {$I+}
  If IOResult > 0 Then Begin
    K:= Pos('.',BinFile);
    If K = 0 Then BinFile:= BinFile + '.BIN'
             Else BinFile:= Copy(BinFile,1,K) + 'BIN';
    Assign(fb,BinFile);      {$I-} Reset(fb);  {$I+}
    If IOResult > 0 Then Begin
      Rewrite(fb);
      With OneRec Do Begin
        Title:= 'These are the X Coordinates for the data in this file.                     ';
        FileN:= 'X-COORD        ';
        FillChar(DR,SizeOf(StdGrid),0);
        End;
      Write(fb,OneRec);
      OneRec.Title:= 'These are the Y Coordinates for the data in this file.                     ';
      OneRec.FileN:= 'Y-COORD        ';
      Write(fb,OneRec);
      FillChar(Xg,SizeOf(StdGrid),0);
      FillChar(Yg,SizeOf(StdGrid),0);
      End
    Else Begin
      Read(fb,OneRec);   Xg:= OneRec.DR;
      Read(fb,OneRec);   Yg:= OneRec.DR;
      End;
    End
  Else Begin
    Read(fb,OneRec);   Xg:= OneRec.DR;
    Read(fb,OneRec);   Yg:= OneRec.DR;
    End;
```

```
 { assemble the list of input files }
  FileCount:= 0;
  For N:= 2 to ParamCount Do Begin
    WrkName:= ParamStr(N);       Lng:= Length(WrkName);
    For K:= 1 to Lng Do WrkName[K]:= UpCase(WrkName[K]);
    If WrkName[Lng] = '.' Then Begin
      Delete(WrkName,Lng,1);     Dec(Lng);
      End;
    K:= Pos(Bslash,WrkName);
    If (WrkName[Lng] < 'A') and ((Lng-K) > 2) Then Verify_Files(0)  { check one file }
      Else Begin         { loop until no more files }
        If WrkName[Succ(K)] = 'W' Then GrpCount:= -1
                                  Else GrpCount:= 0;
        MoreFiles:= true;
        While MoreFiles Do Begin
          Inc(GrpCount);      Str(GrpCount:2,GrpN);
          If GrpCount < 10 Then GrpN[1]:= '0';
          WrkName:= Copy(WrkName,1,Lng) + GrpN;
          Verify_Files(9);
          End;
        End;
    End;
  Writeln;
  TextAttr:= White;   Writeln('BINCALI will process the files listed below:');
  TextAttr:= Yellow;  Writeln('Binary File: ',BinFile);
  TextAttr:= LightCyan;
  For N:= 1 to FileCount Do Write(Copy(MCfile[N]+'                ',1,20));
  If WhereX > 61 Then Writeln;
  TextAttr:= Yellow;  Writeln('FileCount: ',FileCount);
  Writeln;
End;


Procedure Initialize;
Var  J : Integer;   WrkStr : Str19;
Begin
 { header line with spreadsheet column ID }
  Hdr1:= '    A';  WrkStr:= '     ';
  For J:= 2 to 26 Do Begin
    WrkStr[5]:= Chr(J+64);
    Hdr1:= Hdr1 + WrkStr;
    End;
  Hdr2:= '';
  For J:= 27 to Ymax Do Begin
    WrkStr[4]:= Chr((Pred(J) div 26)+64);
    WrkStr[5]:= Chr(Succ(Pred(J) mod 26)+64);
    Hdr2:= Hdr2 + WrkStr;
    End;
End;


Procedure Read_MCNPH_Values;
{ Reads the two input files and matches them. }
Var  I,J,Err,a,Xc,Yc : Integer;
     Xcoord,Ycoord,Zcoord : Single;
     ReadSum,NeedZ,More : Boolean;     fi,fs  : Text;
     LineI,LineS  : String;            Xs,Ys  : String[2];
Procedure Show_Titles(Hdr:Str79);
{ Displays title lines in LineI and LineS on the screen }
Var  Lng : Integer;
Begin
  TextAttr:= Yellow;    Writeln(Hdr,' from ',MCfile[F],' and ',MCTALext,':');
  TextAttr:= LightCyan;
  While LineI[1] = Space Do Delete(LineI,1,1);
  Writeln('input: ',LineI);
  While LineS[1] = Space Do Delete(LineS,1,1);
  Lng:= Length(LineS);   While LineS[Lng] = Space Do Dec(Lng);
  LineS[0]:= Chr(Lng);   Writeln('mctal: ',LineS);
  Writeln;
End;
```

```
Procedure Get_Coord(Var Strt:Integer; Var NewVal,OldVal:Single;  Msg:Str79);
{ Reads a real number in LineI beginning at Strt.  If the string to real con-
  version is valid then NewVal is the number, and Strt is at the first blank.
  Otherwise, Show_How is called with the Msg string.  If OldVal is greater than
  zero the values are compared and differences reported.  OldVal:= NewVal    }
Var   Fini : Integer;
Begin
  While LineI[Strt] = Space Do Inc(Strt);    { start of X-coordinate }
  Fini:= Succ(Strt);
  While LineI[Fini] <> Space Do Inc(Fini);   { end of number }
  Val(Copy(LineI,Strt,Fini-Strt),NewVal,Err);
  If Err > 0 then Show_How('Invalid '+Msg+': '+Copy(LineI,Strt,Fini-Strt));
  Strt:= Fini;
  If (OldVal > 0) and (Abs(OldVal-NewVal) > 0.001*NewVal) Then
    Writeln('Possible grid ',Msg,' error at (',Xc,Yc,')  New:',NewVal:8:2,'   Old:',OldVal:8:2);
  OldVal:= NewVal;
End;
Begin
  FillChar(DR,SizeOf(DR),0);         FillChar(RE,SizeOf(DR),0);
  Assign(fi,MCfile[F]);              Reset(fi);
  Assign(fs,MCfile[F]+MCTALext);     Reset(fs);
 { read run title lines }
  Readln(fi,LineI); { input file title }
  Readln(fs,RunInfo);   Delete(RunInfo,1,18);    Delete(RunInfo,9,40);
  Readln(fs,LineS);
  Show_Titles('Main Titles');                    Title1:= LineI;
  Writeln('  MCNPH run began on ',RunInfo);      Writeln;
 { read detector title line }
  Repeat    Readln(fi,LineI);
  Until Copy(LineI,1,3) = 'fc5';
  Delete(LineI,1,5);
  For I:= 1 to 3 Do Readln(fs);                  Read(fs,LineS);
  Show_Titles('Detector Titles');                Title2:= LineI;
 { read and store the MCNPH dose rates }
  Repeat    Readln(fs,LineS);
  Until Copy(LineS,1,4) = 'vals';
  ReadSum:= true;     NeedZ:= true;
  Repeat   { loop over dose points in the input file }
    Readln(fi,LineI);   More:= Copy(LineI,1,5) = '     ';
    If Copy(LineI,1,4) = 'f5:p' Then More:= true;
    If More Then Begin
     { find the coordinates of the detector point }
      I:= Pos('$',LineI);   LineI:= LineI + Space;
      Inc(I);    While LineI[I] = Space Do Inc(I);
      Ys:= LineI[I];   Inc(I);   Xs:= '';
      If LineI[I] > '9' Then Ys:= Ys + LineI[I]
                        Else Xs:= LineI[I];
      Inc(I);
      While LineI[I] <> Space Do Begin
        Xs:= Xs + LineI[I];  Inc(I);  End;
      Val(Xs,Xc,Err);   If Err > 0 Then Show_How('Invalid NS index: '+Xs);
      Yc:= Ord(Ys[1]) - 64;
      If Length(Ys) > 1 Then Yc:= Yc*26 + Ord(Ys[2]) - 64;
     { read the X and Y coordinates of the detector point }
      I:= 6;
      Get_Coord(I,Xcoord,Xg[Xc,Yc],'X-coordinate');
      Get_Coord(I,Ycoord,Yg[Xc,Yc],'Y-coordinate');
      If NeedZ Then Begin
        Xcoord:= 0;
        Get_Coord(I,Zcoord,Xcoord,'Z-coordinate');
        If Zcoord > 100 Then HtStr:= 'Chest'   Else HtStr:= 'Knee';
        NeedZ:= false;
        End;
     { read the MCNPH dose rate }
      If ReadSum Then Begin Readln(fs,LineS);  a:= 3;  End
                 Else a:= 43;
      ReadSum:= not ReadSum;
      Val(Copy(LineS,a,11),DR[Xc,Yc],Err);
      If Err > 0 Then Show_How('Invalid MCNPH Dose Rate: '+Copy(LineS,a,11));
     { read the MCNPH relative error }   a:= a + 13;
      Val(Zero+Copy(LineS,a,5),RE[Xc,Yc],Err);
      If Err > 0 Then Show_How('Invalid MCNPH Relative Error: '+Copy(LineS,a,5));
      RE[Xc,Yc]:= 100.0*RE[Xc,Yc];
      End;
 Until not More;
```

```
    Readln(fs,LineS);
    If Copy(LineS,1,3) <> 'tfc' Then
      Show_How('Input file done but summary file not!!');
   { read the number of points and the source comment line }
    If Copy(LineI,1,3) = 'nps' Then Begin   Delete(LineI,1,5);
      RunInfo:= RunInfo + '     Source Points: ' + LineI;
      End;
    Repeat    Readln(fi,LineI);
    Until Copy(LineI,1,2) = 'sc';
    Delete(LineI,1,5);
    While LineI[1] = Space Do Delete(LineI,1,1);   Title3:= LineI;
    Close(fi);    Close(fs);
  End;


Procedure Write_Array;
{ Creates and writes output tables. }
Var  I,J : Integer;          WrkStr : String[9];
  FileName : Str79;          fo,fs  : Text;
Procedure Dump_Table(ID:Integer);
{ Writes a 2 dimensional array to the .2D file.
  ID=1,2,3,4 means arrays for DR,RE,Xg,Yg  }
Var   p,q : Integer;
Begin
  If ID = 1
    Then Begin  Writeln(fo,Title1);   Writeln(fo,Title2);
    Writeln(fo,Title3);   Writeln(fo,RunInfo);   End     Else
  If ID = 2
    Then Writeln(fo,'MCNPH Relative Errors (percent) -- '+HtStr+' Level')   Else
  If ID = 3
    Then Writeln(fo,'Detector X-coordinate (cm)')          Else
  If ID = 4
    Then Writeln(fo,'Detector Y-coordinate (cm)');
  Writeln(fo);
  Writeln(fo,'West',Space:46,'North',Space:46,'East');
  Writeln(fo,Hdr1,Hdr2);
  For p:= 1 to Xmax Do Begin
    For q:= 1 to Ymax Do Begin
      If DR[p,q] = 0.0 Then WrkStr:= '     '
        Else Begin
          If ID = 1 Then Begin
            If DR[p,q] < 1.0 Then Str(DR[p,q]:5:2,WrkStr)
                             Else Str(DR[p,q]:5:1,WrkStr);
            End    Else
          If ID = 2 Then Begin
            If RE[p,q] < 1.0 Then Str(RE[p,q]:5:1,WrkStr)
                             Else Str(RE[p,q]:5:0,WrkStr);
            End    Else
          If ID = 3 Then Begin Str(Xg[p,q]:5:0,WrkStr);
            End    Else
          If ID = 4 Then Begin Str(Yg[p,q]:5:0,WrkStr);
            End;
          End;
      Write(fo,WrkStr);
      End;
    Writeln(fo);
    End;
  Writeln(fo);     Writeln(fo);
End;
Procedure Dump_SSfmt;
{ Writes the dose rate table transposed for input to a spreadsheet }
Var   p,q : Integer;     LongST : String;
Begin
  Assign(fs,FileName+Zero);   Rewrite(fs);
  Writeln(fs,Title1);
  Writeln(fs);
  For q:= 1 to Ymax Do Begin
    LongST:= '';
    For p:= 1 to Xmax Do Begin
      If DR[p,q] = 0.0 Then WrkStr:= '   0.0 '
        Else Begin
          If DR[p,q] < 1.0 Then Str(DR[p,q]:7:4,WrkStr)
                           Else Str(DR[p,q]:7:3,WrkStr);
          End;
      LongST:= LongST + WrkStr;
      End;
    Writeln(fs,LongST);
```

