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Beta and Gamma Dose Calculations for PWR and BWR Containments

Prepared by D. B. King

Sandia National Laboratories

Prepared for
U.S. Nuclear Regulatory
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NUREG/CR-4949, "Source Term Calculations for Assessing Radiation Dose to Equipment", R.S. Denning, R. Freeman-Kelly, P. Cybulskis, L.A.Curtis, Battelle Columbus Laboratory, July 1989.

ABSTRACT

Analyses of gamma and beta dose in selected regions in PWR and BWR containment buildings have been performed for a range of fission product releases from selected severe accidents. The objective of this study was to determine the radiation dose that safety-related equipment could experience during the selected severe accident sequences. The resulting dose calculations demonstrate the extent to which design basis accident qualified equipment would also be qualified for the severe accident environments. Surry was chosen as the representative PWR plant while Peach Bottom was selected to represent BWRs. Battelle Columbus Laboratory performed the source term release analyses. The AB epsilon scenario (an intermediate to large LOCA with failure to recover onsite or offsite electrical power) was selected as the base case surry accident, and the AE scenario (a large break LOCA with one initiating event and a combination of failures in two emergency cooling systems) was selected as the base case Peach Bottom accident. Radionuclide release was bounded for both scenarios by including spray operation and arrested sequences as variations of the base scenarios. Sandia National Laboratories used the source terms to calculate dose to selected containment regions. Scenarios with sprays operational resulted in a total dose comparable to that (2.20×10^8 rads) used in current equipment qualification testing (for design basis accidents or Regulatory Guide 1.89). The base case scenarios resulted in some calculated doses roughly an order of magnitude above the current 2.20×10^8 rad equipment qualification test region.

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EXECUTIVE SUMMARY

Analytical investigations of potential beta and gamma radiation dose to selected regions in PWR and BWR containment buildings have been conducted for a range of fission product releases from selected severe accidents. Total dose was calculated for the selected severe accident sequences using NUREG-0956 methods. Battelle Columbus Laboratory (BCL) has calculated time-dependent distributions of radionuclides within containment following severe accident scenarios using the NRC source term code package. The selected LWR severe accident conditions did not satisfy the design basis accident (DBA) criteria but were realistic estimates of severe accidents that have many characteristics of the prescribed DBA as used in the equipment qualification rule 10CFR50.49 and Regulatory Guide 1.89. Sandia National Laboratories (SNL) used the resulting radionuclide distributions to calculate radiation dose in containment. The dose calculation results provide a basis to evaluate the extent to which DBA qualified equipment is also qualified for the selected severe accident environments.

Surry was chosen to be the representative PWR plant because it is one of the NUREG-1150 reference plants for which many source term code package analyses have been performed. Peach Bottom was selected as a representative BWR plant due to available source term code package work that supported the preparation of NUREG-0956. Both plants have been extensively analyzed and are representative of a large number of plants.

The accident scenario selected by BCL for the PWR analysis was the AB epsilon scenario. The AB epsilon scenario is an intermediate to large LOCA with failure to recover onsite or offsite electrical power. BCL noted that this scenario would produce the most severe radionuclide release into containment. Three additional variations of the AB epsilon scenario were developed to envelope the radionuclide release for less severe accidents. The first variation investigated the effect of reestablishing core cooling and arresting the sequence before vessel failure by removing all radionuclide contribution from the core-concrete attack period. Variation two simulated spray operation with full core meltdown. All airborne activity (except noble gas activity) and surface activity were washed to the sump. The third variation was an arrested sequence with spray operation. No leakage from containment to the environment was assumed in any of the cases.

The BWR accident scenario selected to determine radionuclide release to containment was the AE sequence. The AE sequence is a large break LOCA with one initiating event and a combination of failures in two emergency cooling systems. The AE sequence is analogous to the PWR AB sequence. Three additional variations of the AE scenario were also developed to bound the radionuclide release. These variations were identical in nature to the PWR variations for no core-concrete attack and containment spray operation.

Calculated radionuclide releases for the source terms were time dependent locational distributions within containment following the accident. Locational distribution refers to airborne radionuclide release, radionuclide plateout on walls, radionuclide deposition to floors, or radionuclide release washed into the sump. The BCL Surry PWR source term

calculations treated the containment as a single volume and the Peach Bottom BWR source term calculations treated the containment as two volumes (the drywell and wetwell).

Gamma dose rate was calculated by Sandia using the PATH point kernel code. PATH calculations are based upon exponential attenuation from source point to dose point with appropriate adjustment by buildup factors. PATH was developed at General Atomic. Beta dose rates were calculated using the ITS code. ITS calculations use Monte Carlo solution of linear time-integrated electron radiation transport.

Combinational geometry subroutines in PATH and ITS allowed true modeling of each room or containment region in both Surry and Peach Bottom. Major structures such as walls, ceilings, and floors were modeled for each containment. Rooms and containment regions were generally further divided into subzones for beta dose calculations.

The results of this study represent a scoping effort and provide approximate estimate of dose. The radionuclide release for the airborne, plate-out, and waterborne sources was assumed to be uniformly distributed throughout containment at each calculational time period. Containment models were kept relatively simple due to the scoping nature of this study. The calculations do allow the effects of engineering safety features (ESF) operation from case to case to be compared. The effect of compartment size and structure on dose will also be evident from the results.

The accident scenario calculations with sprays operational for the Surry PWR resulted in a maximum total dose of 2.60×10^8 rads in interior compartments, 1.80×10^8 rads in the basement, 2.3×10^8 rads in the annulus, and 7.3×10^7 rads in the dome region. Maximum Peach Bottom total dose during spray operation was calculated to be 1.10×10^8 rads in the drywell. For comparison, Reg Guide 1.89, Appendix D, suggests an equipment qualification dose of 2.20×10^8 rads. Safety-related equipment is currently tested through $\sim 2.2 \times 10^8$ rads. Radionuclide release to containment during spray operation appears to pose no significant challenge to equipment tested to 2.20×10^8 rads.

The base Surry AB epsilon severe accident scenario calculations resulted in maximum total doses of 2.3×10^9 rads in interior compartments, 3×10^9 rads in the basement, 1.2×10^9 rads in the annulus, and 1.7×10^9 rads in the dome region. Peach Bottom severe accident calculations resulted in a maximum total dose of 1.8×10^9 rads in the drywell. The calculated total dose is roughly an order of magnitude above current equipment qualification testing limits.

The results from this study suggest two follow-on tasks. Studies designed to calculate the physical transport of radionuclides from the release point in containment to other parts of containment should be performed. Assuming instantaneous radionuclide dispersement in containment results in low dose rate calculations in the release zone and conservative dose rate calculations far from the release point. The base case Surry and Peach Bottom beta surface dose rate calculations should be re-examined with more finely divided zoned regions; this exercise should result in improved (and possibly lower) dose calculations.

1.0 INTRODUCTION

During a loss-of-coolant accident (LOCA), reactor core fuel damage may occur resulting in release of fission product inventory from the core to the containment. Brookhaven National Laboratory published an early analysis (WASH-740)[1] of a nuclear power plant accident and fission product release in 1957. This publication specified the radiation source term to be an instantaneous release of 50 percent of the noble gases, 50 percent of the halogens, and 50 percent of the solid fission products from the reactor fuel. The WASH-740 source term was believed to represent an upper bound; the release values were assumed high due to lack of technical data at the time. Fission product transport from the core to the rest of containment was not analyzed. Current accident source terms were reestimated in TID 14844.[2] The TID source term is similar to the WASH-740 source term and assumes 100 percent release of noble gases, 50 percent release of iodine, and 1 percent release of solid fission products. The fission product release pathway or physical phenomena were not modeled or analyzed in either study. Current NRC Regulatory Guides use the TID source terms as representative values for an upper bound credible accident source term. These source term values form the basis for the current radiation environment under which safety-related equipment must be qualified to operate.

The Accident Source Term Program was initiated by the NRC after the Three Mile Island Unit 2 accident. The scope of the program included assessing the technical basis for predicting severe accident source terms, to develop improved methods of analysis, and to determine whether the existing treatment of source terms in the regulatory process was conservative. The results of the NRC staff reassessment of analytical procedures for estimating accident source terms were published in NUREG-0956, "Reassessment of the Technical Bases for Estimating Source Terms," in June 1986.[3] The report recommended that the Source Term Code Package (STCP) be used as a basis for source term analyses; the STCP represents an improved approach to predicting severe accident source terms.

The objective of this SNL study was to determine the radiation dose that safety related equipment could experience during the severe accident sequences using updated source terms based on NUREG-0956 methods. Battelle Columbus Laboratory (BCL) developed time-dependent distributions of radionuclides within containment following a severe accident using the STCP. The radionuclide release for the LWR accident conditions were realistic estimates of severe accidents that have many of the characteristics of the prescribed DBA as used in the equipment qualification rule 10CFR50.49 and Regulatory Guide 1.89.[4] Sandia National Laboratories used the radionuclide distribution supplied by BCL to calculate radiation dose in containment. The source term and dose calculation results will demonstrate the extent to which DBA qualified equipment would also be qualified for severe accident environments.

2.0 SOURCE TERM CALCULATIONS

Source term calculations were performed for a PWR containment (Surry) and a BWR containment (Peach Bottom). Surry was chosen as a representative PWR containment because it is one of the NUREG-1150 reference plants for which a number of STCP analyses have been performed. Peach Bottom was also chosen due to STCP work performed to support the preparation of NUREG-0956. Both plants have been extensively analyzed and are representative of a large number of plants.

2.1 Surry Source Term Calculations

Three accident scenarios were considered for the Surry source term calculations: AB epsilon, S_2D epsilon, and TMLB epsilon. BCL concluded that the AB epsilon scenario would provide the best basis for analyzing equipment radiation dose and dose rates. BCL noted that the AB epsilon scenario involved the fastest core meltdown due to early core uncovery, there was little radionuclide retention in the reactor coolant system, there was no overlying pool of water in the reactor cavity which could scrub out the released radionuclides, and there was no operation of containment sprays which could lead to rapid removal of airborne radionuclides. The conditions listed above would produce a radionuclide release into containment simulating a severe accident.

Four variations of the AB epsilon scenario were developed to provide an envelope of radionuclide release. Case 1 STCP was the base case with full core meltdown; the results were taken directly from the STCP analyses. No leakage to the environment from containment was assumed; therefore, the results were renormalized to account for any predicted leakage to the environment by the STCP analyses. The Case 1 calculation ended at 24 hours at which time airborne radionuclides other than the noble gases were assumed to be deposited to surfaces. Case 2 investigated the effect of reestablishing core cooling and arresting the sequence without RPV failure. The radionuclide contribution from the core-concrete attack period was thus removed. Case 3 simulated containment spray operation by removing all airborne radioactivity (except noble gas activity) instantaneously to the sump. No activity was assumed to remain on the containment surfaces. Case 3 also involved full core meltdown. Case 4 was an arrested sequence with spray operation and simulated a design basis accident. Airborne activity in Case 4 was transferred directly to the sump and no activity was assumed on the containment surfaces.

For all cases, ORIGEN2 calculations were performed to determine the time dependent inventory of radionuclides during the first year following the accident. The ORIGEN2 calculations were needed because the codes used to calculate dose rate to equipment require the activity of all released radionuclides as a function of time.

2.2 Peach Bottom Source Term Calculations

BCL selected the AE sequence to use for calculating radionuclide release to containment for a severe accident. The AE sequence is analogous to the PWR AB sequence. The characteristics of the AE sequence which made it appropriate to use as a base case are early core uncovery and fission product release, little retention in the reactor coolant system, direct release of radionuclides to the drywell during the in-vessel melting period, large ex-vessel release of fission products, and no operation of the drywell spray.

Four variations of the AE sequence were also developed to bound the radionuclide release to containment. Case 1 was the base case with full core meltdown. Any leakage which was predicted to occur after containment failure by the STCP was reassigned to the airborne species in the drywell. Case 2 was an arrested sequence; the contribution due to the core-concrete attack was removed from the results. Case 3 simulated drywell spray operation by removing all airborne radionuclides to the suppression pool. No activity was assumed to remain on the drywell surfaces. Full core meltdown was assumed. Case 4 simulated an arrested sequence with drywell sprays operating and approximates a design basis accident.

An ORIGEN2 calculation was also performed for the Peach Bottom Source term calculations.

Sections 1.0 and 2.0 of the text have summarized the text from NUREG/CR-4949, "Source Term Calculations for Assessing Radiation Dose to Equipment." This work was performed by Battelle Columbus Laboratory. The reader is referred to NUREG/CR-4949 for greater detail regarding the source term calculations.

Source term is defined in this report to be the release of radioactive material from the core to the containment. Release of radioactive material from the containment to the environment was not considered in this report.

Radionuclide releases for the source terms were time-dependent locational distributions within containment following the severe accident. The locational distributions refer to airborne radionuclide release, radionuclide diffusion to walls, radionuclide deposition to floors, and radionuclide release to the sump. The Surry PWR source term calculations treated the containment as a single volume and the Peach Bottom BWR source term calculations treated the containment as two volumes (the drywell and the wetwell).

3.0 RADIATION DOSE CALCULATIONAL TOOLS

Two computer codes were used to calculate radiation dose rate in containment for the radioactive beta and gamma fission product source terms calculated by BCL. One code (PATH) was used to calculate gamma dose rate, and the second code (ITS) was used to calculate beta dose rate.

The PATH[5] code is a shielding code which uses the common point-kernel integration technique to treat gamma radiation from reactors, radioactive components, and complex piping systems. The code is based upon exponential attenuation from source point to dose point with appropriate adjustment by buildup factors. PATH's major features include complex geometry capability, various source options, and an extensive data library for radionuclides. The PATH code was developed by the General Atomic Company.

Beta or electron dose rates were calculated using ITS[6], "The Integrated Series of Coupled Electron/Photon Monte Carlo Transport Codes." This series of codes allow the state-of-the-art Monte Carlo solution of linear time-integrated coupled electron/photon radiation transport problems. Physical rigor of the codes has been maintained by using the best available cross sections and sampling distributions as well as the most complete physical model for describing the production and transport of electron/photon cascade from 1.0 GeV to 1.0 keV. The particular code version chosen out of the integrated TIGER series (ITS) was ACCEPT. The ACCEPT code provides the ability to calculate electron transport through three-dimensional multimaterial geometries. The ITS was developed at Sandia National Laboratories.

4.0 CONTAINMENT MODELS

The volume of the Surry containment building is approximately 1,750,000 cubic feet (5.0×10^{10} cm^3). The geometry of the structure is considerably different from a large dry containment in that it is highly compartmentalized with the only large open volumes being the dome and operating floor. The containment model used in Surry was similar to that used in the ANS Source Term Study.[7] Two longitudinal sections of the building are shown in Figures 4.1 and 4.2. Plan views of the reactor building are shown in Figures 4.3 through 4.6. The compartments are identified in Table 4.1.

Each room in the Surry containment building (Table 4.1) was modeled for the gamma dose rate calculations with the PATH code through use of available combinatorial geometry subroutines. The Surry containment building rooms were generally further subdivided for the beta dose rate calculations using combinatorial geometry subroutines available in ITS. Appendix A shows the containment building zones used for the beta dose rate calculations.

Beta and gamma dose rates were calculated for representative points in the dome, operating floor, upper annulus, lower annulus, basement, the incore instrumentation room, the residual heat removal (RHR) cubicle, steam generator A cubicle, and steam generator B cubicle. The dose point locations (A-J) for the dome, operating floor, upper annulus, and lower annulus are shown in Figures 4.1 and 4.3. The dose point locations (A-I) for the basement are shown in Figure 4.4. Figure 4.5 illustrates the dose point locations (A-E) for the RHR cubicle and steam generator A cubicle. Figure 4.6 shows the incore instrumentation room and steam generator B cubicle dose point locations (A-E). Table 4.2 lists the containment building coordinates for all of the dose point locations. Dose point locations are given in terms of x, y, and z coordinates in feet. The x and y axes are labeled in Figures 4.3 through 4.6.

The Peach Bottom containment is divided into two zones. The drywell has a light bulb shape with the stem of the bulb pointing upward. The drywell is connected to a toroidal wetwell at the base of the inverted bulb. The drywell and wetwell are made of steel. The drywell volume is approximately 159,000 cubic feet (4.5×10^9 cm^3), and the wetwell volume is approximately 119,000 cubic feet (3.37×10^9 cm^3). A longitudinal section of the Peach Bottom nuclear power plant is shown in Figure 4.7.

The Peach Bottom drywell was modeled as one volume for the gamma dose rate calculations. The reactor vessel and its pedestal were also modeled in place as illustrated in Figure 4.7. The wetwell was modeled in two zones; that of the torus itself and the torus room which surrounds the torus. The drywell was further subdivided for the beta dose rate calculations. The drywell zones used for the beta dose rate calculations are illustrated in Appendix A.