```
    End;
  Writeln(fs,Title2);   Writeln(fs,Title3);
  Writeln(fs,'MCNPH Dose Rates (mrem/h) at '+HtStr+' Level -- Run on ',RunInfo);
  Close(fs);
End;
Begin
 { open output files }
  FileName:= MCfile[F] + '.2D';
  Assign(fo,FileName);        Rewrite(fo);
  Dump_Table(1);
  Dump_SSfmt;
  Dump_Table(2);
  Dump_Table(3);
  Dump_Table(4);
  Close(fo);
End;


Procedure Dump_Binary;
Var  N : LongInt;           Found : Boolean;
Begin
  TextAttr:= LightGreen;    Writeln('Updating ',BinFile,' with ',MCshrt[F]);
  Reset(fb);
  Repeat   Read(fb,OneRec);
    Found:= OneRec.FileN = MCshrt[F];
  Until Eof(fb) or Found;
  If Found Then Seek(fb,Pred(FilePos(fb)));
  With OneRec Do Begin
    FillChar(Title,SizeOf(Title),Space);
    FillChar(FileN,SizeOf(FileN),Space);
    Title:= Title3;   FileN:= MCshrt[F];
    End;
  OneRec.DR:= DR;
  Write(fb,OneRec);
  Writeln;
End;


Begin
  If ParamCount < 2 Then Show_How('');
  Make_Input_File_List;
  Initialize;
  For F:= 1 to FileCount Do Begin
    Read_MCNPH_Values;
    Write_Array;
    Dump_Binary;
    End;
  TextAttr:= LightCyan;     Writeln('Updating Xg & Yg');
  Reset(fb);
  With OneRec Do Begin
    FillChar(Title,SizeOf(Title),Space);
    Title:= Title1;         FileN:= 'X-COORD       ';
    End;
  OneRec.DR:= Xg;           Write(fb,OneRec);
  With OneRec Do Begin
    FillChar(Title,SizeOf(Title),Space);
    Title:= Title2;         FileN:= 'Y-COORD       ';
    End;
  OneRec.DR:= Yg;           Write(fb,OneRec);
  Close(fb);
  TextAttr:= White;         Writeln;
  Writeln('Run Completed!');
End.
```

Appendix H. Program to Compute Weighted Total Dose Rates

```
Program SpreadSheet_Substitute;
{ Author:   Paul D. Rittmann, PhD CHP
  Purpose:  Reads initial concentrations and the dose rate binary files
            and provides a way to fine-tune the amounts by manual adjustment
            of concentrations or linear least squares fits.
  Input:    SOURCE.INI - initial concentrations in each source region.
            SOURCE.CH  - path to binary files, conc units & source names.
            CHST1.BIN & KNEE1.BIN with the MCNP dose rates (calibration).
            CHST2.BIN & KNEE2.BIN with the MCNP dose rates (stage 2).
            9CHEST.BIN & 9KNEE.BIN with the measured dose rates.
  Output:   SSS-xx.D has the 2D files of total dose rates,
            SSS-xx.S has the corresponding source concentrations,
            SSS-xx.R has the graphics for each source showing its fractional
                    contribution to the total dose rate at a point.
            SSS-xx.T has the major source contributors to each point using
                    characters found in SOURCE.CH
            SSS-xx.Z has the necessary spreadsheet format for the total
}

Uses  Crt, DOS, Utility;

Const  Version = 'SSS Version 1.5   April 30, 1997';
  Chst = false;     Knee = true;
  Watr16 = false;  Watr17 = true;
  LevelST : Array[Chst..Knee] of ST7 = ('Chest','Knee');
  Xmax = 20;  { number of points in the NS direction }
  Ymax = 56;  { number of points in the EW direction }
  MaxProduct = Xmax*Ymax; { total number of array positions }
  SrcPool = 25;  { number of water & wall sources }
  SrcOthr = 26;  { index to the first non-pool source }
  SrcMax = 102;  { number of distinct radiation sources }
  SrcMp1 = SrcMax+1; { number of columns in the augmented matrix }
  SumBlk = 6; { number of records lumped together to reduce disk access }
  SumMax = SrcMax div SumBlk; { number of sums }
  SortMax = 9; { number of highest contributors to each dose point }
  Eps = 1.0E-7;{ matrix is singular if the largest potential pivot < Eps }
  DRmin = 0.001; { the minimum dose rate shown on 2D plots }
  SrcCharFile = 'SOURCE.CH';  { file with characters representing each source }
  SrcInitFile = 'SOURCE.INI'; { file with the default best guesses }
  RPTfile    : Array[Chst..Knee] of ST10 = ('9CHEST.BIN','9KNEE.BIN');
  MCNPfile: Array[Watr16..Watr17,Chst..Knee] of ST9 =
            (('CHST1.BIN','KNEE1.BIN'),('CHST2.BIN','KNEE2.BIN'));
  DepthST    : Array[Watr16..Watr17] of ST9 = (' (16''10") ',' (17''2") ');
  StdFileName = 'SSS-';{ file extension will vary: D=2D plot, R=Individual Ratios,
                       S=Source Amounts, T=Main Contributors, Z=SS input }
  ConcUnits : Array[1..5] of ST7 = ('µCi/L  ','µCi/cm²','Ci/m3  ','mCi/m  ','Ci     ');
  ConcColor : Array[1..5] of Byte = (LightCyan, Cyan,  LightRed, LightGreen, Green );
  Spectrum  : Array[0..17] of Byte =
   (black, blue, blue,  darkgray,  cyan,  green,  magenta,  brown,  red,
    lightblue,lightgray,lightgreen,lightmagenta,lightcyan,yellow,lightred,white,
    white+blink);
  Roff      : Array[Chst..Knee] of Byte = (4,27);
  Cpos      : Array[0..2] of Byte = (1,28,54);
  MaxPg = 8;  Sg1Pg = 7;  MREpg = 6;  GrCPg = 5;  GrRPg = 4;   DatPg = 3;
  DataTitle : Array[false..true,1..DatPg] of ST66 = (
   ('   There must be an error here somewhere!!',
    'Ratios -- Calibration to Stage 1 Transition',
    'Ratios -- Stage 1 to Stage 2 Transition     '),
   ('Concentrations for Calibration Dose Rates ',
    'Concentrations for Stage 1 Dose Rates      ',
    'Concentrations for Stage 2 Dose Rates      '));
  HelpCnt = 35;   HelpSkip : Set of Byte = [6,8,18,27];
  HelpLines : Array[1..HelpCnt] of ST66 = (
   'SSS allows you to adjust the activity in any of the main',
   'radiation sources and then see the effect that this has on',
   'the combined total dose rate.  You can also try linear least',
   'squares fitting to calibrate the MCNP model.',
   'SSS then allows calculation of Stage 1 & Stage 2 dose rates.',

   'There are 8 pages:  3 data entry screens and 5 graphical',
   '(text mode) screens of dose rates.',

   'The following key commands are enabled (both parts):',
   '  Alt-X = exit the SSS.EXE program (return to DOS)',
   '  Cursor keys = move the cursor around the screen',
   '  PgUp,PgDn = move between pages',
   '  F1  = displays this help screen',
```

```
     ' F2  = create files with source fractions & ranking',
     ' Shift-F2 = same as F2 for Stage 1 & Stage 2 cases',
     ' F8  = do least squares fit on marked sources & points',
     ' F9  = compute Calibration dose rates & comparisons',
     ' F10 = compute Stage 1 & Stage 2 dose rates',

     'The following key commands are enabled (source lists only):',
     ' F3  = restore original value from '+SrcInitFile+' (all=Alt-F3)',
     ' F4  = restore last grid conc (Alt-F4 does all)',
     ' F5  = mark/unmark source for least squares fitting',
     ' F6  = mark group of sources back to the nearest F5',
     ' Alt-F5,Alt-F6 = mark or unmark all sources',
     ' F7  = toggle display of concentration or fractions',
     ' Tab = change columns on screen',
     ' Home,End = jump to the top or bottom of the list',

     'The following key commands are enabled (graphical display only):',
     ' 1,2,3,0 = which grid to display: RPT, MCNP, ratios, sources',
     ' Space = mark/unmark an individual grid location for LLSq fitting',
     ' F4  = mark/unmark a column of points for least square fitting',
     ' F5  = mark/unmark a row of points for least square fitting',
     ' F6  = mark/unmark the whole grid for least square fitting',
     ' Alt-F4,-F5,-F6 = mark/unmark every 2, 3, or 4 points',
     ' Tab = change from chest to knee on screen (& LLSQ fit)',
     ' Home,End = jump to the top or bottom of the grid');
  CursCH = #4;  { used in the graphical displays }
  GrfCH : Array[0..18] of Char = '====----- +++++****';

Type
 { these are used for X & Y coordinates and dose rates }
  StdGrid = Array[1..Xmax,1..Ymax] of Single; { 4480 bytes }
  StdPtr = ^StdGrid;
  StdPtr2 = Array[Chst..Knee] of StdPtr;
 { these are used for indices to various sources }
  StdGridByte = Array[1..Xmax,1..Ymax] of Byte; { 1120 bytes }
  StdPtrByte = ^StdGridByte;
  StdPtrByte2 = Array[Chst..Knee] of StdPtrbyte;
 { data as found in the binary files }
  DRptr = ^DRrec;
  DRrec = Record    { 4576 bytes per record }
    Title  : ST79;
    FileN  : ST15;
    DR     : StdGrid;
    End;
  DRfileType = File of DRrec;
 { collection of information about the current sources }
  SrcRec = Record
    Name   : ST66;   { title of this source region }
    UnitID : Integer;{ which units for the concentration }
    OrigC,OrigF,     { original concentration or factor read from SrcInitFile }
    GridC,GridF,     { concentration or factor used in the previous grid plot }
    Conc,            { current concentration to be used for next calculation }
    FaCn   : Array[1..DatPg] of Single; { scale factors for next calculation }
   { array element 1 = Calibration values (Fctr is always 1.000)
     array element 2 = Stage 1 values (Fctr is ratio of Stage 1 to Calibration)
     array element 3 = Stage 2 values (Fctr is ratio of Stage 2 to Stage 1)  }
    DoSrc  : Array[1..DatPg] of Boolean;{ identifies non-zero sources }
    FITsrc : Boolean;{ sources marked for LLSQ fitting }
    End;
 { these are used in the simple character graphic displays }
  ScrCharType = Record { screen display at one point }
    Achar  : Char;
    Acolor : Byte;
    End;
  WholeGrid = Array[1..Xmax,1..Ymax] of ScrCharType;
  GridRec = Record
    GrdName : ST79;       { title of the grid }
    GrfPlot : WholeGrid;  { contents of the grid }
    End;
 { these are used for the linear least squares fitting }
  VectPtr = ^SimultVector;   { used when solving simultaneous equations }
  SimultVector = Array[1..SrcMp1] of Double; { 824 bytes }
 { these are used for quick rewrites on the number entry screens }
  ScreenBlk = Array[1..4000] of Integer;
  ScreenPtr = ^ScreenBlk;