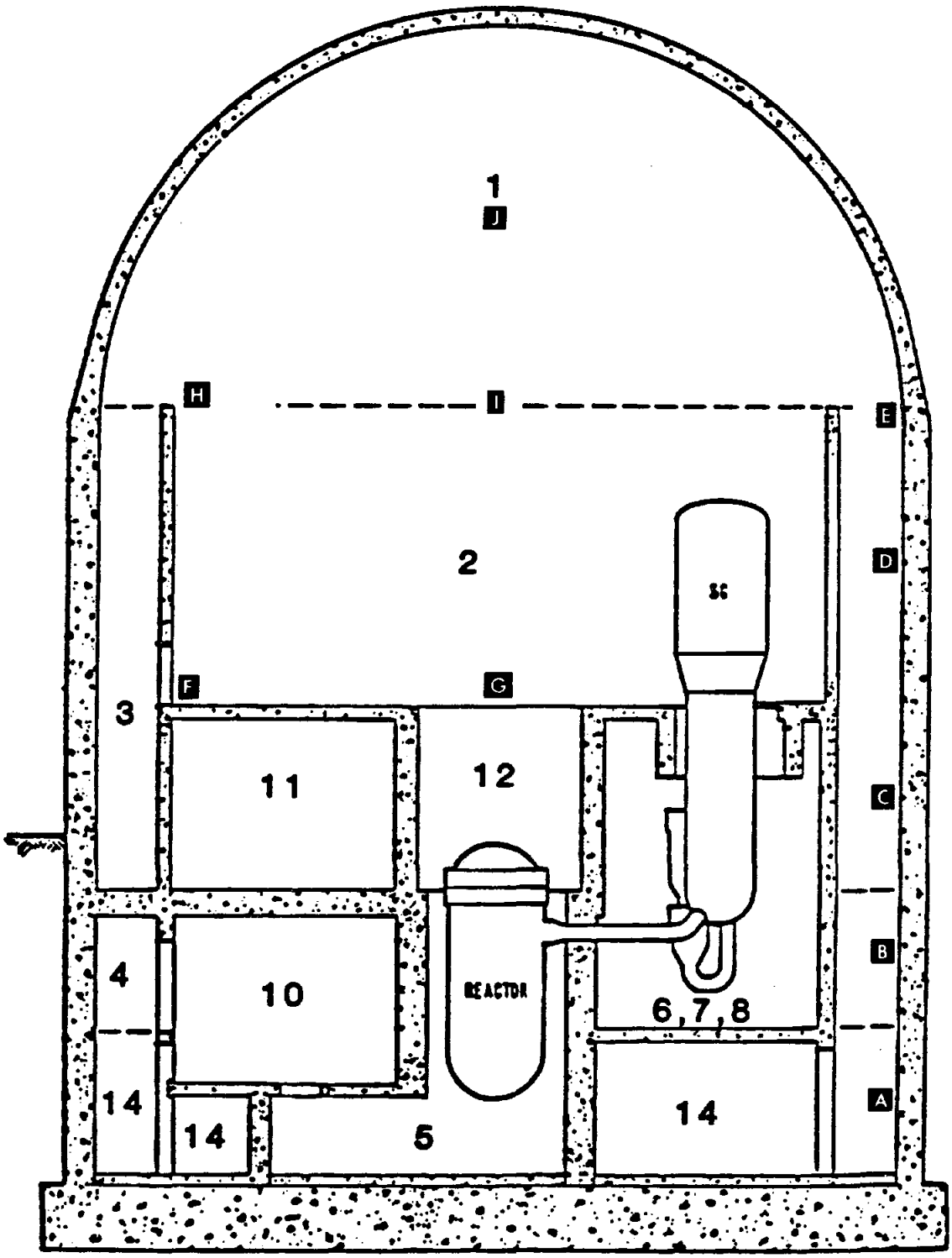


Figure 4.1. Surry Containment Section A

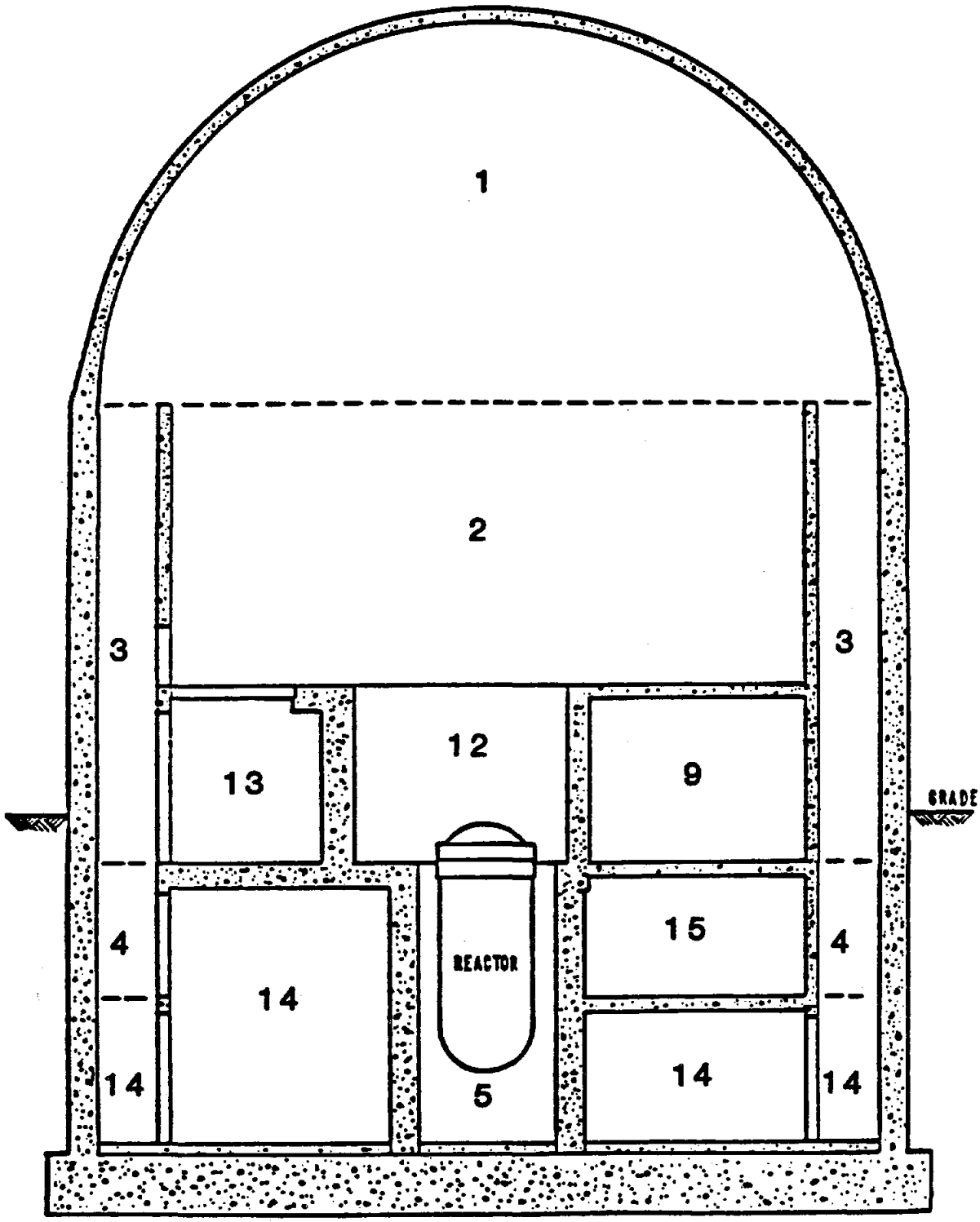


Figure 4.2. Surry Containment Section B

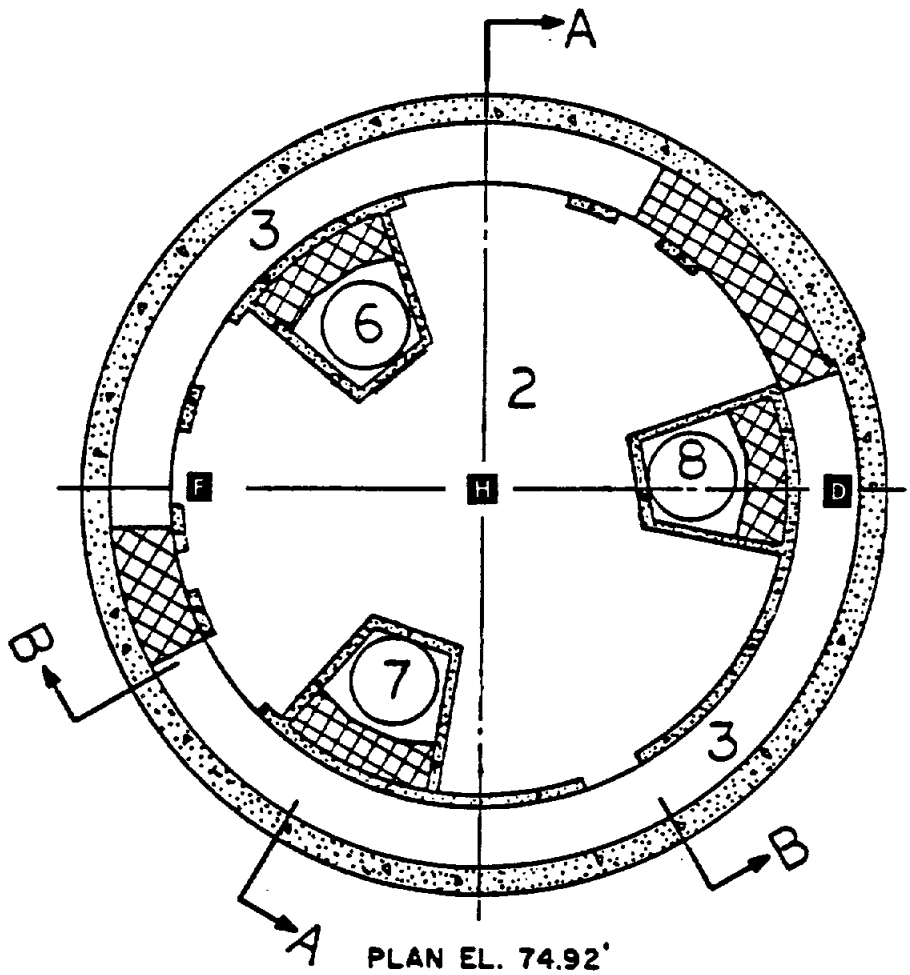


Figure 4.3. Surry Plan View Elevation 74.92 Feet

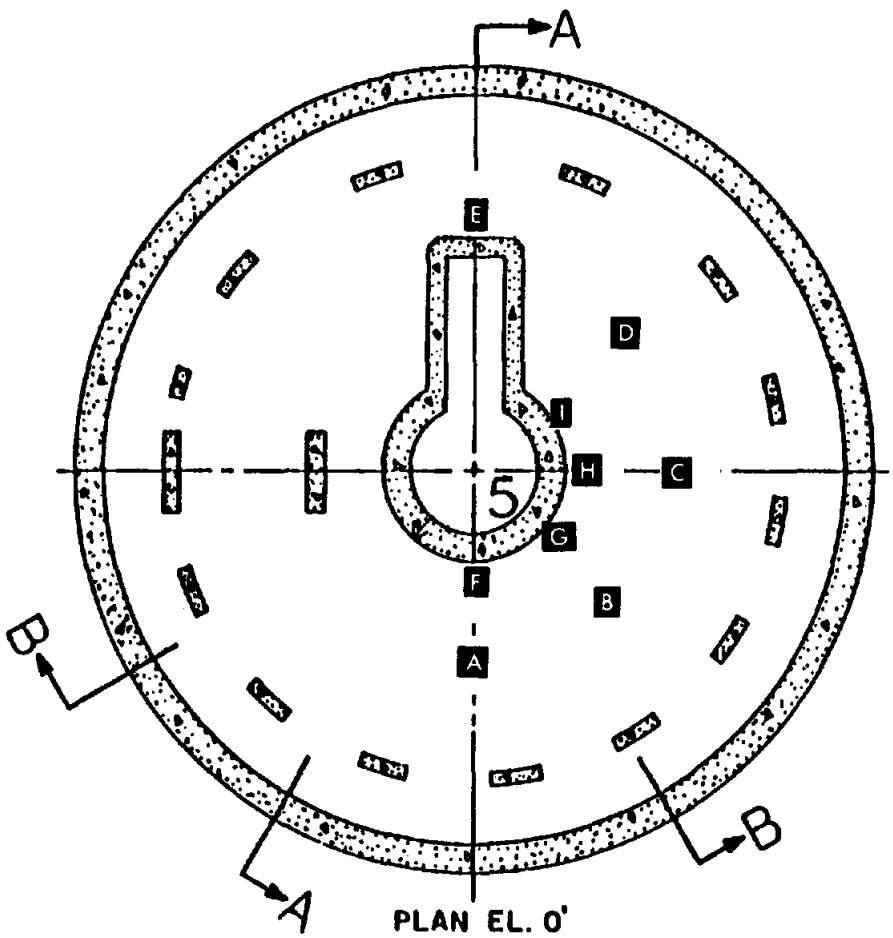


Figure 4.4. Surry Plan View Elevation 0 Feet

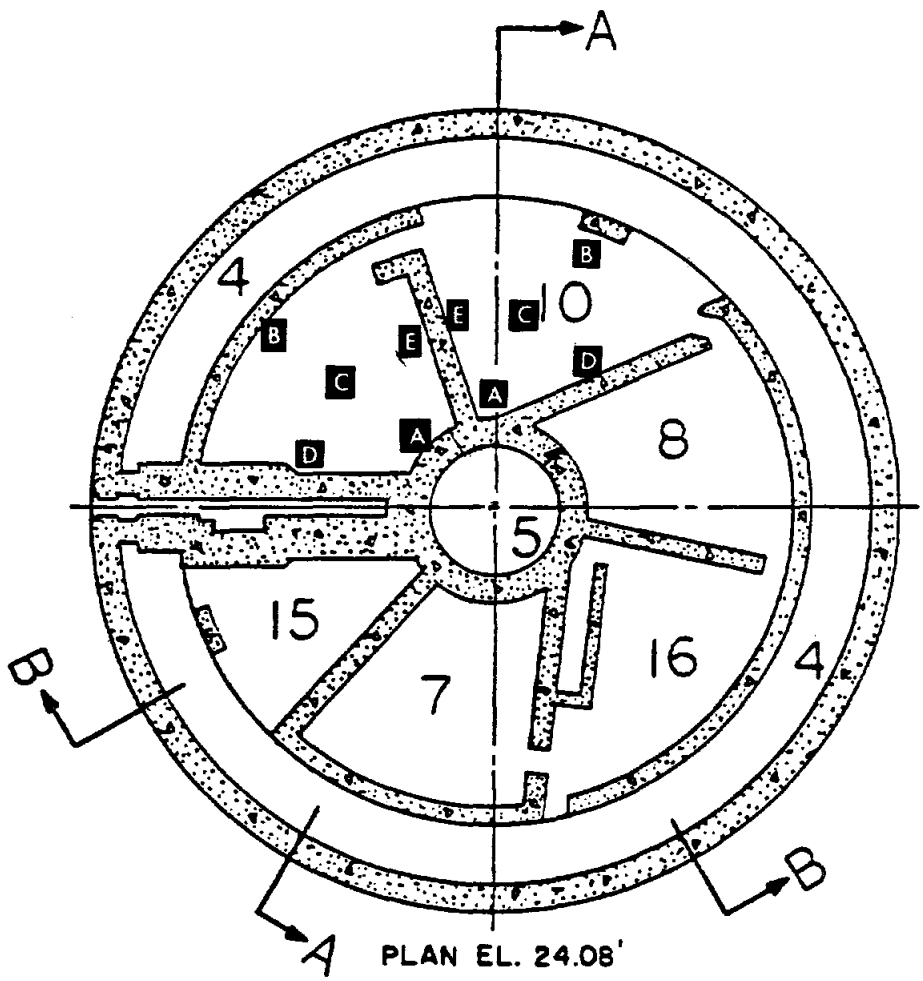


Figure 4.5. Surry Plan View Elevation 24.08 Feet

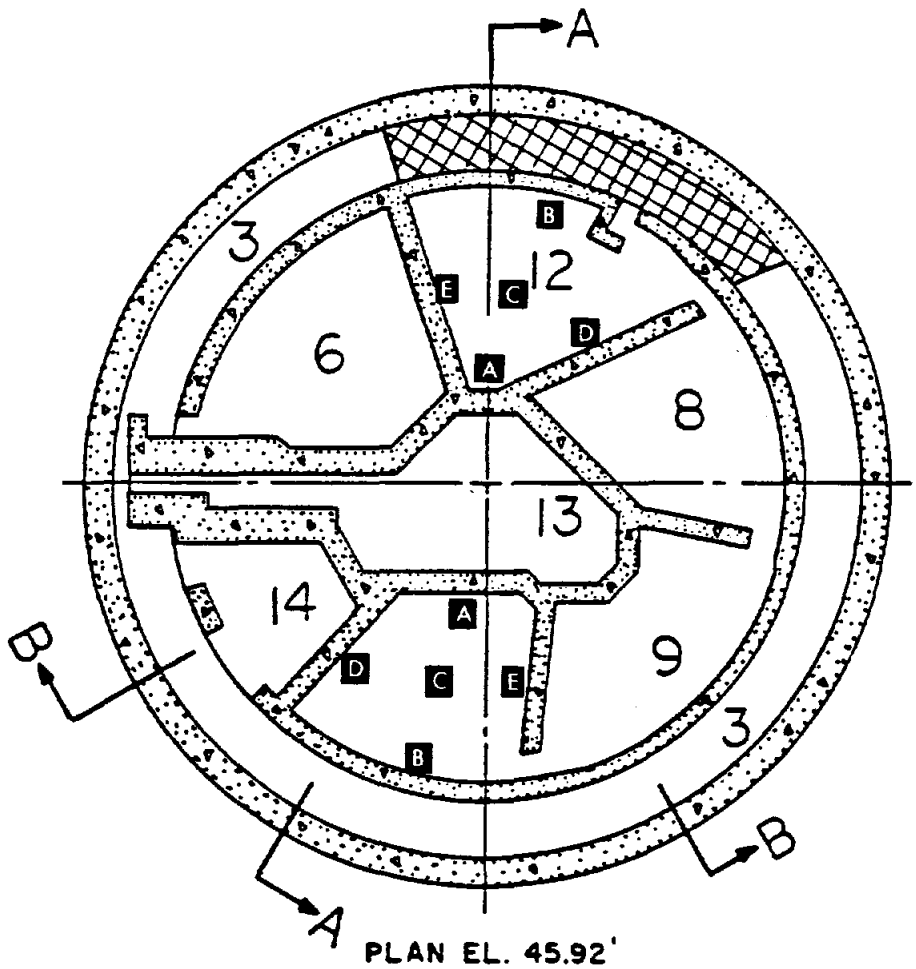


Figure 4.6. Surry Plan View Elevation 45.92 Feet

Table 4.1

Surry Compartment Identification

Compartment No.	Compartment	Volume (ft^3)
1	Dome	519,633
2	Operating Floor	347,065
3	Upper Annulus	263,512
4	Lower Annulus	75,915
5	Reactor Cavity	11,678
6	Steam Generator A Cubicle	46,834
7	Steam Generator B Cubicle	40,529
8	Steam Generator C Cubicle	42,363
9	Pressurizer Cubicle	24,613
10	RHR Cubicle	30,315
11	Incore Instrumentation Room	31,114
12	Refueling Cavity	33,032
13	Upper Hoist Space	13,847
14	Basement	253,757
15	Pressurizer Relief Tank Cubicle	18,793

Table 4.2

Surry Dose Point Locations

Dose Point	Location (ft)		
	X	Y	Z
Dome, Operating Floor, and Annulus			
A	63.0	0.0	12.0
B	63.0	0.0	34.0
C	63.0	0.0	59.5
D	63.0	0.0	97.5
E	63.0	0.0	120.0
F	0.0	-51.0	75.0
G	0.0	-51.0	120.0
H	0.0	0.0	75.0
I	0.0	0.0	120.0
J	0.0	0.0	150.0
Basement			
A	0.0	-39.3	12.0
B	-27.8	-27.8	12.0
C	39.3	0.0	12.0
D	27.8	27.8	12.0
E	0.0	39.3	12.0
F	0.0	-16.0	12.0
G	-11.3	-11.3	12.0
H	16.0	0.0	12.0
I	11.3	11.3	12.0
RHR Cubicle			
A	-3.0	14.7	28.0
B	14.0	46.6	28.0
C	5.5	30.8	28.0
D	17.1	23.0	28.0
E	-7.7	30.9	28.0
Steam Generator A Cubicle			
A	-11.5	10.6	48.5
B	-36.8	31.3	48.5
C	-24.2	21.0	48.5
D	-32.5	7.0	48.5
E	-11.9	30.5	48.5

Table 4.2

Surry Dose Point Locations (Concluded)

Dose Point	Location (ft)		
Steam Generator B Cubicle	X	Y	Z
A	5.8	-21.4	48.5
B	-12.2	-48.2	48.5
C	-3.2	-34.8	48.5
D	-23.5	-28.1	48.5
E	7.0	-35.5	48.5
Incore Instrumentation Room			
A	-0.7	15.7	59.5
B	18.9	45.8	59.5
C	9.1	30.8	59.5
D	19.5	23.8	59.5
E	-8.2	31.8	59.5

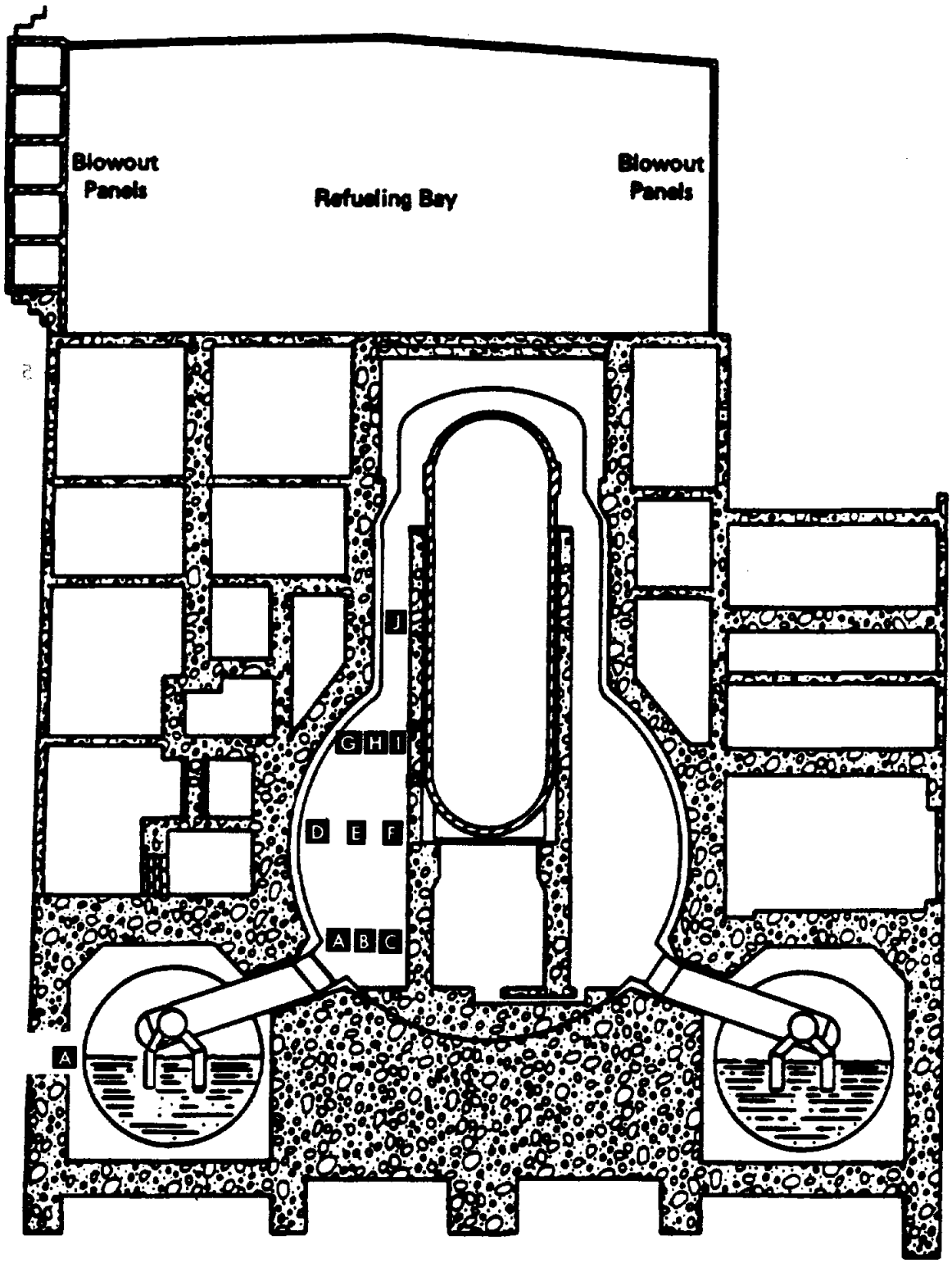


Figure 4.7. Peach Bottom Containment Section

Beta and gamma doses were calculated for representative points in the drywell and wetwell torus room. Dose point locations for the drywell and torus room are shown in Figure 4.7. Location J in the drywell represents three dose points at the same drywell elevation. Location A in the wetwell represents two dose points at the midpoint elevation of the torus. The first wetwell point is in the torus room and the second wetwell point is in one of the quad rooms. Table 4.3 lists the dose point coordinates for the drywell and torus room.

Table 4.3

Peach Bottom Dose Point Locations

Dose Point	Location (ft)		
Drywell	X	Y	Z
A	26.8	0.0	126.7
B	20.1	0.0	126.7
C	13.9	0.0	126.7
D	32.0	0.0	145.0
E	23.3	0.0	145.0
F	13.9	0.0	145.0
G	26.7	0.0	163.6
H	20.3	0.0	163.6
I	13.9	0.0	163.6
J	18.8	0.0	187.2
K	16.4	0.0	187.2
L	13.9	0.0	187.2
Wetwell			
A	-52.5	-51.0	112.6
B	-56.0	-54.0	112.6

5.0 DOSE RESULTS

The dose rate and dose results presented in this report represent a scoping effort to obtain an estimate of dose rate and dose. Containment models were kept relatively simple due to the scoping nature of this study. Experience gained in using PATH, ITS, and the containment models will provide better insight into using these tools for future accident dose calculations.

Dose rate is very specific to containment building structure and time-dependent spatial distribution of radionuclides as well as knowledge of radionuclide energy release and accident scenarios. The radionuclide release for the airborne, plate-out, and waterborne sources was assumed to be uniformly distributed throughout containment; multicompartment radionuclide transport throughout containment after the accident scenarios was beyond the scope of this work. Treating the source as uniformly spatially distributed is expected to result in high estimates of dose in the Surry containment building during early time periods in the accident. Other studies have assumed uniform distribution in PWR containments that are relatively open and have modeled the containments as large open cylinders. Treating source terms as being uniformly distributed in Peach Bottom should produce reasonable results because the drywell is relatively open, and uniform mixing could also be expected to occur for radionuclide release into the wetwell.

These calculations also allow the relative magnitudes of dose and dose rate for each case to be compared. The effects of ESF operation can also be compared from case to case.

The effect of compartment size and structure on dose rate and total dose will also be evident from the results. Modeling of major equipment was beyond the scope of this work. All compartments and regions in containment are modeled as open rooms. Major structural features such as floors, walls, and ceilings have been taken into account.

5.1 Surry Dose Results

Four variations of the AB epsilon scenario were calculated. This scenario involves an intermediate to large LOCA with failure to recover onsite or offsite electrical power. Containment vessel meltthrough occurs. Case 1 is the base case or the AB epsilon scenario itself. Case 2 investigates the effect of arresting the base scenario; all core-concrete attack radionuclide release is removed. Case 3 is the base case with sprays operational; all airborne activity (except noble gas) has been removed to the sump. Containment surfaces are assumed to have no activity. Full core meltdown occurs. Case 4 is similar to Case 3 but is an arrested sequence.

The results are presented in terms of dose rate and total dose to selected containment regions. Figures are used to illustrate combined airborne, wall, floor, or sump total doses. Abbreviated tables are used to present combined airborne, wall, floor, or sump dose rates at one hour and one year; the integrated total dose at one year for these source

terms is also presented in the abbreviated table. Detailed tables are presented in Appendix C, which break out the individual airborne, wall, floor, or sump contribution to dose rates for selected containment locations.

5.1.1 Case 1 Dose Results

Figures 5.1.1 and 5.1.2 illustrate total dose for the Case 1 accident at the basement dose point locations A through I. Basement integrated gamma dose at one year ranged from 1.7 to 2.7 x 10^8 rads. Basement integrated beta dose at one year ranged from 0.97 to 2.8 x 10^9 rads. Appendix C lists the relative dose rate contributions of the airborne, wall, and floor sources for representative locations in containment. Tables C.1 and C.2 indicate that the floor source was the leading contributor to gamma and beta dose at location A in the basement. The wall source contribution to total gamma dose at location F showed a substantial increase when compared to location A but did not surpass the contribution due to the floor source. For total beta dose at location F, the wall source and floor source contributions to total dose were approximately equivalent.

Total dose for the Surry annulus is shown in Figures 5.1.3 and 5.1.4. Gamma dose was largest for the location point at the top of the annulus which views the rest of the dome region and at the bottom of the annulus which views the rest of the basement region. Beta dose was highest at the bottom of the annulus. Annulus integrated gamma and beta dose ranged from 0.6 to 1.0 x 10^8 rads and 0.25 to 1.1 x 10^9 rads, respectively. The wall source was the major contributor to gamma total dose for annulus locations C and E; both the floor and wall source were major contributors to gamma total dose at location A (Table C.3). The airborne and wall sources were the major contributors to beta total dose at locations C and E; the floor source made no contribution to total beta dose at C and E. Both source contributions were roughly equivalent. The floor, wall, and airborne sources were approximately equal contributors to beta total dose at location A (Table C.4).

Operating floor and dome total dose are illustrated in Figures 5.1.5 and 5.1.6. Gamma dose was highest at the top of the operating floor while beta dose was highest near the walls and floors of the operating floor. Gamma total dose at one year ranged from 0.57 to 1.90 x 10^8 rads. Beta total dose ranged from 1.1 x 10^8 rads in the dome center to 1.8 x 10^9 rads along the walls and floors of the operating floor. The floor and wall sources were major contributors to gamma total dose at locations H, I, and J. The airborne source term was also a significant contributor to total dose through 8 hours but rapidly decayed thereafter (Table C.5). Major contributors to the total beta dose at location J were the airborne and wall sources; the operating floor source made no contribution. The airborne source was the only significant contributor to total beta dose at location I; wall and floor source contributions were minor. Total beta dose at location H was due to the airborne and wall sources (Table C.6).