Var
  OneSrc,             { data for one radiation source, chest & knee }
```

```
  RelErr,             { modified relative error between MCNP and RPT data }
  RPTdata,            { measured dose rates, mR/h }
  SumTotal,           { total dose rate from MCNPH }
  SumTotS1,           { total dose rate for Stage 1 }
  SumTotS2  : StdPtr2; { total dose rate for Stage 2 }
  Xg,Yg     : StdPtr;  { coordinates of detector point }
  SumB      : Array[1..SumMax] of StdPtr2; { sums of 4 StdGrids }
  NewSumB   : Array[1..SumMax] of Boolean; { flag sums needing updates }
  OneRec    : DRrec;
  fb        : Array[Chst..Knee] of DRfileType;  { binary files }
  SortDR    : Array[1..SortMax] of StdPtr2; { major contributors }
  SortID    : Array[1..SortMax] of StdPtrByte2;{ source indices }
  SortNum,   { how many sources are in the sorted index array, SortID }
  FileIndx,  { which number to use on next output file }
  Na,        { number of sources selected for LLSQ; rows in augmented matrix }
  Nap1,      { Nap1=Na+1 }
  NumPt,     { number of valid grid points selected for calculation }
  WhchPg,Wsv,{ which page to show:  0=Calib src; 1=Stg1 src; 2=Stg2 src;
               3=RPT grf; 4=MCNP grf; 5=MRE grf; 6=Stg 1 grf; 7=Stg 2 grf }
  Row, Col, Rsave,Csave,
  Isrc,Imax,Isave, Ix,Iy,
  Nsrc,Nsp1 : Integer;
  SrcInfo   : Array[1..SrcMax] of SrcRec; { source concentrations }
  SrcChar   : Array[0..SrcMax] of Char;{ characters to represent each source }
  RatioST   : Array[0..18] of ST15;   { ranges for each color }
  RatioColor: Array[0..18] of Byte;   { colors for display of ratios }
  RatioHi,                            { for display of ratios }
  DRhigh    : Array[0..18] of Single; { used in display of dose rates }
  HighST    : Array[0..16] of ST19;   { shows high dose rate cutoffs }
  RowID     : Array[1..SrcMax] of ST3;{ integers for the row display }
  ColID     : Array[1..Ymax] of ST3; { spreadsheet column headings }
  Hdr1,Hdr2 : String; { spreadsheet header columns }
  InScreen  : Array[1..DatPg] of ScreenPtr; { data entry screens }
  GridTitle, { color of title lines on Plot pages }
  FITBkgrd  : Byte;
  ShowMore,              { true if there is something on the command line }
  RecomputeCal,          { calculate total dose rates and plots - calibration }
  RecomputeStg,          { calculate total dose rates and plots - stage 1 & 2 }
  Depth1,                { true if pool depth is 16'10" }
  DoFit,                 { time to do the LLSQ fit }
  DoStatsCal,            { write the ratios & ranking file -- calibration case }
  DoStatsStg,            { write the ratios & ranking file -- stages 1 & 2 }
  CountSrc,              { signals need to count number of selected sources }
  CountPt,               { signals need to count number of valid grid points }
  BothGrd,               { update FITpoint info on both grids }
  Lower,Lsave,           { which grid the cursor is in }
  SwitchPage  : Boolean; { signals time to move }
  ReDoConc,              { need to display new source amounts }
  PressToCalc,           { display the need to recompute dose rates }
  ShowC     : Array[1..DatPg] of Boolean; { show concentrations or fractions }
  FITpoint  : Array[1..Xmax,1..Ymax] of Boolean;
  GridData  : Array[GrRPg..MaxPg,Chst..Knee] of GridRec;
  A         : Array[1..SrcMax] of VectPtr;{ the augmented coefficient matrix }
  FITorder  : Array[1..SrcMp1] of Integer;{ order of variable source conc }
  FITRelErr,            { sum of relative errors at chosen points only }
  TotRelErr : Array[Chst..Knee] of Single; { sum of relative errors }
  FileDrive : ST19; { DOS path where the files are found (in SrcCharFile) }
  SrcTitle1,
  SrcTitle2 : ST66; { title lines from SOURCE.INI }


Procedure New_Screen;
{ Clears the screen and places the distinctive header on the top line }
Begin
  TextAttr:= White;       ClrScr;
  TextAttr:= HelpTitle;   ClrEol;         Write(Space,Version);
  TextAttr:= HelpText;    Msg(78-Length(Author),1,Author);
  ClrMsg(1,50,
  ' AltX:Exit   F1:Help   F2:Ratios   F8:LLSQ   F9:Calibration DR   F10:Stage 1&2 ');
  TextAttr:= TblColor;    GotoXY(1,2);    ScnLine:= 2;
End;


Procedure Pause_To_Look;
Begin
  If ShowMore Then Begin
    TextAttr:= HiColor;
    Press_Any_Key(3+ScnLine);
```

```
    End;
End;


Procedure No_File(Msng:ST79);
{ stops program with an error message }
Begin
  TextAttr:= ErrColor;       Inc(ScnLine,2);
  Msg(6,ScnLine,'Oops!  The file '+Msng+' could not be located!');
  Halt;
End;


Procedure Check_Free_Memory(VarST:ST19);
{ terminates execution if there is less than 2*StdGrd available }
Begin
  Inc(ScnLine);
  If MaxAvail < 2*SizeOf(StdGrid) Then Begin
    TextAttr:= ErrColor;    Inc(ScnLine);    GotoXY(6,ScnLine);
    Writeln('Not enough memory left: ',MaxAvail,' bytes');
    Halt;    End;
  GotoXY(6,ScnLine);        TextAttr:= HdrColor;
  Write('After ',VarST,MaxAvail:8,' bytes');
End;


Procedure Switch_Assigns(Lvl:Boolean);
Begin
  Close(fb[Lvl]);
  Assign(fb[Lvl],FileDrive+MCNPfile[Depth1,Lvl]);
  Reset(fb[Lvl]);
  Add_Line('Now Using '+FileDrive+MCNPfile[Depth1,Lvl]);
End;


Procedure Initialize;
Var    L,K : Integer;      WrkST : ST19;       fi : Text;
Procedure Open_MCNP_Bin(Lvl:Boolean);
{ read the MCNP dose rate file }
Var  I : Integer;
Procedure Check_Binary(STR:ST79);
Begin
  Assign(fb[Lvl],STR);    {$I-} Reset(fb[Lvl]); {$I+}
  If IOResult > 0 Then No_File(STR);
  Add_Line('Found the binary file '+STR);
End;
Begin
  Check_Binary(FileDrive+MCNPfile[Watr17,Lvl]);
  Check_Binary(FileDrive+MCNPfile[Watr16,Lvl]); { default is 16'10" level }
  If Lvl Then Begin
    Read(fb[Lvl],OneRec);    Xg^:= OneRec.DR;
    Read(fb[Lvl],OneRec);    Yg^:= OneRec.DR;
    End;
 { zero the SumTotal and SumB arrays }
  For I:= 1 to SumMax Do FillChar(SumB[I,Lvl]^,SizeOf(StdGrid),0);
  FillChar(SumTotal[Lvl]^,SizeOf(StdGrid),0);
  FillChar(SumTotS1[Lvl]^,SizeOf(StdGrid),0);
  FillChar(SumTotS2[Lvl]^,SizeOf(StdGrid),0);
End;
Procedure Full_Screen(Whch:Integer);
Var    J,Line : Integer;      Tmp : Single;
Procedure Write_Source(N,Lng:Integer);
Begin
  With SrcInfo[J+N*Imax] Do Begin
    If ShowC[Whch] Then Tmp:= Conc[Whch]     Else Tmp:= FaCn[Whch];
    TextAttr:= HiColor;             Msg(Cpos[N],Line,PadNumStr0(Tmp));
    TextAttr:= ConcColor[UnitID];  Write(Copy(Name,1,Lng));
    End;
End;
Begin
  TextMode(Co80+Font8x8);    New_Screen;
  TextAttr:= TblColor;  Msg(2,2,'Page'+RowID[Whch]);  Msg(72,2,'Page'+RowID[Whch]);
  TextAttr:= White;     Center_Msg(3,DataTitle[ShowC[Whch],Whch]);
  For J:= 1 to Imax Do Begin         Line:= J + 3;
    Write_Source(0,19);   Write_Source(1,18);   Write_Source(2,18);
    End;
  TextAttr:= HelpTitle;      ClrMsg(1,Imax+4,
   '       Colors refer to these concentration units:           ('+RowID[Nsrc]+' Sources)');
```

```
    For J:= 1 to 5 Do Begin
      TextAttr:= ConcColor[J];   Msg(11*J,Imax+5,ConcUnits[J]);    End;
    TextAttr:= HelpTitle;      ClrMsg(1,Imax+6,
    ' F3:Restore Original Value    F4:Restore Last Value    Alt-F3,-F4:Restore All');
    New(InScreen[Whch]);
    Move(Mem[$B800:0],InScreen[Whch]^,8000);  { stores the current screen }
    ScnLine:= 41;    Pause_To_Look;
  End;
  Begin
    ShowMore:= ParamCount > 0;
    FITBkgrd:= LightGray;      GridTitle:= Black + 16*Cyan;
    New_Screen;
   { initialize the source data array; also read the characters representing
     each source }
    FileDrive:= blanks;        Depth1:= Watr16;
    Assign(fi,SrcCharFile);     {$I-}  Reset(fi);  {$I+}
    If IOResult > 0 Then No_File(SrcCharFile);
    Add_Line('Reading the binary file path and source names from '+SrcCharFile);
    Readln(fi,FileDrive);
    L:= 1;         While FileDrive[L] <> Space Do Inc(L);
    FileDrive[0]:= Chr(Pred(L));
    SrcChar[0]:= Space;         Nsrc:= 0;
    While not Eof(fi) Do Begin
      Inc(Nsrc);       With SrcInfo[Nsrc] Do Begin
      Readln(fi,ST);
      SrcChar[Nsrc]:= ST[1];
      WrkST:= Copy(ST,9,7);
      UnitID:= 1;   While WrkST <> ConcUnits[UnitID] Do Inc(UnitID);
      Name:= Copy(ST,18,70);
      FITsrc:= true;
      End;   End;
    Nsp1:= Succ(Nsrc);  Imax:= Nsp1 div 3;
    Close(fi);
   { read the default source concentration file }
    ST:= FileDrive + SrcInitFile;
    Assign(fi,ST);      {$I-}  Reset(fi);  {$I+}
    If IOResult > 0 Then No_File(ST);
    Add_Line('Reading the default concentrations from '+ST);
    Readln(fi,SrcTitle1);       Readln(fi,SrcTitle2);
    For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
      Readln(fi,OrigC[1],OrigF[2],OrigF[3]);
      FaCn[1]:= 1.0;          OrigF[1]:= 1.0;
      FaCn[2]:= OrigF[2];    OrigC[2]:= OrigF[2]*OrigC[1];
      FaCn[3]:= OrigF[3];    OrigC[3]:= OrigF[3]*OrigC[2];
      For K:= 1 to 3 Do Begin
        GridC[K]:= OrigC[K];   GridF[K]:= OrigF[K];   Conc[K]:= OrigC[K];
        DoSrc[K]:= Conc[K] > 0.0;
        End;
      End;
   { header line with spreadsheet column ID for 2D files }
    Hdr1:= '    A';  WrkST:= '     ';     ColID[1]:= ' A';
    For L:= 2 to 26 Do Begin
      WrkST[5]:= Alphabet[L];      Hdr1:= Hdr1 + WrkST;
      ColID[L]:= Space + WrkST[5];
      End;
    Hdr2:= '';
    For L:= 27 to Ymax Do Begin
      WrkST[4]:= Alphabet[Pred(L) div 26];
      WrkST[5]:= Alphabet[Succ(Pred(L) mod 26)];
      Hdr2:= Hdr2 + WrkST;
      ColID[L]:= WrkST[4] + WrkST[5];
      End;
   { definition of RowID }
    For L:= 1 to 2*Imax Do Str(L:2,RowID[L]);
    For L:= Succ(2*Imax) to SrcMax Do Str(L:3,RowID[L]);
   { relative error display arrays }
    RatioHi[ 0]:= -9.0;      RatioColor[ 0]:= White + Blink;
    RatioHi[ 1]:= -5.0;      RatioColor[ 1]:= White;
    RatioHi[ 2]:= -3.0;      RatioColor[ 2]:= LightRed;
    RatioHi[ 3]:= -2.0;      RatioColor[ 3]:= Yellow;
    RatioHi[ 4]:= -1.5;      RatioColor[ 4]:= LightCyan;
    RatioHi[ 5]:= -1.0;      RatioColor[ 5]:= LightMagenta;
    RatioHi[ 6]:= -0.7;      RatioColor[ 6]:= LightBlue;
    RatioHi[ 7]:= -0.4;      RatioColor[ 7]:= Brown;
    RatioHi[ 8]:= -0.2;      RatioColor[ 8]:= LightGray;
    RatioHi[18]:= TopReal;   RatioColor[ 9]:= Black;
    For L:= 10 to 18 Do Begin
      RatioColor[L]:= RatioColor[18-L];
```