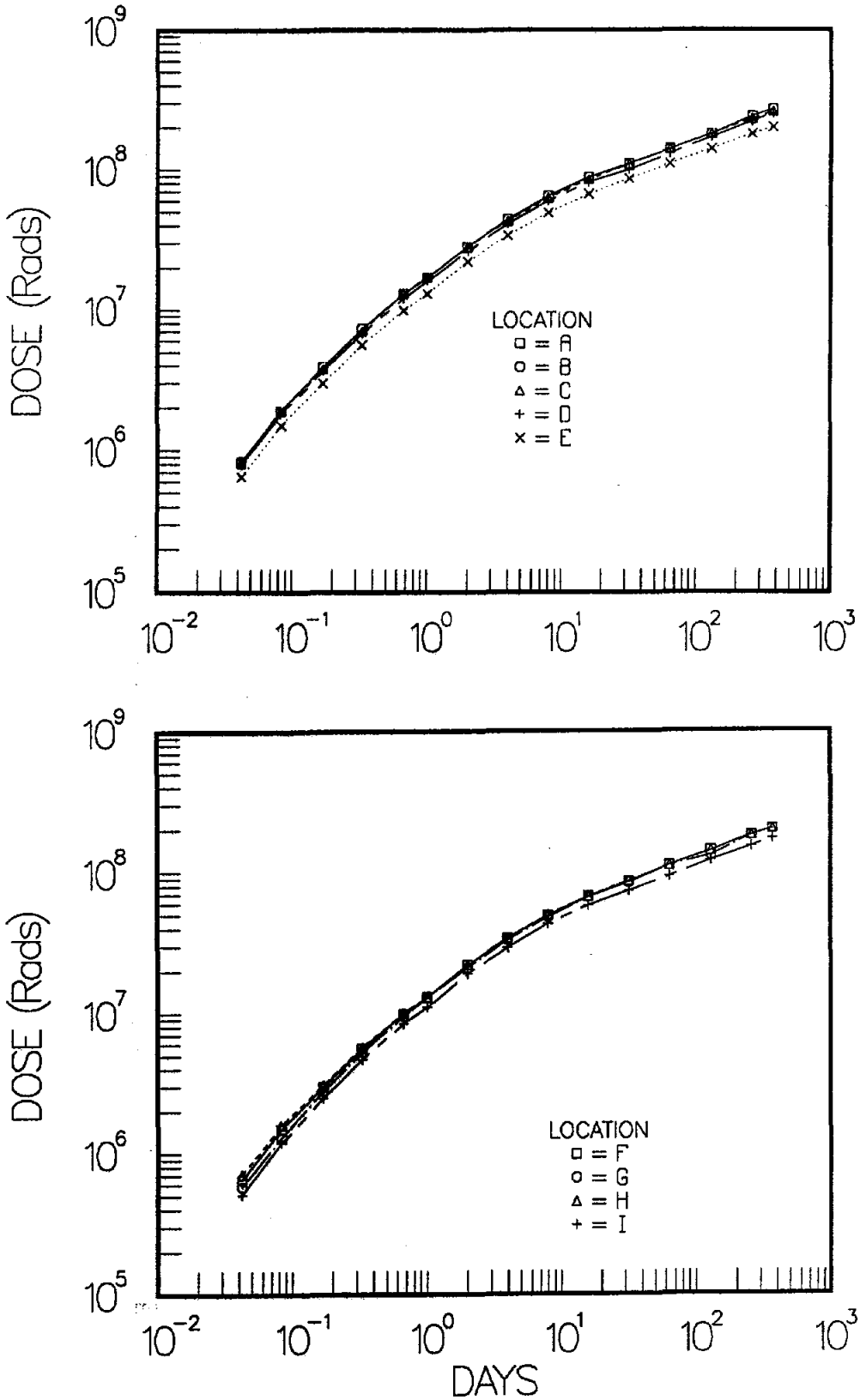
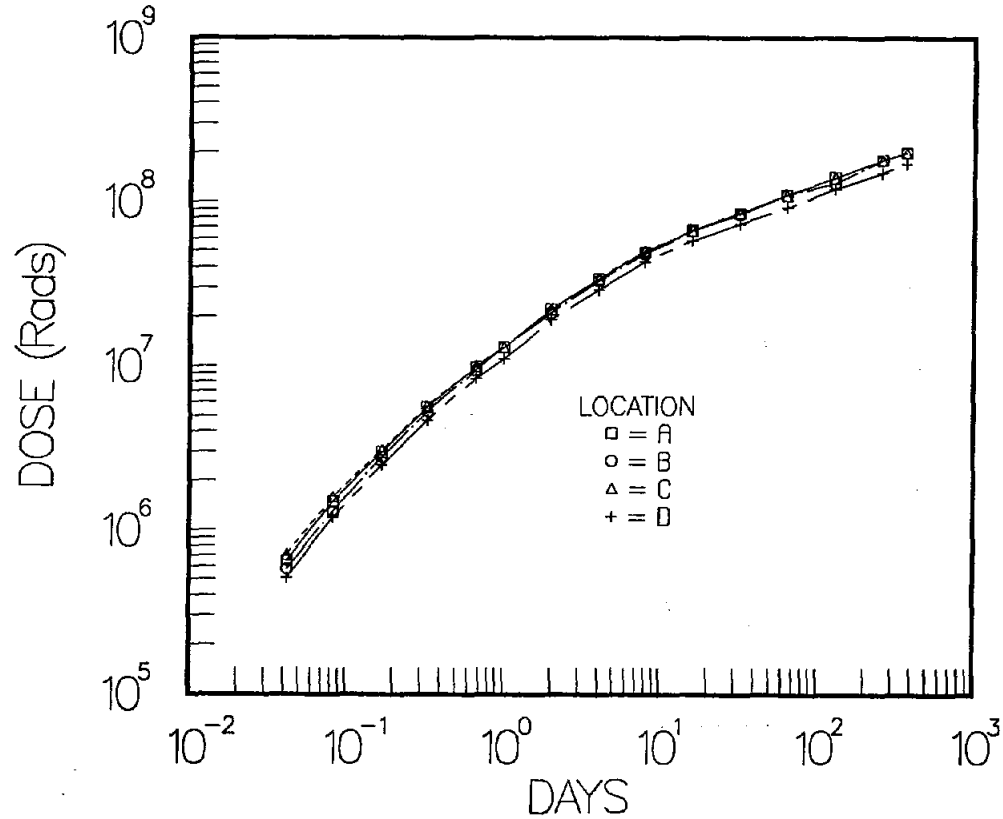


Figure 5.1.1. Surry Case 1 Basement Total Gamma Dose



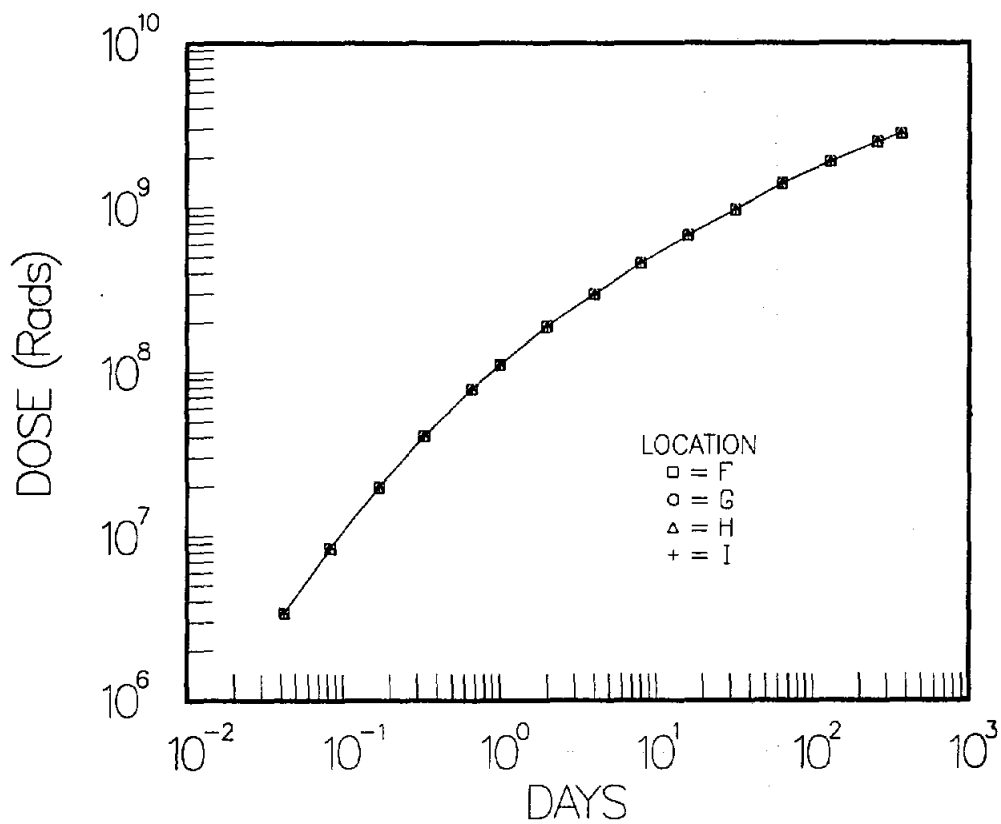


Figure 5.1.2. Surry Case 1 Basement Total Beta Dose

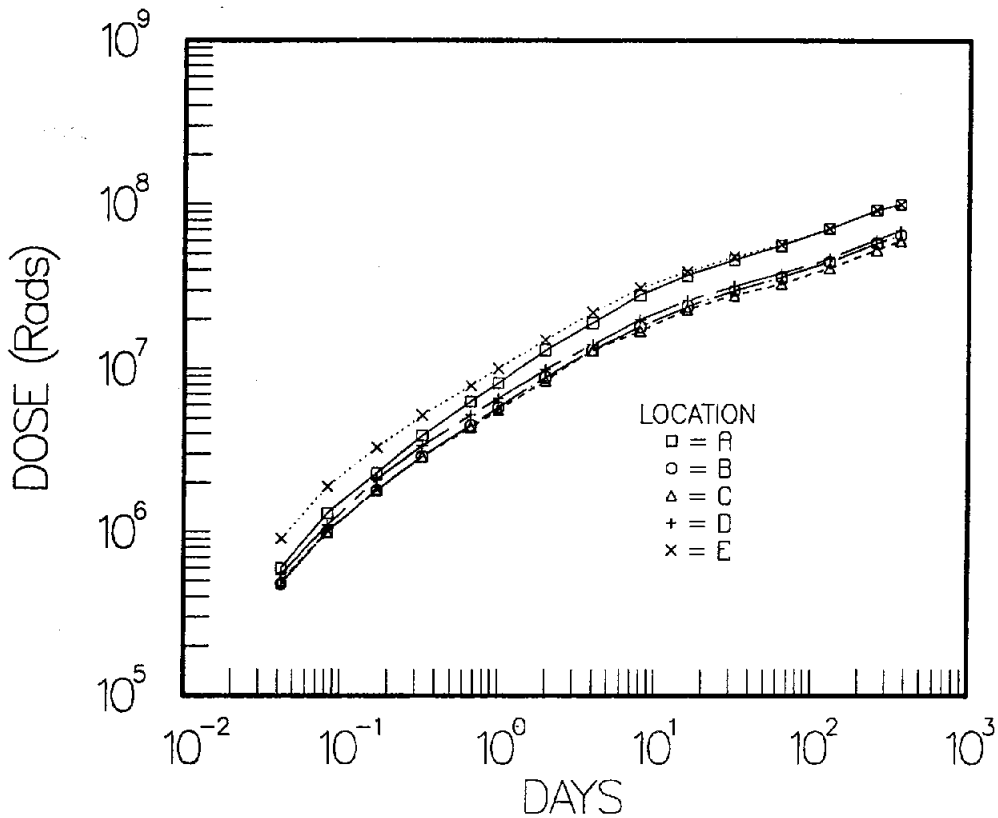


Figure 5.1.3. Surry Case 1 Annulus Total Gamma Dose

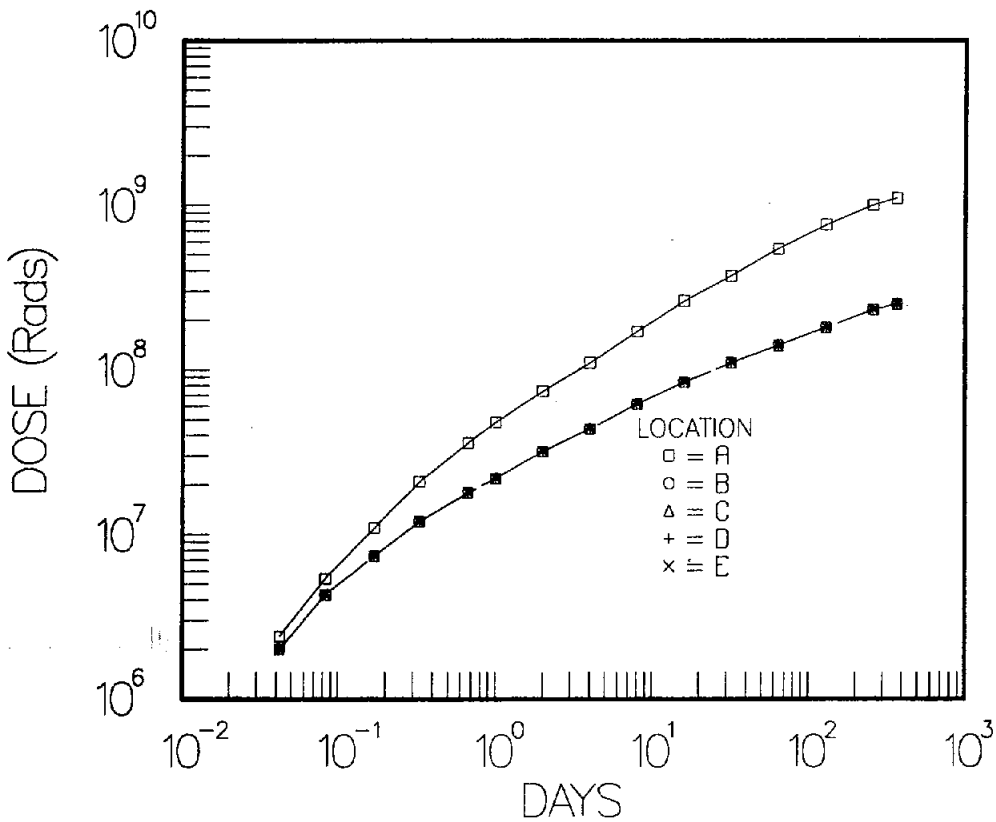


Figure 5.1.4. Surry Case 1 Annulus Total Beta Dose

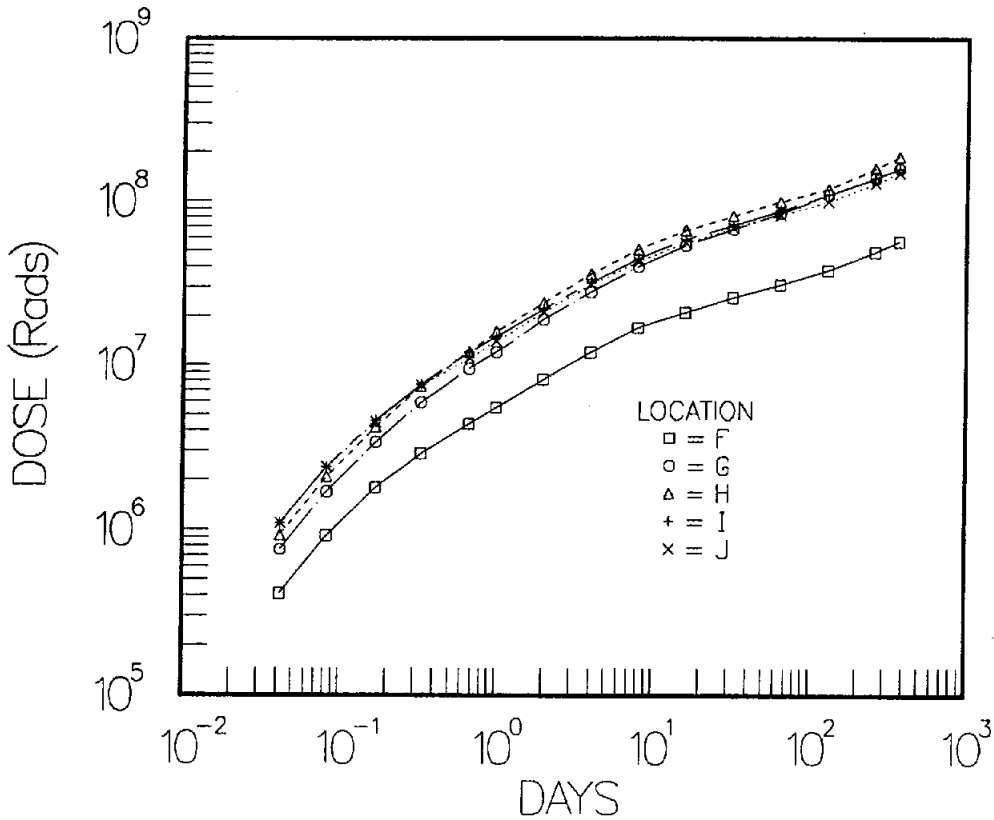


Figure 5.1.5. Surry Case 1 Operating Floor and Dome Total Gamma Dose

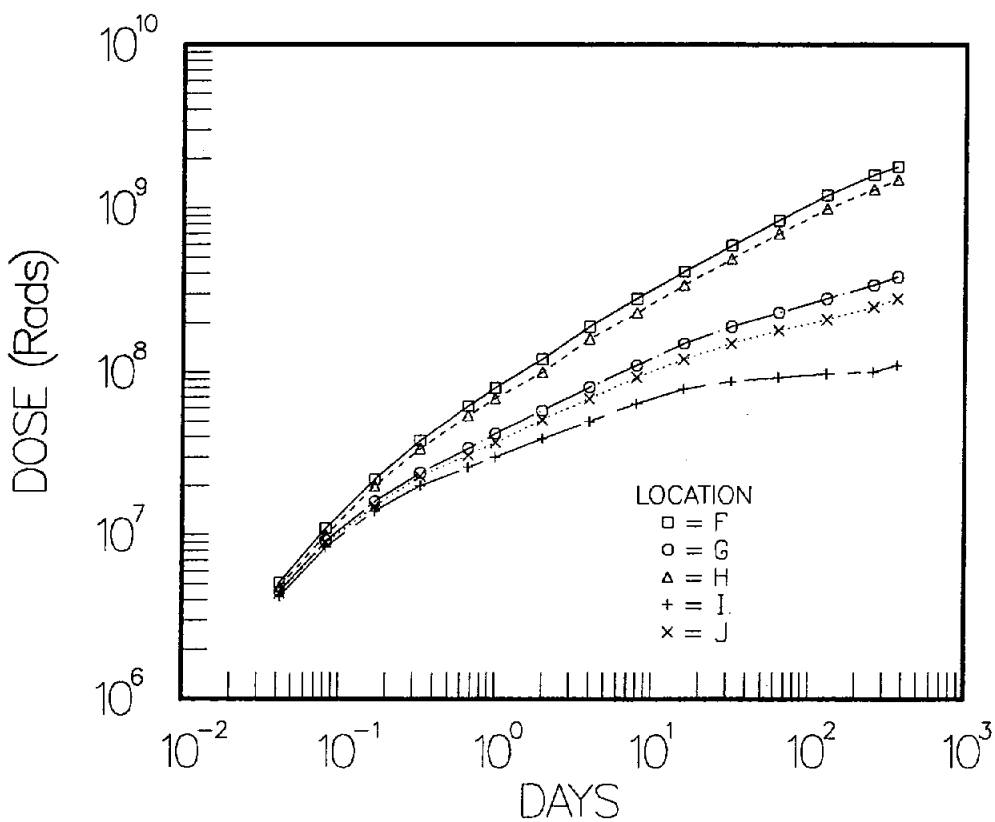


Figure 5.1.6. Surry Case 1 Operating Floor and Dome Total Beta Dose

Figures 5.1.7 and 5.1.8 show total dose for the steam generator A cubicle. Gamma dose showed minor fluctuation with respect to cubicle position. Beta dose rate at the walls also showed minor variations with respect to wall location. Beta dose rate at the compartment center was significantly decreased compared to beta dose rate at the walls (wall and floor sources had less effect at the compartment center). Total gamma dose for the cubicle ranged from 6.8×10^7 rads to 8.9×10^7 rads. Total beta dose along the walls at one year ranged from 1.3×10^9 to 2.2×10^9 rads, and total centerline beta dose at one year was approximately 1.7×10^8 rads. The wall sources were the major contributors to locations D and E for total gamma dose. Contribution to total dose at location C was equally distributed between the wall and floor sources (Table C.7). The floor, wall, and airborne sources were approximately equivalent contributors to the total beta dose at locations D and E; the airborne source was the major contributor to dose at location C (Table C.8).

The gamma and beta dose rate figures corresponding to Figures 5.1.1 through 5.1.8 are shown in Appendix B. Steam generator B cubicle dose rate and dose figures were similar to those of steam generator A cubicle and are shown in Appendix B.

The RHR cubicle total dose is pictured in Figures 5.1.9 and 5.1.10. The RHR cubicle has a volume of 30315 ft^3 compared to the steam generator A cubicle volume of 46834 ft^3. Gamma dose was lower than that in the steam generator A cubicle and showed almost no variation with respect to cubicle position. As in the steam generator A cubicle, beta dose at the walls was higher than the centerline beta dose rate. However, the difference between the centerline and wall dose rate in the RHR cubicle was not as great as the difference in the steam generator A cubicle because the RHR cubicle is 25 percent smaller than the steam generator A cubicle.

The in-core instrumentation room calculated dose rate and total dose values were similar to those of the RHR cubicle and are shown in Appendix B.

Table 5.1 partially summarizes the dose rate and total dose values by presenting the gamma and beta dose rates at 1 hour and 1 year for each location. Gamma and beta total dose is listed at one year.

The gamma and beta dose rate and dose are tabularized in Appendix C for each calculated time period and according to airborne, wall, floor, or sump source.