```
      RatioHi[Pred(L)]:= -RatioHi[18-L];
      End;
    For L:= 1 to 17 Do Begin
      Str(RatioHi[Pred(L)]:5:1,WrkST);    Str(RatioHi[L]:5:1,ST);
      RatioST[L]:= GrfCH[L] + WrkST + ' to' + ST;
      End;
   { figure out which number output file to use next }
    ST:= FileDrive + StdFileName;     FileIndx:= 0;
    Repeat          Close(fi);
      Inc(FileIndx);          Str(FileIndx:2,WrkST);
      If WrkST[1] = Space Then WrkST[1]:= Zero;
      Assign(fi,ST+WrkST+'.D');   {$I-}  Reset(fi);  {$I+}
      SwitchPage:= IOResult > 0;
    Until SwitchPage or (FileIndx > 99);
    If FileIndx = 99 Then FileIndx:= 1;
    Dec(FileIndx);
   { use the heap space for various dose rate arrays }
    Add_Line('Assigning memory space for various arrays');
    For L:= 1 to SumMax Do Begin
      New(SumB[L,Chst]);       New(SumB[L,Knee]);
      Check_Free_Memory('SumB['+RowID[L]+']');
      NewSumB[L]:= true;
      End;
    New(SumTotal[Chst]);       New(SumTotal[Knee]);
    Check_Free_Memory('SumTotal ');
    New(RelErr[Chst]);         New(RelErr[Knee]);
    Check_Free_Memory('DR RelErr');
    New(SumTotS1[Chst]);       New(SumTotS1[Knee]);
    Check_Free_Memory('SumTotS1 ');
    New(SumTotS2[Chst]);       New(SumTotS2[Knee]);
    Check_Free_Memory('SumTotS2 ');
    New(Xg);                   New(Yg);
    Check_Free_Memory('Xg & Yg  ');
   { read the MCNP dose rate files to initialize the sums }
    Open_MCNP_Bin(Chst);       Open_MCNP_Bin(Knee);
    TextAttr:= HiColor;
    Pause_To_Look;
   { initial values }
    Isrc:= 1;    WhchPg:= 1;
    Row:= 1;     Col:= 1;
    CountSrc:= true;           DoFit:= false;
    CountPt:= true;            Lower:= false;
    DoStatsCal:= false;        DoStatsStg:= false;
    RecomputeCal:= true;       RecomputeStg:= not ShowMore;
    For K:= 1 to DatPg Do Begin
      ReDoConc[K]:= true;      PressToCalc[K]:= true;
      If K = 1 Then ShowC[1]:= true
               Else ShowC[K]:= false;
      Full_Screen(K); { show the list on the screen }
      End;
End;


Procedure Show_Help_Page;
Var  J,K : Integer;        TmpScreen : Array[1..4000] of Integer;
Begin
  Move(Mem[$B800:0],TmpScreen,8000);  { stores the current screen }
  TextAttr:= HelpTitle;       ClrScr;
  Center_Msg(3,'Summary of Features for '+Version);
  TextAttr:= HelpText;        Center_Msg(4,Author);
  J:= 6;
  For K:= 1 to HelpCnt Do Begin
    Inc(J);
    If K in HelpSkip Then Inc(J);
    Msg(11,J,HelpLines[K]);
    End;
  TextAttr:= HelpTitle;       Press_Any_Key(J + 3);
  Move(TmpScreen,Mem[$B800:0],8000);  { restores the original screen }
End;