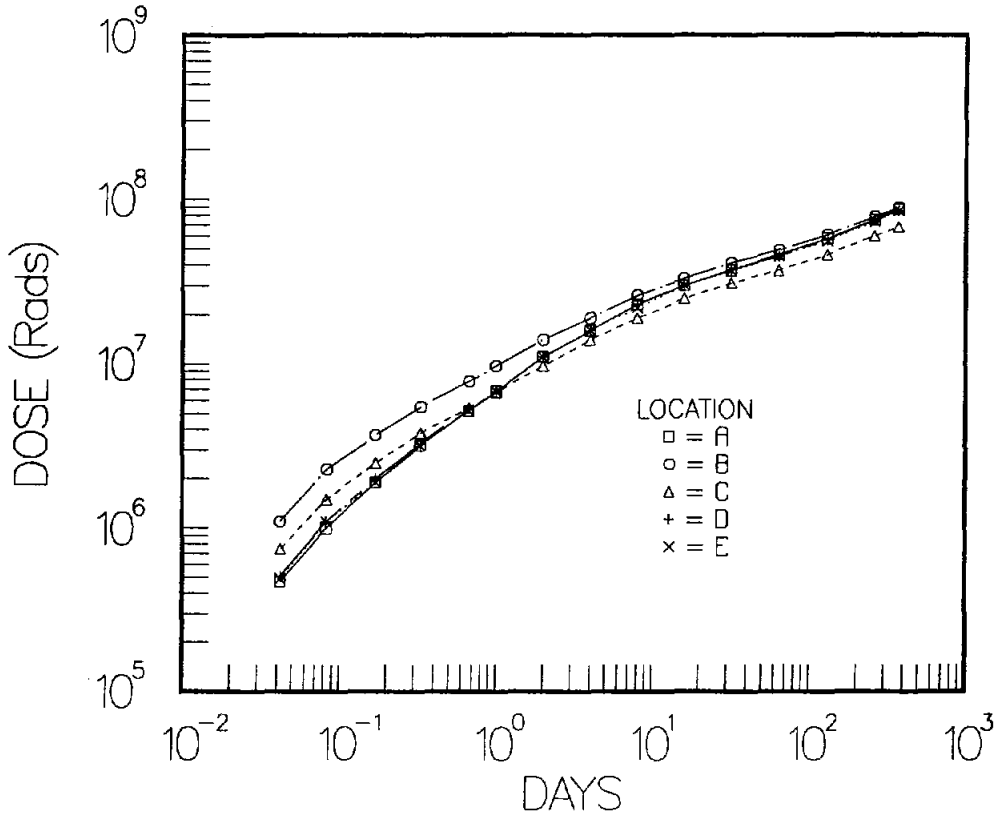


Figure 5.1.7. Surry Case 1 Steam Generator A Cubicle Gamma Total Dose

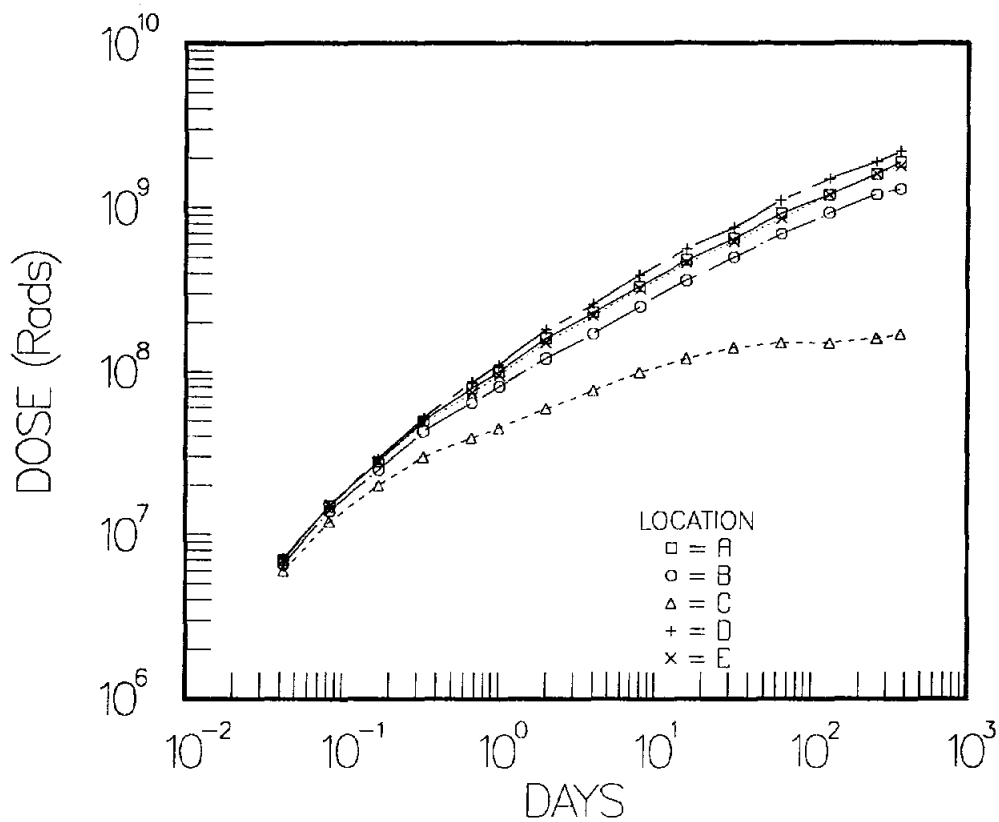


Figure 5.1.8. Surry Case 1 Steam Generator A Cubicle Beta Total Dose

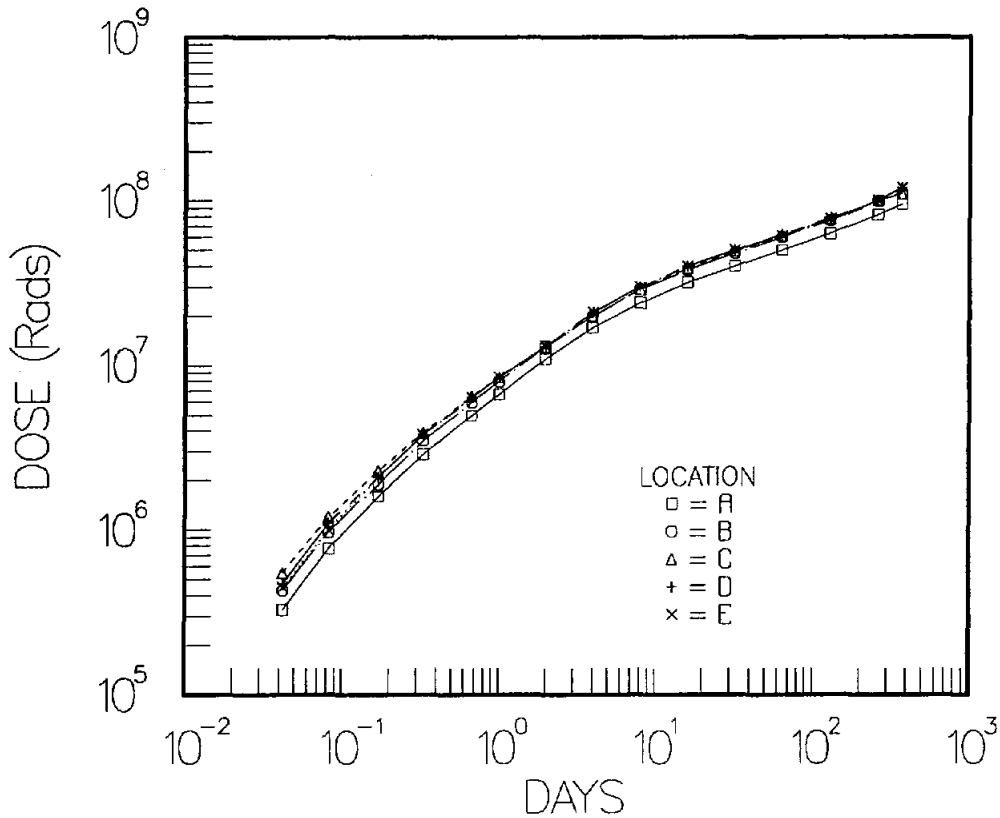


Figure 5.1.9. Surry Case 1 RHR Cubicle Total Gamma Dose

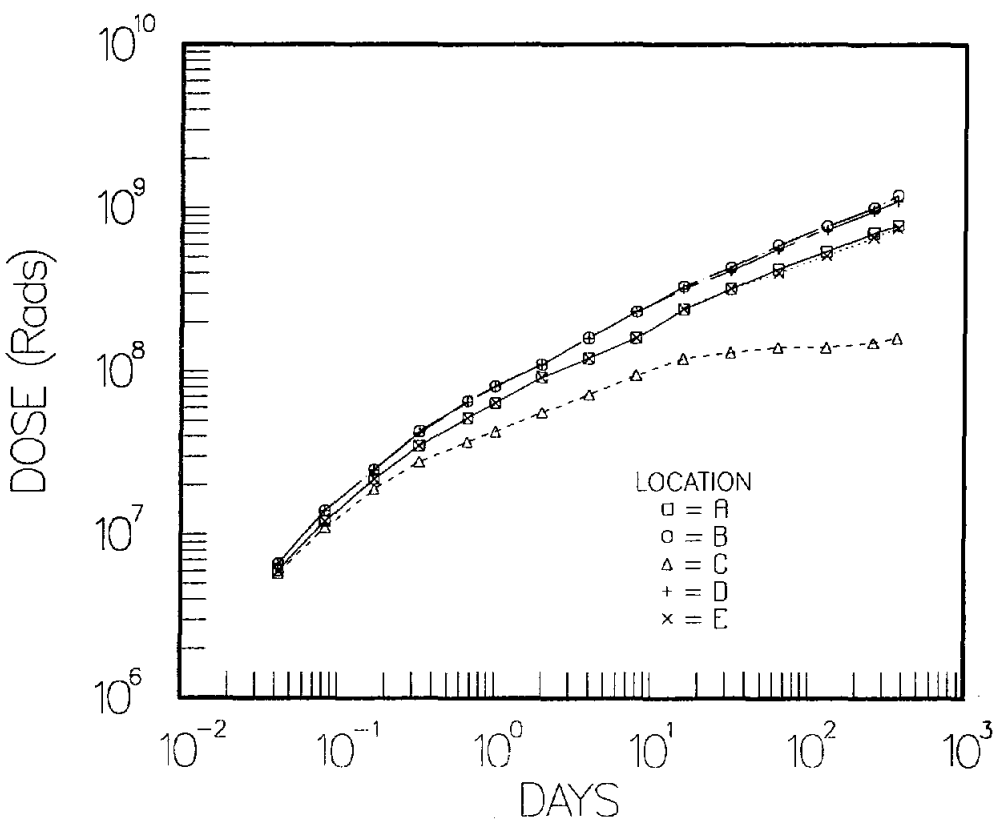


Figure 5.1.10. Surry Case 1 RHR Cubicle Total Beta Dose

Table 5.1

Case 1 Dose Rate and Total Dose

Basement		A	B	C	D	E	F	G	H	I
1h	gr	1.11e6	1.12e6	1.09e6	1.06e6	8.70e5	8.70e5	7.67e5	9.42e5	6.85e5
	br	1.90e6	1.90e6	1.90e6	1.90e6	1.90e6	4.50e6	4.50e6	4.50e6	4.50e6
1y	gr	1.19e4	1.20e4	1.16e4	1.10e4	9.20e3	9.16e3	9.09e3	9.19e3	7.18e3
	br	3.63e4	3.63e4	3.63e4	3.63e4	3.63e4	1.23e5	1.23e5	1.23e5	1.23e5
1y	gt	2.70e8	2.70e8	2.60e8	2.50e8	2.0e8	2.0e8	2.0e8	2.0e8	1.70e8
	bt	9.7e8	9.7e8	9.7e8	9.7e8	9.7e8	2.8e9	2.8e9	2.8e9	2.8e9

Annulus		A	B	C	D	E
1h	gr	7.97e5	6.42e5	6.64e5	7.26e5	1.21e6
	br	3.24e6	2.71e6	2.70e6	2.70e6	2.70e6
1y	gr	4.88e3	1.34e3	2.98e3	1.76e3	5.30e3
	br	4.15e4	7.77e3	7.77e3	7.77e3	7.77e3
1y	gt	1.00e8	6.50e7	6.00e7	6.00e7	1.00e8
	bt	1.10e9	2.50e8	2.50e8	2.50e8	2.50e8

Op Floor/Dome		F	G	H	I	J
1h	gr	8.10e5	1.35e6	1.67e6	2.17e6	2.11e6
	br	6.84e6	5.97e6	6.44e6	5.57e6	5.89e6
1y	gr	2.76e3	7.21e3	8.96e3	7.39e3	7.25e3
	br	6.57e4	1.41e4	5.33e4	1.73e3	8.75e3
1y	gt	5.70e7	1.60e8	1.90e8	1.60e8	1.50e8
	bt	1.80e9	3.80e8	1.50e9	1.10e8	2.80e8

1h: one hour
1y: one year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

Table 5.1

Case 1 Dose Rate and Total Dose (Continued)

RHR Cubicle		A	B	C	D	E
1h	gr	4.40e5	5.70e5	7.30e5	6.30e5	6.03e5
	br	8.03e6	8.83e6	7.66e6	8.81e6	8.03e6
1y	gr	4.46e3	5.31e3	5.14e3	5.44e3	5.40e3
	br	2.70e4	6.10e4	2.83e3	4.76e4	2.70e4
1y	gt	9.5e7	1.10e8	1.10e8	1.20e8	1.20e8
	bt	7.8e8	1.20e9	1.60e8	1.10e9	7.50e8

Steam Gen A		A	B	C	D	E
1h	gr	6.30e5	1.52e6	9.95e5	6.74e5	6.56e5
	br	9.36e6	8.83e6	8.03e6	9.50e6	9.32e6
1y	gr	4.12e3	4.01e3	3.02e3	4.01e3	4.00e3
	br	6.83e4	4.23e4	2.78e3	8.67e4	7.05e4
1y	gt	8.70e7	8.90e7	6.80e7	8.50e7	8.50e7
	bt	1.90e9	1.30e9	1.70e8	2.20e9	1.80e9

1h: one hour
1y: one year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

5.1.2 Case 2 Dose Results

The Case 2 scenario simulated resumption of emergency core cooling and arresting core meltdown by removing the core-concrete radionuclides calculated in Case 1. Removal of radionuclide activity attributed to the core-concrete attack period resulted in lower dose rates at the selected dose point locations. Table 5.2 summarizes the dose rate and total dose values for gamma and beta radiation and may be compared to Table 5.1 to see the effect of arresting core meltdown. For example, Case 1 basement total gamma and beta dose were 1.7×10^8 to 2.7×10^8 rads and 0.97×10^9 to 2.8×10^9 rads, respectively. Corresponding Case 2 basement total gamma and beta dose were calculated to be 1.1×10^8 to 1.5×10^8 rads and 0.18×10^9 to 1.3×10^9 rads, respectively. The reductions in total dose were due mainly to reductions in activity of the floor and wall sources; the airborne source activity also decreased but not as significantly as the floor and wall sources. The trends noted for Case 1 also apply to the results of Case 2.

Gamma and beta dose rate values for Case 2 are shown in Appendix B. Airborne, wall, and floor contributions for selected containment locations are listed in Appendix C.