Procedure Source_Info_ST(Sn:Integer);
{ Uses ST to give the source information summary - amount, units & name }
Var    WrkST : ST9;
Begin  With SrcInfo[Sn] Do Begin
  ST:= MinNumStr(GridC[1]);
  While Length(ST) < 7 Do Insert(Space,ST,1);
  WrkST:= MinNumStr(GridF[2]);
```

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  While Length(WrkST) < 7 Do Insert(Space,WrkST,1);
  ST:= ST + Space + WrkST;
  WrkST:= MinNumStr(GridF[3]);
  While Length(WrkST) < 7 Do Insert(Space,WrkST,1);
  ST:= ST + Space + WrkST + '  ' + Name;
End;   End;


Procedure Make_Stat_Files(Whch:Integer);
{ Writes a file showing the fractional contribution to the total from each
  source at each grid point.  Also writes a file showing the major
  contributors to the dose rate at each point.  Also writes the total dose
  rates in a form readable by spreadsheets.  Whch is 1, 2, or 3. }
Var  I,J,N,Ksrt : Integer;        fo : Text;       WrkST : ST79;
     PP : Pointer;           Fctr : Single;
Procedure Do_Ratios(Ptr:StdPtr2;  Strt,Fini:Integer);
Var  Src : Integer;
Procedure One_Table(Lvl:Boolean);
{ Reads one binary record and writes one table to the output file. }
Var  I,J,K,M : Integer;      TmpD,TmpT : Single;
Begin                        Writeln(fo);
  Writeln(fo);               Write(fo,LevelST[Lvl],' -- ',ST);
  If Src < 26 Then Writeln(fo,DepthST[Depth1])    Else Writeln(fo);
  Writeln(fo,'  ',Alphabet,Alphabet,'ABCD');
  Seek(fb[Lvl],Succ(Src));   Read(fb[Lvl],OneRec);
  With OneRec Do Begin       Msg(70,ScnLine,FileN+Space);
  For I:= 1 to Xmax Do Begin
    WrkST:= RowID[I];
    For J:= 1 to Ymax Do Begin
     { insert the individual dose rates on the sorted list of grids }
      TmpD:= Fctr*DR[I,J];
      If TmpD > 1.0E-08 Then Begin
        K:= 1;
        While (K < SortNum) and (TmpD < SortDR[K,Lvl]^[I,J]) Do Inc(K);
        For M:= Pred(SortNum) downto K Do Begin
          SortDR[Succ(M),Lvl]^[I,J]:= SortDR[M,Lvl]^[I,J];
          SortID[Succ(M),Lvl]^[I,J]:= SortID[M,Lvl]^[I,J];
          End;
        SortDR[K,Lvl]^[I,J]:= TmpD;
        SortID[K,Lvl]^[I,J]:= Src;
        End;
     { determine the ratio character and add to the line }
      TmpT:= Ptr[Lvl]^[I,J];
      If TmpT > 0
        Then Begin
          CH:= IntChar[Round(10.0*TmpD / TmpT)];
          If CH = Zero Then CH:= Space;
          End
        Else CH:= Space;
      WrkST:= WrkST + CH;
      End;
    Writeln(fo,WrkST,Space,RowID[I]);
    End;
  End;
End;
Begin
  TextAttr:= HiColor;
  For Src:= Strt to Fini Do With SrcInfo[Src] Do Begin
    Fctr:= SrcInfo[Src].Conc[Whch];
    If Fctr > 0.0 Then Begin
      ST:= MinNumStr(Fctr);    While Length(ST) < 7 Do Insert(Space,ST,1);
      ST:= ST + Space + ConcUnits[UnitID] + '  ' + Name;
      Inc(Ksrt);
      If Ksrt < SortMax Then SortNum:= Ksrt    Else SortNum:= SortMax;
      One_Table(Chst);           One_Table(Knee);
      End;
    End;
End;
Procedure Rank_Table(Lvl:Boolean);
{ Writes one main contributor table to the output file. }
Var  I,J : Integer;
Begin                      Writeln(fo);
  Writeln(fo);             Writeln(fo,LevelST[Lvl],' -- ',ST,DepthST[Whch>1]);
  Writeln(fo,'  ',Alphabet,Alphabet,'ABCD');
  For I:= 1 to Xmax Do Begin
    WrkST:= RowID[I];
    For J:= 1 to Ymax Do WrkST:= WrkST + SrcChar[SortID[N,Lvl]^[I,J]];
    Writeln(fo,WrkST,Space,RowID[I]);
```

```
    End;
End;
Procedure SS_Readable(Ptr:StdPtr2;  Lvl:Boolean);
Var  p,q : Integer;      LongST : String;
     Tmp : Single;       WrkStr : ST15;
Begin
  Writeln(fo,LevelST[Lvl],
   ' Level Total Dose Rates (Transposed) from MCNP, mrem/h',DepthST[Whch>1]);
  Writeln(fo);
  For q:= 1 to Ymax Do Begin
    LongST:= '';
    For p:= 1 to Xmax Do Begin
      Tmp:= Ptr[Lvl]^[p,q];
      If Tmp = 0.0 Then WrkStr:= '    0.0 '
        Else Begin
          If Tmp < 1.0 Then Str(Tmp:7:4,WrkStr)
                       Else Str(Tmp:7:3,WrkStr);
          End;
      LongST:= LongST + WrkStr;
      End;
    Writeln(fo,LongST);
    End;
End;
Begin   { Make_Stat_Files }
  New_Screen;
 { use the heap space for the sorted dose rate arrays }
  Add_Line('Assigning memory space for the sorting arrays');
  Mark(PP);
  For N:= 1 to SortMax Do Begin
    New(SortDR[N,Chst]);     New(SortDR[N,Knee]);
    New(SortID[N,Chst]);     New(SortID[N,Knee]);
    Check_Free_Memory('SortDR['+RowID[N]+']');
    FillChar(SortDR[N,Chst]^,2*SizeOf(StdGrid),0);
    FillChar(SortID[N,Chst]^,2*SizeOf(StdGridByte),0);
    End;
 { assemble the name of the ratio file }
  Str(FileIndx:2,ST);          If ST[1] = Space Then ST[1]:= Zero;
  ST:= FileDrive + StdFileName + ST + '.R' + IntChar[Whch];
  Add_Line('Writing the ratios from each source to '+ST);
  TextAttr:= HdrColor;         Inc(ScnLine);
  Msg(8,ScnLine,'(from '+DataTitle[true,Whch]+')');
 { compute and write the tables of ratios }
  Assign(fo,ST);               Rewrite(fo);              Ksrt:= 0;
  Writeln(fo,'Fractions That Each Source Contributes to the Total Dose Rate');
  Writeln(fo,'from ',DataTitle[true,Whch]);
  If Whch = 1 Then Do_Ratios(SumTotal,1,SrcMax)
    Else Begin  { start with the water at 17'2" }
      Append(fo);              Depth1:= Watr17;
      Switch_Assigns(Chst);  Switch_Assigns(Knee);
      If Whch = 2 Then Do_Ratios(SumTotS1,1,SrcPool)
                  Else Do_Ratios(SumTotS2,1,SrcMax);
      Depth1:= Watr16;
      Switch_Assigns(Chst);  Switch_Assigns(Knee);
      If Whch = 2 Then Do_Ratios(SumTotS1,SrcOthr,SrcMax);
      End;
  Close(fo);
 { assemble the name of the main contributor file }
  Str(FileIndx:2,ST);          If ST[1] = Space Then ST[1]:= Zero;
  ST:= FileDrive + StdFileName + ST + '.T' + IntChar[Whch];
  Add_Line('Writing the grids showing major sources to '+ST);
 { write the main contributor file }
  Assign(fo,ST);               Rewrite(fo);
  Writeln(fo,'Major Contributors to the Total Dose Rate for ',DataTitle[true,Whch]);
  Writeln(fo);
  Writeln(fo,'The sources are identified using the key below:');
  For N:= 1 to Imax Do Begin
    ST:= RowID[N] + Space + SrcChar[N] + Space + SrcInfo[N].Name + Blanks;
    ST[0]:= #27;               Csave:= N + Imax;
    ST:= ST + RowID[Csave] + Space + SrcChar[Csave] + Space + SrcInfo[Csave].Name + Blanks;
    ST[0]:= #50;               Csave:= N + 2*Imax;
    Writeln(fo,ST,RowID[Csave],Space,SrcChar[Csave],Space,SrcInfo[Csave].Name);
    End;
  For N:= 1 to Pred(SortNum) Do Begin
    ST:= 'Importance Rank Number '+RowID[N];
    Rank_Table(Chst);          Rank_Table(Knee);
    End;
  Close(fo);
 { assemble the name of the spreadsheet readable file }
```

```
  Str(FileIndx:2,ST);          If ST[1] = Space Then ST[1]:= Zero;
  ST:= FileDrive + StdFileName + ST + '.Z' + IntChar[Whch];
  Add_Line('Writing the spreadsheet readable tables to '+ST);
 { write the main contributor file }
  Assign(fo,ST);               Rewrite(fo);
  If Whch = 1 Then Begin     DoStatsCal:= false;
    SS_Readable(SumTotal,Chst);
    Writeln(fo);    Writeln(fo);
    SS_Readable(SumTotal,Knee);
    End       Else
  If Whch = 2 Then Begin     DoStatsStg:= false;
    SS_Readable(SumTotS1,Chst);
    Writeln(fo);    Writeln(fo);
    SS_Readable(SumTotS1,Knee);
    End       Else
  If Whch = 3 Then Begin     DoStatsStg:= false;
    SS_Readable(SumTotS2,Chst);
    Writeln(fo);    Writeln(fo);
    SS_Readable(SumTotS2,Knee);
    End;
  Close(fo);
  Release(PP);
  Pause_To_Look;
End;


Procedure Dump_2D_File(Whch:Integer;  Ptr:StdPtr2;  IDst:ST79);
{ Writes the DR grid in Ptr for chest & knee level to the next source file.
    Whch=4 is the measured dose rates (RPTdata)
    Whch=5 is the MCNP computed sum for the calibration case (SumTotal)
    Whch=6 is the modified relative error for SumTotal and RPTdata (RelErr)
    Whch=7 is the Stage 1 dose rates (SumTotS1)
    Whch=8 is the Stage 2 dose rates (SumTotS2)   }
Var  fo : Text;
Procedure Write_2D(Lvl:Boolean);
Var  p,q : Integer;          Tmp : Single;
Begin
  Writeln(fo,GridData[Whch,Lvl].GrdName);
  Writeln(fo,'West',Space:46,'North',Space:46,'East');
  Writeln(fo,Hdr1,Hdr2);
  For p:= 1 to Xmax Do Begin
    For q:= 1 to Ymax Do Begin
      Tmp:= Ptr[Lvl]^[p,q];
      If Abs(Tmp) > DRmin Then Str(Tmp:5:1,ST)
                          Else ST:= '     ';
      Write(fo,ST);
      End;
    Writeln(fo);
    End;
  If Whch = MREpg Then
    Writeln(fo,'Sum of Magnitudes of Modified Relative Errors is ',
               MinNumStr(TotRelErr[Lvl]),' at ',LevelST[Lvl],' Level')
    Else Writeln(fo);
End;
Begin
  If Whch = GrRPg Then ST:= StdFileName+'00.D'
    Else Begin   Str(FileIndx:2,ST);
      If ST[1] = Space Then ST[1]:= Zero;
      ST:= StdFileName + ST + '.D';
      End;
  Add_Line('Adding a 2D '+IDst+' table to '+ST);
  Assign(fo,FileDrive+ST);    { the summary file }
  If Whch < MREpg Then Rewrite(fo)     Else Append(fo);
  Write_2D(Chst);          Write_2D(Knee);
  Close(fo);
End;


Procedure Make_DR_Grid(Whch:Integer;  Ptr:StdPtr2;  Title:ST79);
{ Stores the current data in GridData[Whch,Lvl].  The 2D file is generated. }
Procedure Put_Grid(Lvl:Boolean);
Var  I,J,K : Integer;      Tmp : Single;
Begin
With GridData[Whch,Lvl] Do Begin
  GrdName:= Title + ' -- ' + LevelST[Lvl] + ' Level' + DepthST[Whch>MREPg];
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do Begin
      K:= 0;     Tmp:= Ptr[Lvl]^[I,J];
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      While Tmp > DRhigh[K] Do Inc(K);
      With GrfPlot[I,J] Do Begin
        Acolor:= Spectrum[K];     Achar:= #219;
        End;
      End;
  End;
End;
Begin
  Put_Grid(Chst);             Put_Grid(Knee);
  Dump_2D_File(Whch,Ptr,Title);
End;


Procedure Make_RPT_Grid;
{ Puts the grid with RPT data into GridData[4]. }
Var  I,J,K,L : Integer;             Chk : Boolean;
  GridMin,GridMax,ScaleFactor,Tmp : Single;
Procedure Read_RPT_DR(Lvl:Boolean);
{ read the RPT dose rate file }
Type  RPTGrid = Array[1..26,1..56] of Single;
Var   RPTin : RPTgrid; { measured dose rates, mR/h }
      fr : File of RPTgrid;       I,J : Integer;
Begin
  ST:= FileDrive+RPTfile[Lvl];
  Assign(fr,ST);  {$I-} Reset(fr); {$I+}
  If IOResult > 0 Then No_File(ST);
  Add_Line('Reading the RPT data in '+ST);
  Read(fr,RPTin);             Close(fr);
  New(RPTdata[Lvl]);
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do
      RPTdata[Lvl]^[I,J]:= RPTin[I,J];
End;
Begin
  New_Screen;
  Read_RPT_DR(Chst);          Read_RPT_DR(Knee);
 { identify GridMax and GridMin }
  GridMin:= TopReal;          GridMax:= 0;       NumPt:= 0;
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do Begin
      Tmp:= RPTdata[Chst]^[I,J];
      FITpoint[I,J]:= Tmp > 0;
      If Tmp > 0 Then Begin   Inc(NumPt);
        If GridMax < Tmp Then GridMax:= Tmp;
        If GridMin > Tmp Then GridMin:= Tmp;
        End;
      Tmp:= RPTdata[Knee]^[I,J];
      If Tmp > 0 Then Begin
        If GridMax < Tmp Then GridMax:= Tmp;
        If GridMin > Tmp Then GridMin:= Tmp;
        End;
      End;
  If GridMin < 0.1 Then GridMin:= 0.1;
 { set the color scale }
  ScaleFactor:= Exp(Ln(GridMax/GridMin)/16.0);  { 16 logarithmic steps }
  DRhigh[0]:= GridMin;        DRhigh[16]:= GridMax + 0.01;
  For K:= 1 to 15 Do DRhigh[K]:= DRhigh[Pred(K)]*ScaleFactor;
  DRhigh[17]:= TopReal;
 { show the graphs }
  Make_DR_Grid(GrRPg,RPTdata,'Measured Dose Rates (mR/h)');
  Inc(ScnLine,2);   GotoXY(6,ScnLine);
  Write(NumPt,' grid points were found in RPTdata');
End;


Procedure Get_A_Matrix(Lvl:Boolean);
{ Reads the MCNP binary file many times to compute the augmented coefficient
  matrix.  Only the selected source and grid points are used. }
Var  Irow,Icol,I,J,K,N : Integer;        Sum : Double;
     Determined  : Boolean;          WrkRec : DRrec;
Begin
  Add_Line('Computing the augmented coefficient matrix  ');
 { read the binary files to generate the full coefficient matrix }
  Inc(ScnLine);               GotoXY(6,ScnLine);
  Writeln('Number of sources: ',Na,'      Number of grid points: ',NumPt);
  K:= 0;
  For N:= 1 to Nsrc Do If SrcInfo[N].DoSrc[1] Then Inc(K);
  Write(K:8,' Data Records will be used in the fit');
```

```
  Determined:= NumPt = Na; { just enough data to solve }
  For I:= 1 to Xmax Do     { initialize the constant vector }
    For J:= 1 to Ymax Do
      RelErr[Lvl]^[I,J]:= RPTdata[Lvl]^[I,J];
  For N:= 1 to Nsrc Do Begin
    New(A[N]);   FillChar(A[N]^,SizeOf(SimultVector),0);
    End;
  Irow:= 0;     Inc(ScnLine,4);     TextAttr:= HiColor;
  For N:= 1 to Nsrc Do With SrcInfo[N] Do If DoSrc[1] Then Begin
    GotoXY(60,ScnLine);      Write('Record ',N);
   { read one column of original matrix }
    Seek(fb[Lvl],Succ(N));   Read(fb[Lvl],OneRec);
    If FITsrc
      Then Begin { compute Nth row in the coefficient matrix }
        Write(' - A');
        Inc(Irow);     Icol:= 0;      FITorder[Irow]:= N;
        If Determined
          Then Begin      { assume Irow is actually a column }
            For I:= 1 to Xmax Do
              For J:= 1 to Ymax Do If FITpoint[I,J] Then Begin
                Inc(Icol);     A[Icol]^[Irow]:= OneRec.DR[I,J];
                End;
            End
          Else Begin
            For K:= 1 to Nsrc Do If SrcInfo[K].FITSrc Then Begin
              Sum:= 0.0;
              Seek(fb[Lvl],Succ(K));   Read(fb[Lvl],WrkRec);{ column K in A matrix }
              For I:= 1 to Xmax Do
                For J:= 1 to Ymax Do If FITpoint[I,J] Then
                  Sum:= Sum + WrkRec.DR[I,J]*OneRec.DR[I,J];
              Inc(Icol);         A[Irow]^[Icol]:= Sum;
              End;
            End;
        End
      Else Begin { update the constant vector }
        Write(' - B');
        For I:= 1 to Xmax Do
          For J:= 1 to Ymax Do If FITpoint[I,J] Then
            RelErr[Lvl]^[I,J]:= RelErr[Lvl]^[I,J] - OneRec.DR[I,J]*Conc[1];
        End;
    End;
  Nap1:= Succ(Na);      FITorder[Nap1]:= Nsp1;
 { multiply A transpose times the original constant vector }
  Add_Line('Computing the constant vector');
  If Determined
    Then Begin
      Icol:= 0;
      For I:= 1 to Xmax Do
        For J:= 1 to Ymax Do If FITpoint[I,J] Then Begin
          Inc(Icol);     A[Icol]^[Nap1]:= RelErr[Lvl]^[I,J];
          End;
      End
    Else Begin
      For Irow:= 1 to Na Do Begin
        Seek(fb[Lvl],Succ(FITorder[Irow]));   Read(fb[Lvl],OneRec);
        Sum:= 0.0;
        For I:= 1 to Xmax Do
          For J:= 1 to Ymax Do If FITpoint[I,J] Then
            Sum:= Sum + OneRec.DR[I,J]*RelErr[Lvl]^[I,J];
        A[Irow]^[Nap1]:= Sum;
        End;
      End;
End;


Procedure Write_A_Matrix(Lvl:Boolean);
{ Writes the file SSS.Mxx with the values of the augmented matrix. }
Var  fo : Text;      LS,WrkST : String;       Tmp : Single;
  I,J,K,N,Strt,Fini : Integer;
Begin
 { assemble the name of the output file }
  Str(FileIndx:2,ST);        If ST[1] = Space Then ST[1]:= Zero;
  ST:= FileDrive + StdFileName + ST + '.F';
  Add_Line('Writing the '+LevelST[Lvl]+' level augmented matrix to '+ST);
 { write these computed results to an output file }
  Assign(fo,ST);            Rewrite(fo);
  Writeln(fo,LevelST[Lvl],' Level Augmented Coefficient Matrix');
  Fini:= 0;    K:= 0;
```

```
  While Fini < Na Do Begin
    Writeln(fo);
    Strt:= Succ(15*K);   Inc(K);   Fini:= 15*K;
    If Fini > Na Then Fini:= Na;
    WrkST:= '';
    For J:= Strt to Fini Do Begin
      Str(FITorder[J]:8,ST);  WrkST:= WrkST + ST;   End;
    Delete(WrkST,1,2);
    LS:= LineStr + LineStr;   LS[0]:= Chr(8*(Fini-Strt)+10);
    If Fini = Na Then Begin
      WrkST:= WrkST + '       Constants';
      LS[0]:= Chr(8*(Fini-Strt)+22);
      End;
    Writeln(fo,WrkST);       Writeln(fo,LS);
    For I:= 1 to Na Do Begin
      Str(FITorder[I]:2,WrkST);
      For J:= Strt to Fini Do Begin
        Tmp:= A[I]^[J];
        If Tmp > 1.0E-3 Then ST:= Space + MinNumStr(Tmp) + '      '
                        Else ST:= Sci1(Tmp);
        ST[0]:= #8;          WrkST:= WrkST + ST;
        If J = Na Then WrkST:= WrkST + '  ¦'+PadNumStr0(A[I]^[Nap1]);
        End;
      Writeln(fo,WrkST);
      End;
    Writeln(fo,LS);
    End;
 { add a grid showing the points used in this fit }
  Writeln(fo);   Writeln(fo,NumPt,' Points were used in the ',LevelST[Lvl],' Level LLSQ Fit:');
  Writeln(fo);
  Writeln(fo,'  ',Alphabet,Alphabet,'ABCD');
  For I:= 1 to Xmax Do Begin
    WrkST:= RowID[I];
    For J:= 1 to Ymax Do Begin
      If FITpoint[I,J] Then CH:= '+'   Else CH:= Space;
      WrkST:= WrkST + CH;    End;
    Writeln(fo,WrkST,Space,RowID[I]);
    End;
 { add a list of sources used in this fit }
  Writeln(fo);
  Writeln(fo);   Writeln(fo,Na,' Sources were used in the ',LevelST[Lvl],' Level LLSQ Fit:');
  Writeln(fo);
  For N:= 1 to Nsrc Do With SrcInfo[N] Do If DoSrc[1] Then Begin
    If FITsrc Then ST:= 'Fitted'    Else ST:= 'Fixed ';
    Writeln(fo,ST,N:5,'  ',Name);
    End;
  Close(fo);
End;


Procedure Simultaneous;
{ Source: Applied Numerical Methods by Brice Carnahan, H.A. Luther, and James O. Wilkes
          John Wiley & Sons, Inc., 1969.
  Gauss-Jordan complete elimination method with maximum pivot strategy.
  The matrix A is inverted and the solution is stored in X.   }
Var
  Piv, Piv1,   { index to pivot ID number and Piv1 = Piv - 1 }
  Row, Col,    { array index }
  RowX,ColX,   { pointer index }
  Count      : Integer; { counts number of interchanges }
  PivOrdr,     { array with proper order for pivots }
  RowP,ColP  : Array[1..SrcMax] of Integer; { subscripts of pivot elements }
  Aij,                  { array element being adjusted }
  Deter,                { determinant of the coefficient matrix }
  PivotValue : Double;  { value of pivot element }
Function Seek_Max : Boolean;
{ Returns true if the current values for Row and Col are not in a
  previous pivot position.  }
Var  RowS,ColS : Integer; { subset of array index }
Begin
  Seek_Max:= false;
  For RowS:= 1 to Piv1 Do If Row = RowP[RowS] Then Exit;
  For ColS:= 1 to Piv1 Do If Col = ColP[ColS] Then Exit;
  Seek_Max:= true;
End;
Begin
  Add_Line('Attempting to solve the simultaneous equations');
  GotoXY(10,Succ(ScnLine));    Write('    (',MaxAvail,' bytes free)');
```

```
 { elimination procedure }
  Deter:= 1.0;              TextAttr:= LightGreen;
  For Piv:= 1 to Na Do Begin
   { look for pivot element }
    Piv1:= Pred(Piv);        PivotValue:= 0.0;
    For Row:= 1 to Na Do
      For Col:= 1 to Na Do If Seek_Max Then Begin { look for largest value }
        If PivotValue < Abs(A[Row]^[Col]) Then Begin
          PivotValue:= A[Row]^[Col];   RowP[Piv]:= Row;  ColP[Piv]:= Col;
          End;
        End;
    RowX:= RowP[Piv];        ColX:= ColP[Piv];
    GotoXY(66,ScnLine);      Write('Pivot',Piv:3);
    Msg(65,Succ(ScnLine),Sci2(PivotValue));
   { check for large enough pivot }
    If Abs(PivotValue) < Eps Then Begin
      TextAttr:= ErrColor;   Inc(ScnLine,2);
      Msg(6,ScnLine,'Solution is not possible!!');
      Exit;   End;
   { update the determinant }
    Deter:= Deter*PivotValue;
   { normalize pivot row elements }
    For Col:= 1 to Nap1 Do A[RowX]^[Col]:= A[RowX]^[Col] / PivotValue;
   { do elimination and develop inverse }
    A[RowX]^[ColX]:= 1.0 / PivotValue;
    For Row:= 1 to Na Do If Row <> RowX Then Begin
      Aij:= A[Row]^[ColX];    A[Row]^[ColX]:= -Aij / PivotValue;
      For Col:= 1 to Nap1 Do If Col <> ColX Then
        A[Row]^[Col]:= A[Row]^[Col] - Aij*A[RowX]^[Col];
      End;
    End;
 { order solution values and create the PivOrdr array }
  For Row:= 1 to Na Do Begin
    RowX:= RowP[Row];        ColX:= ColP[Row];
    PivOrdr[RowX]:= ColX;    SrcInfo[FITorder[ColX]].Conc[1]:= A[RowX]^[Nap1];
    End;
 { adjust sign of the determinant }
  Count:= 0;
  For Row:= 1 to Pred(Na) Do Begin
    For Col:= Succ(Row) to Na Do If PivOrdr[Col] < PivOrdr[Row] Then Begin
      RowX:= PivOrdr[Col];   PivOrdr[Col]:= PivOrdr[Row];
      PivOrdr[Row]:= RowX;   Inc(Count);
      End;
    End;
  If Odd(Count) Then Deter:= -Deter;
  Add_Line('Determinant of coefficient matrix is '+PadNumStrO(Deter));
End;


Procedure Do_LLSQ_Fit;
{ Carries out a linear least squares fit to the selected data.  The Lower
  variable selects whether the calculation is at chest or knee level. }
Var  PP : Pointer;
Begin
  New_Screen;    Add_Line('Linear Least Squares Fit to the Marked Data');
  Write('    (',MaxAvail,' bytes free)');
  Mark(PP);
  Get_A_Matrix(Lower);
  Write_A_Matrix(Lower);     Simultaneous;
  Release(PP);
  WhchPg:= 1;                DoFit:= false;
  ReDoConc[1]:= true;
  Pause_To_Look;
End;

{===== Source Concentration Page ===================================}

Procedure  Write_Item( s:Integer;  c:Byte );
{ Writes current values for SrcInfo[s] on the screen.
  The Conc value is written using the background color c.  The Source
  name is written according to the current status of the FITsrc flag. }
Var   Culur : Byte;
Begin
 { find the screen positions of the beginning of the highlighted cell }
  Iy:= 4 + (Pred(s) mod Imax);  { specifies row on the screen }
  Ix:= Cpos[Pred(s) div Imax];  { column on the screen }
 { set the color of the source name and write it }
  With SrcInfo[s] Do Begin
```

```
  If FITsrc Then TextAttr:= ConcColor[UnitID]
           Else TextAttr:= ConcColor[UnitID]+16*FITBkgrd;
  Msg(Ix+8,Iy,Copy(Name,1,18));
 { set the color of the source concentration and write it }
  If c = black  Then Culur:= HiColor
                Else Culur:= Black;
  TextAttr:= Culur + 16*c;
  If ShowC[Wsv] Then Msg(Ix,Iy,PadNumStr0(Conc[Wsv]))
                Else Msg(Ix,Iy,PadNumStr0(FaCn[Wsv]));
  End;
  GotoXY(Ix,Iy);
End;


Procedure Change(D:Integer);
{ Changes Isrc by D subject to the maximum value Nsrc.
  Smallest value is 1. }
Begin  Isrc:= Succ(Pred(Isrc + Nsrc + D) mod Nsrc);          End;

Procedure Down_Page;
Begin  SwitchPage:= true;  WhchPg:= Succ(WhchPg mod 8);      End;

Procedure Up_Page;
Begin  SwitchPage:= true;  WhchPg:= Succ((WhchPg+6) mod 8);  End;


Procedure Process_FuncKey_Src;
Var  L : Integer;
Begin
  CH:= ReadKey;
  Case CH of
     AltX : HellFreezes:= true;
     UP   : Change(-1);
     DN   : Change(+1);
    LFT   : Change(-Imax);
     RT   : Change(Imax);
     F1   : Show_Help_Page;
     F2   : Begin  DoStatsCal:= true;     SwitchPage:= true;  End;
     SF2  : Begin  DoStatsStg:= true;     SwitchPage:= true;  End;
     F3   : With SrcInfo[Isrc] Do Begin
              Conc[WhchPg]:= OrigC[WhchPg];
              FaCn[WhchPg]:= OrigF[WhchPg];
              End;
     AF3  : For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
              Conc[WhchPg]:= OrigC[WhchPg];
              FaCn[WhchPg]:= OrigF[WhchPg];
              Write_Item(L,black);
              End;
     F4   : With SrcInfo[Isrc] Do Begin
              Conc[WhchPg]:= GridC[WhchPg];
              FaCn[WhchPg]:= GridF[WhchPg];
              End;
     AF4  : For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
              Conc[WhchPg]:= GridC[WhchPg];
              FaCn[WhchPg]:= GridF[WhchPg];
              Write_Item(L,black);
              End;
     F5   : With SrcInfo[Isrc] Do Begin
              FITsrc:= not FITsrc;          CountSrc:= true;
              End;
     AF5  : Begin     CountSrc:= true;
              For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
                FITsrc:= true;   Write_Item(L,black);
                End;
              End;
     F6   : Begin     CountSrc:= true;          L:= Isrc;
              FunctionPressed:= not SrcInfo[Isrc].FITsrc;
              While (L > 1) and (SrcInfo[L].FITsrc xor FunctionPressed) Do
                With SrcInfo[L] Do Begin
                FITsrc:= not FITsrc;    Write_Item(L,black);
                Dec(L);   End;
              End;
     AF6  : Begin     CountSrc:= true;
              For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
                FITsrc:= false;         Write_Item(L,black);
                End;
              End;
     F7   : If WhchPg = 1 Then Beep
```

```
          Else Begin
            ShowC[WhchPg]:= not ShowC[WhchPg];
            ReDoConc[WhchPg]:= true;     SwitchPage:= true;
            End;
    F8   : Begin  DoFit:= true;     SwitchPage:= true;    End;
    F9   : If PressToCalc[1] Then Begin  RecomputeCal:= true;
            SwitchPage:= true;           WhchPg:= WhchPg + 5;    End;
    F10  : If (PressToCalc[2] or PressToCalc[3]) Then Begin
            RecomputeStg:= true;         RecomputeCal:= PressToCalc[1];
            SwitchPage:= true;           WhchPg:= WhchPg + 5;    End;
    PgDn : Down_Page;
    PgUp : Up_Page;
    HOM  : Isrc:= 1;     { to top of list }
    EndP : Isrc:= Nsrc;  { to bottom of list }
   Else  Beep  End;
  FunctionPressed:= false;
End;


Procedure Get_Real;
{ reads a real number and updates Conc & NewSumB as needed }
Var  NewNumber,OldNo : Single;
Begin
  With SrcInfo[Isrc] Do Begin
    If ShowC[WhchPg] Then NewNumber:= Conc[WhchPg]
                     Else NewNumber:= FaCn[WhchPg];
    OldNo:= NewNumber;
    Read_Real(NewNumber,0,10000,8,Ix,Iy);
    If OldNo <> NewNumber Then Begin
      If ShowC[WhchPg]
        Then Begin
          Conc[WhchPg]:= NewNumber;
          If WhchPg = 1 Then Begin
            Conc[2]:= Conc[1]*FaCn[2];
            Conc[3]:= Conc[2]*FaCn[3];
            End     Else
          If WhchPg = 2 Then Begin
            If Conc[1] = 0.0
              Then Begin
                Conc[2]:= 0.0;   Beep;
                End
              Else Begin
                FaCn[2]:= Conc[2]/Conc[1];
                Conc[3]:= Conc[2]*FaCn[3];
                End;
            End
          Else Begin
            If Conc[2] = 0.0
              Then Begin
                Conc[3]:= 0.0;   Beep;
                End
              Else FaCn[3]:= Conc[3]/Conc[2];
            End;
          End
        Else Begin
          FaCn[WhchPg]:= NewNumber;
          If WhchPg = 2 Then Conc[2]:= Conc[1]*FaCn[2];
          Conc[3]:= Conc[2]*FaCn[3];
          End;
      End;
    End;
  If FunctionPressed Then Process_FuncKey_Src;
End;


Procedure Show_Source_Page;
Var  L : Integer;        Chk : Boolean;
Begin
  Move(InScreen[WhchPg]^,Mem[$B800:0],8000);  { restores the previous screen }
  Wsv:= WhchPg;
  If ReDoConc[WhchPg] Then Begin   ReDoConc[WhchPg]:= false;
    For L:= 1 to Nsrc Do Write_Item(L,Black);
    End;
  TextAttr:= White;      Center_Msg(3,DataTitle[ShowC[WhchPg],WhchPg]);
  TextAttr:= HiColor;    GotoXY(60,48);    Write(Space,MaxAvail,' bytes free  ');
  If WhchPg = 1 Then Begin  GotoXY(6,46);    Write(NumPt,' points  ');   End;
  SwitchPage:= false;
  TextAttr:= TblColor;  Msg(60,46,DepthST[WhchPg>1]);
```

```
  Repeat
    Isave:= Isrc;
    If CountSrc Then Begin
      Na:= 0;          CountSrc:= false;
      For L:= 1 to Nsrc Do If SrcInfo[L].FITsrc Then Inc(Na);
      TextAttr:= HiColor;
      GotoXY(30,46);    Write(Na,' LLSQ Sources  ');
      GotoXY(30,48);    Write(Nsrc-Na,' Fixed Sources  ');
      End;
    Write_Item(Isrc,BoxBkgrd);
    CH:= UpCase(ReadKey);
    Case CH of
       #0     : Process_FuncKey_Src;
      Space   : With SrcInfo[Isrc] Do Begin
                  FITsrc:= not FITsrc;      CountSrc:= true;
                End;
      Period,
     '0'..'9' : Get_Real;
       TAB    : Change(Imax);
       CR     : Change(+1);
      Else  Beep  End;
    Write_Item(Isave,black);
  Until SwitchPage or HellFreezes;
  Move(Mem[$B800:0],InScreen[Wsv]^,8000);  { stores the whole screen }
 { Changes PressToCalc to true if an input changed.
   The NewSumB flags are set if Whch=1. }
  Chk:= false;
  For L:= 1 to Nsrc Do With SrcInfo[L] Do Begin
    DoSrc[Wsv]:= FITsrc or (Conc[Wsv] <> 0.0);
    If Conc[Wsv] <> GridC[Wsv] Then Begin        Chk:= true;
      If Wsv = 1 Then NewSumB[Pred(L+SumBlk) div SumBlk]:= true;
      GridC[Wsv]:= Conc[Wsv];   GridF[Wsv]:= FaCn[Wsv];
      End;
    End;
  If Chk and not PressToCalc[Wsv] Then Begin
    If Wsv = 1 Then Begin
      PressToCalc[1]:= true;
      PressToCalc[2]:= true;
      If not ShowMore Then RecomputeCal:= true;
      End   Else
    If Wsv = 2 Then PressToCalc[2]:= true;
    PressToCalc[3]:= true;
    If not ShowMore Then RecomputeStg:= true;
    End;
End;

{===== Graphical (text mode) Page ===================================}

Procedure  Compute_Relative_Errors;
{ Recompute the relative errors between RPTdata and SumTotal }
Var   I,J : Integer;
  TotC,TotK,SumC,SumK,WrkC,WrkK : Single;
Function Find_Rel_Err(Lvl:Boolean) : Single;
{ performs calculation for chest or knee }
Var  Datm,Calc,Rat : Single;
Begin
  Datm:= RPTdata[Lvl]^[I,J];          Calc:= SumTotal[Lvl]^[I,J];
  If (Datm > 0.0) and (Calc > 0.0)
    Then Begin
      If Datm < Calc Then Find_Rel_Err:= (Calc-Datm) / (Datm+1.0)
                     Else Find_Rel_Err:= (Calc-Datm) / (Calc+1.0)
      End
    Else Begin
      FITpoint[I,J]:= false;         Find_Rel_Err:= 0.0;
      End;
End;
Begin
  SumC:= 0.0;                        SumK:= 0.0;
  TotC:= 0.0;                        TotK:= 0.0;
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do Begin
      WrkC:= Find_Rel_Err(Chst);     RelErr[Chst]^[I,J]:= WrkC;
      WrkK:= Find_Rel_Err(Knee);     RelErr[Knee]^[I,J]:= WrkK;
      TotC:= TotC + Abs(WrkC);       TotK:= TotK + Abs(WrkK);
      If FITpoint[I,J] Then Begin
        SumC:= SumC + Abs(WrkC);     SumK:= SumK + Abs(WrkK);
        End;
      End;
```

```
  FITRelErr[Chst]:= SumC;           FITRelErr[Knee]:= SumK;
  TotRelErr[Chst]:= TotC;           TotRelErr[Knee]:= TotK;
End;


Procedure Make_Ratio_Grid;
Procedure Put_Grid(Lvl:Boolean);
{ Computes the dose rate ratios grid, including the title }
Var  I,J,K : Integer;     Tmp : Single;
Begin
With GridData[MREpg,Lvl] Do Begin
  GrdName:= 'MCNP Compared with Measurements -- '+LevelSt[Lvl]+' Level'+DepthST[Watr16];
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do Begin
      Tmp:= RelErr[Lvl]^[I,J];       K:= 0;
      While Tmp > RatioHi[K] Do Inc(K);
      With GrfPlot[I,J] Do Begin
        Acolor:= RatioColor[K];     Achar:= GrfCH[K];
        End;
      End;
  End;
End;
Begin
  Compute_Relative_Errors;
  Put_Grid(Chst);             Put_Grid(Knee);
  Dump_2D_File(MREpg,RelErr,'Modified Relative Error');
End;


Procedure  New_Source_File;
{ Writes a listing of the current source assumptions to a file. }
Var  fo : Text;         N : Integer;
Begin
  Str(FileIndx:2,ST);    If ST[1] = Space Then ST[1]:= Zero;
  Assign(fo,FileDrive+StdFileName+ST+'.S');      Rewrite(fo);
  Add_Line('Writing the source list to '+ST);
  Writeln(fo,SrcTitle1); Writeln(fo,SrcTitle2);
  For N:= 1 to Nsrc Do Begin
    Source_Info_ST(N);   Writeln(fo,ST);
    End;
  Writeln(fo);
  Writeln(fo,'Sum of Magnitudes of Modified Relative Errors:');
  Writeln(fo,MinNumStr(TotRelErr[Chst]),' (chest), and ',MinNumStr(TotRelErr[Knee]),' (knee)');
  Close(fo);
End;


Procedure Read_MCNP_Binary(Blk:Integer; Lvl:Boolean);
{ This updates both SumB[Lvl,Blk] and SumTotal[Lvl].  }
Var  I,J,N,Strt : Integer;      Cnc,Tmp : Single;
Begin
 { zero the SumB[Blk,Lvl] array }
  FillChar(SumB[Blk,Lvl]^,SizeOf(StdGrid),0);
 { read in the new values for SumB }
  Strt:= Blk*SumBlk - Pred(SumBlk);{ starting index for this group of sources }
  Seek(fb[Lvl],Succ(Strt));
  For N:= Strt to Pred(Strt+SumBlk) Do Begin
    Cnc:= SrcInfo[N].Conc[1];
    Read(fb[Lvl],OneRec);{ dose rates from the Nth source }
    If SrcInfo[N].DoSrc[1] Then
      For I:= 1 to Xmax Do
        For J:= 1 to Ymax Do Begin
          Tmp:= OneRec.DR[I,J]*Cnc;
          If Tmp > 1.0E-06 Then Begin
            SumTotal[Lvl]^[I,J]:= SumTotal[Lvl]^[I,J] + Tmp;
            SumB[Blk,Lvl]^[I,J]:= SumB[Blk,Lvl]^[I,J] + Tmp;
            End;
          End;
    End;
End;


Procedure Redo_Calibration_Grid;
{ Recomputes the SumB and SumTotal arrays  }
Var  I,J,K,L : Integer;
Begin
  New_Screen;                         Inc(FileIndx); { new set of files }
  RecomputeCal:= false;               PressToCalc[1]:= false;
```

```
  Add_Line('Computing the new total dose rates -- calibration case');
 { recompute the SumTotal array, updating SumB is needed }
  FillChar(SumTotal[Chst]^,2*SizeOf(StdGrid),0);
  For L:= 1 to SumMax Do Begin
    If NewSumB[L]
      Then Begin { read the binary files }
        Read_MCNP_Binary(L,Chst);   Read_MCNP_Binary(L,Knee);
        NewSumB[L]:= false;
        End
      Else Begin { just add SumB to SumTotal }
        For I:= 1 to Xmax Do
          For J:= 1 to Ymax Do Begin
            SumTotal[Chst]^[I,J]:= SumTotal[Chst]^[I,J] + SumB[L,Chst]^[I,J];
            SumTotal[Knee]^[I,J]:= SumTotal[Knee]^[I,J] + SumB[L,Knee]^[I,J];
            End;
        End;
    End;
 { update the graph arrays }
  Make_DR_Grid(GrCpg,SumTotal,'MCNP Dose Rates (mrem/h)');
  Make_Ratio_Grid; { computes RelErr array & appends to the 2D file }
  New_Source_File; { writes the current source file }
  Pause_To_Look;
End;


Procedure Redo_Stage_Grids;
{ Recomputes the SumTotS1 and SumTotS2 arrays  }
Var  K,Whch : Integer;
Procedure Total_Doses(Ptr:StdPtr2;  Lvl:Boolean;  Strt,Fini:Integer);
Var   I,J,N : Integer;                  Cnc,Tmp : Single;
Begin
  For N:= Strt to Fini Do Begin  { water & wall sources }
    Cnc:= SrcInfo[N].Conc[Whch];
    If Cnc > 0.0 Then Begin
      Seek(fb[Lvl],Succ(N));  Read(fb[Lvl],OneRec);
      If SrcInfo[N].DoSrc[Whch] Then
        For I:= 1 to Xmax Do
          For J:= 1 to Ymax Do Begin
            Tmp:= OneRec.DR[I,J]*Cnc;
            If Tmp > 1.0E-06 Then
              Ptr[Lvl]^[I,J]:= Ptr[Lvl]^[I,J] + Tmp;
            End;
      End;
    End;
End;
Begin
  New_Screen;                           PressToCalc[2]:= false;
  RecomputeStg:= false;                 PressToCalc[3]:= false;
 { Stage 1 dose rates ================ }
  Add_Line('Computing the new total dose rates -- Stage 1 case');
  Whch:= 2;
 { recompute the SumTotS1 array }
  FillChar(SumTotS1[Chst]^,2*SizeOf(StdGrid),0);
  Total_Doses(SumTotS1,Chst,SrcOthr,SrcMax);
  Total_Doses(SumTotS1,Knee,SrcOthr,SrcMax);
  Depth1:= Watr17;  { 17'2" depths }
  Switch_Assigns(Chst);  Switch_Assigns(Knee);
  Total_Doses(SumTotS1,Chst,1,SrcPool);
  Total_Doses(SumTotS1,Knee,1,SrcPool);
 { update the graph arrays }
  Make_DR_Grid(Sg1Pg,SumTotS1,'Stage 1 Dose Rates (mrem/h)');
 { Stage 2 dose rates ================ }
  Add_Line('Computing the new total dose rates -- Stage 2 case');
  Whch:= 3;
 { recompute the SumTotS2 array }
  FillChar(SumTotS2[Chst]^,2*SizeOf(StdGrid),0);
  Total_Doses(SumTotS2,Chst,1,SrcMax);
  Total_Doses(SumTotS2,Knee,1,SrcMax);
 { update the graph arrays }
  Make_DR_Grid(MaxPg,SumTotS2,'Stage 2 Dose Rates (mrem/h)');
  Depth1:= Watr16;  { 16'10" depths }
  Switch_Assigns(Chst);  Switch_Assigns(Knee);
  Pause_To_Look;
End;


Procedure Write_Point_Total;
Begin
```

```
  TextAttr:= HiColor;   GotoXY(65,47);   Write(NumPt,' points  ');
End;


Procedure Write_Grid;
{ Displays the dose rate grid on the screen, beginning with the title. }
Procedure Put_Grid(Lvl:Boolean);
Var  I,J : Integer;          Tmp : Single;
Begin
With GridData[WhchPg,Lvl] Do Begin
  Writeln;
  TextAttr:= GridTitle;      Write(Space,GrdName);
  TextAttr:= White;
  If WhchPg > MREpg Then Writeln
    Else Begin               GotoXY(63,WhereY);
    Writeln('MRE: '+MinNumStr(FITRelErr[Lvl])+'/'+MinNumStr(TotRelErr[Lvl])+'  ');
    End;
  Writeln('  ',Alphabet,Alphabet,'ABCD');
  For I:= 1 to Xmax Do Begin
    TextAttr:= White;        Write(RowID[I]);
    For J:= 1 to Ymax Do
      If FITpoint[I,J] or (WhchPg > MREpg)
        Then  With GrfPlot[I,J] Do Begin
          TextAttr:= Acolor; Write(Achar);
          End
        Else Begin
          TextAttr:= Black;  Write(Space);
          End;
    TextAttr:= White;        Write(RowID[I]);
    If I > 17 Then Writeln
    Else Begin
      If WhchPg = 6
        Then Begin
          TextAttr:= RatioColor[I];         Writeln('  ',RatioST[I]);
          End
        Else Begin
          If I = 17 Then Writeln   Else Begin
            TextAttr:= Spectrum[I];
            Writeln('    ',#219,' < ',MinNumStr(DRhigh[I]));
            End;
          End;
      End;
    End;
  End;
End;
Begin
  New_Screen;
  Put_Grid(Chst);            Put_Grid(Knee);
  TextAttr:= TblColor;       Msg(72,2,'Page'+RowID[WhchPg]);
  TextAttr:= HelpTitle;
  ClrMsg(1,48,
    ' F5:Mark Column   F6:Mark Row   F7:Mark All   AltF5-F7:Mark Pattern ');
  ClrMsg(1,49,
    ' PgUp,PgDn,0-3:Page   Space:Mark Point   Tab:Chest/Knee ');
  Write_Point_Total;
End;


Procedure Write_Grid_Point(x,y:Integer;  c:Byte;  Lvl:Boolean);
Var   TmpC,TmpK : Single;      UnitST : ST9;
Begin
  Iy:= x + Roff[Lvl];        Ix:= y + 2;
  If c = black
    Then Begin If FITpoint[x,y]
      Then With GridData[WhchPg,Lvl].GrfPlot[x,y] Do Begin
        TextAttr:= Acolor;   CH:= Achar;   End
      Else Begin  TextAttr:= black;  CH:= Space;  End;
      End
    Else Begin
      TextAttr:= TblColor;   Msg(67,23,ColID[Col]+RowID[Row]);
      UnitST:= ' mrem/h  ';  Msg(67,45,ColID[Col]+RowID[Row]);
      If WhchPg = GrRPg Then Begin
        TmpC:= RPTdata[Chst]^[x,y];   TmpK:= RPTdata[Knee]^[x,y];
        End    Else
      If WhchPg = GrCpg Then Begin
        TmpC:= SumTotal[Chst]^[x,y];  TmpK:= SumTotal[Knee]^[x,y];
        End    Else
      If WhchPg = MREpg Then Begin    UnitST:= '         ';
```

```
        TmpC:= RelErr[Chst]^[x,y];    TmpK:= RelErr[Knee]^[x,y];
        End    Else
      If WhchPg = Sg1Pg Then Begin
        TmpC:= SumTotS1[Chst]^[x,y];  TmpK:= SumTotS1[Knee]^[x,y];
        End    Else
      If WhchPg = MaxPg Then Begin
        TmpC:= SumTotS2[Chst]^[x,y];  TmpK:= SumTotS2[Knee]^[x,y];
        End;
      Msg(65,24,MinNumStr(TmpC)+UnitST);
      Msg(65,46,MinNumStr(TmpK)+UnitST);
      TextAttr:= 16*c;  CH:= CursCH;
      End;
  Msg(Ix,Iy,CH);    GotoXY(Ix,Iy);
End;


Procedure Process_FuncKey_Grid;
Var  I,J,L,K,Stp,Stp1 : Integer;     Flg : Boolean;
Begin
  CH:= ReadKey;
  Case CH of
     AltX : HellFreezes:= true;
     UP   : Row:= Succ((Row+Xmax-2) mod Xmax);
     DN   : Row:= Succ(Row mod Xmax);
     LFT  : Col:= Succ((Col+Ymax-2) mod Ymax);
     RT   : Col:= Succ(Col mod Ymax);
     F1   : Show_Help_Page;
     F2   : Begin  DoStatsCal:= true;     SwitchPage:= true;  End;
     SF2  : Begin  DoStatsStg:= true;     SwitchPage:= true;  End;
     F5   : Begin   Flg:= not FITpoint[Row,Col];
            For L:= 1 to Xmax Do Begin   FITpoint[L,Col]:= Flg;
              Write_Grid_Point(L,Col,black,Lower);
              Write_Grid_Point(L,Col,black,not Lower);
              End;
            CountPt:= true;
            End;
     F6   : Begin   Flg:= not FITpoint[Row,Col];
            For L:= 1 to Ymax Do Begin   FITpoint[Row,L]:= Flg;
              Write_Grid_Point(Row,L,black,Lower);
              Write_Grid_Point(Row,L,black,not Lower);
              End;
            CountPt:= true;
            End;
     F7   : Begin   Flg:= not FITpoint[Row,Col];
            For L:= 1 to Xmax Do
              For K:= 1 to Ymax Do Begin   FITpoint[L,K]:= Flg;
                Write_Grid_Point(L,K,black,Lower);
                Write_Grid_Point(L,K,black,not Lower);
                End;
            CountPt:= true;
            End;
     AF5,AF6,
     AF7  : Begin
            FillChar(FITpoint,SizeOf(FITpoint),0);
            Stp:= Ord(CH) - 106;        I:= Ymax - (Col mod Stp);
            L:= Xmax - (Row mod Stp);
            While L > 0 Do Begin
              K:= I;
              While K > 0 Do Begin
                FITpoint[L,K]:= true;   Dec(K,Stp);
                End;
              Dec(L,Stp);
              End;
            SwitchPage:= true;          CountPt:= true;
            End;
     PgDn : Down_Page;
     PgUp : Up_Page;
     F8   : Begin  DoFit:= true;          SwitchPage:= true;    End;
     F9   : If PressToCalc[1] Then Begin
              RecomputeCal:= true;        SwitchPage:= true;    End;
     F10  : If (PressToCalc[2] or PressToCalc[3]) Then Begin
              RecomputeCal:= PressToCalc[1];
              RecomputeStg:= true;        SwitchPage:= true;    End;
     HOM  : Row:= 1;    { to top of grid }
     EndP : Row:= Xmax; { to bottom of grid }
    Else  Beep  End;
  FunctionPressed:= false;
End;
```

```
Procedure Show_Grid_Page;
{ Shows the RPT data, MCNP dose rates, and ratios }
Var   CursCH : Char;
Procedure Verify_FITpoint;
{ Checks that invalid points are not marked true.  Also counts valid points. }
Var   I,J : Integer;     Flg : Boolean;
Begin
  NumPt:= 0;          CountPt:= false;
  For I:= 1 to Xmax Do
    For J:= 1 to Ymax Do Begin
      Flg:= (SumTotal[Chst]^[I,J] > 0) and (RPTdata[Chst]^[I,J] > 0) and FITpoint[I,J];
      FITpoint[I,J]:= Flg;        If Flg Then Inc(NumPt);
      End;
  Write_Point_Total;
End;
Begin
  Write_Grid;           SwitchPage:= false;
  If PressToCalc[1] and ((WhchPg = GrCpg) or (WhchPg = MREpg))
    Then Begin  TextAttr:= HiColor;
      Msg(5,25,'Press F9 to Recalculate Calibration Dose Rates');
      End     Else
  If (PressToCalc[2] or PressToCalc[3]) and (WhchPg > MREpg)
    Then Begin  TextAttr:= HiColor;
      Msg(5,25,'Press F10 to Recalculate Stage 1 & 2 Dose Rates');
      End;
  Repeat
    Rsave:= Row;   Csave:= Col;   Lsave:= Lower;
    If CountPt and not PressToCalc[1] Then Verify_FITpoint;
    Write_Grid_Point(Row,Col,BoxBkgrd,Lower);
    CH:= UpCase(ReadKey);
    Case CH of
      #0       : Process_FuncKey_Grid;
      Space    : Begin  BothGrd:= true;   CountPt:= true;
                 FITpoint[Row,Col]:= not FITpoint[Row,Col];    End;
      '1'..'8' : Begin  WhchPg:= Ord(CH) - 48;  SwitchPage:= true;  End;
      Tab      : Lower:= not Lower;
      Else  Beep  End;
    If not SwitchPage Then Write_Grid_Point(Rsave,Csave,black,Lsave);
    If BothGrd Then Begin
      Write_Grid_Point(Rsave,Csave,black,not Lsave);
      BothGrd:= false;       End;
  Until SwitchPage or HellFreezes;
End;

{===== Main Program SSS.PAS =========================================}

Begin
  Initialize;
 { read the RPT dose rate files and prepare the grid }
  Make_RPT_Grid;
  Repeat
    If DoStatsCal Then Begin
      If PressToCalc[1] Then Redo_Calibration_Grid;
      Make_Stat_Files(1);
      End         Else
    If DoStatsStg Then Begin
      If PressToCalc[1] Then Redo_Calibration_Grid;
      If PressToCalc[2] or PressToCalc[3] Then Redo_Stage_Grids;
      Make_Stat_Files(2);      Make_Stat_Files(3);
      End;
    If DoFit and (Na > 0) and (Na <= NumPt) Then Do_LLSQ_Fit;
    If WhchPg < 4 Then Show_Source_Page
      Else Begin
        If RecomputeCal and PressToCalc[1] Then Redo_Calibration_Grid;
        If RecomputeStg and (PressToCalc[2] or PressToCalc[3]) Then Redo_Stage_Grids;
        Show_Grid_Page;
        End;
    Blanks[0]:= #66;
  Until HellFreezes;
  Close(fb[Chst]);          Close(fb[Knee]);
  TextMode(ModeSave);
End.
```

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