Table 5.2

Case 2 Dose Rate and Total Dose

Basement		A	B	C	D	E	F	G	H	I
1h	gr	1.13e6	1.13e6	1.11e6	1.07e6	8.80e5	8.39e5	7.28e5	8.42e5	6.64e5
	br	1.84e6	1.84e6	1.84e6	1.84e6	1.84e6	4.40e6	4.40e6	4.40e6	4.40e6
1y	gr	8.49e3	8.50e3	8.24e3	7.85e3	6.67e3	6.79e3	6.71e3	6.83e3	5.85e3
	br	5.13e3	5.13e3	5.13e3	5.13e3	5.13e3	7.14e4	7.14e4	7.14e4	7.14e4
1y	gt	1.50e8	1.50e8	1.50e8	1.40e8	1.20e8	1.20e8	1.20e8	1.20e8	1.10e8
	bt	1.80e8	1.80e8	1.80e8	1.80e8	1.80e8	1.30e9	1.30e9	1.30e9	1.30e9

Annulus		A	B	C	D	E
1h	gr	7.96e5	6.43e5	6.64e5	7.27e5	1.21e6
	br	3.22e6	2.70e6	2.70e6	2.70e6	2.70e6
1y	gr	4.01e3	2.99e3	2.89e3	3.45e3	5.33e3
	br	6.42e3	2.90e3	2.90e3	2.90e3	2.90e3
1y	gt	7.30e7	5.4e7	5.30e7	6.30e7	9.60e7
	bt	2.40e8	1.2e8	1.2e8	1.2e8	1.20e8

Op Floor/Dome		F	G	H	I	J
1h	gr	8.10e5	1.35e6	1.67e6	2.17e6	2.11e6
	br	6.92e6	6.06e6	5.65e6	5.66e6	5.98e6
1y	gr	8.02e2	1.27e3	4.59e3	3.41e3	5.38e3
	br	1.77e4	1.09e4	8.56e3	1.74e3	6.09e3
1y	gt	4.9e7	9.60e7	1.50e8	1.20e8	1.20e8
	bt	4.6e8	2.6e8	3.0e8	9.9e7	1.80e8

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

Table 5.2

Case 2 Dose Rate and Total Dose (Continued)

RHR Cubicle		A	B	C	D	E
1h	gr	5.08e5	5.78e5	8.00e5	6.88e5	7.33e5
	br	7.96e6	8.40e6	7.30e6	8.48e6	7.69e6
1y	gr	3.82e3	4.44e3	3.91e3	4.52e3	4.50e3
	br	1.07e4	2.74e4	2.71e3	3.07e4	1.07e4
1y	gt	6.80e7	8.0e7	7.20e7	8.10e7	8.10e7
	bt	3.20e8	5.8e8	1.5e8	6.5e8	3.0e8

Steam Gen A		A	B	C	D	E
1h	gr	6.30e5	1.52e6	9.95e5	6.74e5	6.56e5
	br	9.16e6	8.59e6	7.78e6	9.11e6	9.00e6
1y	gr	3.70e3	3.56e3	2.47e3	3.57e3	3.56e3
	br	3.53e4	2.11e4	2.79e3	3.72e4	3.29e4
1y	gt	6.70e7	6.80e7	4.70e7	6.50e7	6.70e7
	bt	7.10e8	4.90e8	1.70e8	7.40e8	6.90e8

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

5.1.3 Case 3 Dose Results

Table 5.3 shows the basement total dose for the Case 3 accident scenario. Calculations showed slight gamma dose rate dependence on position. The combined air and sump sources caused the gamma dose in the basement to be larger than the beta dose during spray operation. Basement total gamma dose at one year ranged from 1×10^8 to 1.4×10^8 rads, and total beta dose at one year was 3.7×10^7 rads. Total gamma dose was dominated by the sump source contribution; the airborne source contribution was at least one order of magnitude smaller than that of the sump source (Table C.19). The beta total dose was due entirely to the airborne source; the sump source was attenuated completely within the sump water.

Gamma dose decreased with increasing annulus elevation as the sump source activity had less influence at higher containment elevations (Table C.20). Gamma total dose in the annulus ranged from 7×10^7 rads at the lower annulus levels to 2.9×10^6 rads at the top of the annulus. Total beta dose at one year for the annulus was 6.8×10^7 rads.

Gamma and beta total dose in the upper regions of containment were due only to airborne sources. Gamma dose for the Case 3 operating floor and dome region were largest in the dome and at the top of the operating floor region. Total gamma dose ranged from 1.6×10^6 rads to 4.6×10^6 rads while total beta dose was 1.6×10^8 rads.

The steam generator A cubicle airborne source resulted in slight gamma dose variation with respect to the five dose point locations. The steam generator A cubicle was modeled as one volume for the beta calculations, therefore, spatial dose rate calculations were not possible. Total dose gamma values at one year ranged from 9.6×10^5 to 1.7×10^6 rads, and the total dose beta value was calculated to be 2.6×10^8 rads. Dose rates and total dose value figures for Case 3 are presented in Appendix B.

The airborne and sump contributions to dose rate for the document and annulus regions are listed in Appendix C. All dose rates for the remainder of containment are due to airborne activity only.

Table 5.3

Case 3 Dose Rate and Total Dose

Basement		A	B	C	D	E	F	G	H	I
1h	gr	8.50e5	8.61e5	8.42e5	8.27e5	6.42e5	6.10e5	6.48e5	6.10e5	5.68e5
	br	4.88e5	4.88e5	4.88e5	4.88e5	4.88e5	4.88e5	4.88e5	4.88e5	4.88e5
1y	gr	6.13e3	6.21e3	6.08e3	5.99e3	4.64e3	4.45e3	4.77e3	4.45e3	4.18e3
	br	7.19e2	7.19e2	7.19e2	7.19e2	7.19e2	7.19e2	7.19e2	7.19e2	7.19e2
1y	gt	1.30e8	1.40e8	1.30e8	1.30e8	1.0e8	9.80e7	1.00e8	9.80e7	9.20e7
	bt	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7

Annulus		A	B	C	D	E
1h	gr	4.79e5	1.51e5	1.07e5	9.96e4	1.32e5
	br	2.18e6	2.18e6	2.18e6	2.18e6	2.18e6
1y	gr	3.14e3	6.84e2	3.04e2	1.28e2	3.82e1
	br	3.14e3	3.14e3	3.14e3	3.14e3	3.14e3
1y	gt	7.00e7	1.60e7	7.8e6	4.20e6	2.90e6
	bt	1.60e8	1.60e8	1.60e8	1.60e8	1.60e8

Op Floor/Dome		F	G	H	I	J
1h	gr	9.09e4	1.72e5	1.61e5	2.69e5	2.48e5
	br	7.86e5	7.86e5	7.86e5	7.86e5	7.86e5
1y	gr	0.77	1.46	1.37	2.29	2.13
	br	1.31e3	1.31e3	1.31e3	1.31e3	1.31e3
1y	gt	1.6e6	3.00e6	2.80e6	4.60e6	4.30e6
	bt	6.80e7	6.80e7	6.80e7	6.80e7	6.80e7

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

Table 5.3

Case 3 Dose Rate and Total Dose (Continued)

Steam Gen A		A	B	C	D	E
1h	gr	5.82e4	5.57e4	1.00e5	6.94e4	6.51e4
	br	3.08e6	3.08e6	3.08e6	3.08e6	3.08e6
1y	gr	0.50	0.40	0.80	0.60	0.50
	br	4.85e3	4.85e3	4.85e3	4.85e3	4.85e3
1y	gt	1.00e6	9.60e5	1.70e6	1.20e6	1.10e6
	bt	2.60e8	2.60e8	2.60e8	2.60e8	2.60e8

RHR Cubicle		A	B	C	D	E
1h	gr	3.15e4	4.31e4	8.19e4	5.15e4	4.74e4
	br	2.99e6	2.99e6	2.99e6	2.99e6	2.99e6
1y	gr	0.27	0.37	0.71	0.44	0.41
	br	4.86e3	4.86e3	4.86e3	4.86e3	4.86e3
1y	gt	5.40e5	7.40e5	1.40e6	8.80e5	8.20e5
	bt	2.60e8	2.60e8	2.60e8	2.60e8	2.60e8

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

5.1.4 Case 4 Dose Results

The Case 3 and Case 4 airborne radionuclide activities were approximately identical. Differences between Case 3 and Case 4 occurred in the sump radionuclide activities. Since Case 4 was an arrested sequence, less radionuclide activity was introduced into the sump when compared to the Case 3 sump activity. Therefore, Case 4 gamma dose rates in the basement region and lower annulus regions can be expected to be less than Case 3 gamma dose rates in the same regions. Beta dose rates for Case 4 were identical to those of Case 3 because the ITS code calculated that no sump electron activity could escape beyond the sump water. All dose points in the basement region were located above the sump in this study.

Table 5.4 lists the gamma total dose for the Surry basement region. Total dose showed a moderate dependence upon location. Total gamma dose for the basement level varied from 5.9×10^7 rads to 8.9×10^7 rads. Recall that Case 3 total gamma dose for the basement region varied from 9.2×10^7 rads to 1.4×10^8 rads.

As in Case 3, dose rate decreased with increasing annulus elevation. Case 4 dose rates were less than the Case 3 dose rates because less activity was in the sump water due to Case 4 being an arrested sequence. Case 4 total gamma dose in the annulus was less than in corresponding Case 3 dose point locations. Interior compartment and dome gamma total doses for Case 4 were identical to those in Case 3.

Dose rate and total dose figures for Case 4 are listed in Appendix B. The airborne and sump contributions to the Case 4 basement and annulus dose rates are listed in Appendix C. Dose rates in the remainder of containment are due only to airborne sources.

Table 5.4

Case 4 Dose Rate and Total Dose

Basement		A	B	C	D	E	F	G	H	I
1h	gr	8.50e5	8.61e5	8.42e5	8.27e5	6.42e5	6.10e5	6.48e5	6.10e5	5.68e5
	br	4.58e5	4.58e5	4.58e5	4.58e5	4.58e5	4.58e5	4.58e5	4.58e5	4.58e5
1y	gr	4.86e3	4.92e3	4.82e3	4.74e3	3.67e3	3.53e3	3.78e3	3.53e3	3.31e3
	br	7.14e2	7.14e2	7.14e2	7.14e2	7.14e2	7.14e2	7.14e2	7.14e2	7.14e2
1y	gt	8.70e7	8.90e7	8.70e7	8.50e7	6.60e7	6.30e7	6.80e7	6.30e7	5.90e7
	bt	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7	3.70e7

Annulus		A	B	C	D	E
1h	gr	4.80e5	1.51e5	1.07e5	9.96e4	1.32e5
	br	7.97e5	7.97e5	7.97e5	7.97e5	7.97e5
1y	gr	2.49e3	5.42e2	2.41e2	1.02e2	3.05e1
	br	1.30e3	1.30e3	1.30e3	1.30e3	1.30e3
1y	gt	4.60e7	1.10e7	5.30e6	3.20e6	2.70e6
	bt	6.80e7	6.80e7	6.80e7	6.80e7	6.80e7

Op Floor/Dome		F	G	H	I	J
1h	gr	9.10e4	1.72e5	1.61e5	2.70e5	2.49e5
	br	2.35e6	2.35e6	2.35e6	2.35e6	2.35e6
1y	gr	0.58	0.58	1.10	1.10	0.33
	br	3.14e3	3.14e3	3.14e3	3.14e3	3.14e3
1y	gt	1.60e6	3.0e6	2.80e6	4.60e6	4.50e6
	bt	1.60e8	1.60e8	1.60e8	1.60e8	1.60e8

Table 5.4

Case 4 Dose Rate and Total Dose (Continued)

RHR Cubicle		A	B	C	D	E
1h	gr	3.14e4	4.31e4	8.19e4	5.15e4	4.77e4
	br	3.08e6	3.08e6	3.08e6	3.08e6	3.08e6
1y	gr	0.27	0.36	0.69	0.44	0.40
	br	4.82e3	4.82e3	4.82e3	4.82e3	4.82e3
1y	gt	5.30e5	7.30e5	1.40e6	8.80e5	8.10e5
	bt	2.60e8	2.60e8	2.60e8	2.60e8	2.60e8

Steam Gen A		A	B	C	D	E
1h	gr	5.82e4	5.57e4	1.00e5	6.94e4	6.51e4
	br	3.01e6	3.01e6	3.01e6	3.01e6	3.01e6
1y	gr	0.49	0.47	0.85	0.59	0.55
	br	4.83e3	4.83e3	4.83e3	4.83e3	4.83e3
1y	gt	1.0e6	9.5e5	1.7e6	1.2e6	1.1e6
	bt	2.6e8	2.6e8	2.6e8	2.6e8	2.6e8

gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

5.2 Peach Bottom Dose Results

Four variations of the AE sequence were calculated. The AE sequence is a large break LOCA with one initiating event and a combination of failures in two emergency cooling systems. Case 1 is the base case or the AE sequence itself. Case 2 investigates the effect of arresting the core meltdown in Case 1, with core-concrete attack radionuclide release being removed. Case 3 simulates drywell spray operation by removing all airborne activity except noble gases. No activity remains on the containment surface. Case 4 simulates an arrested sequence (with drywell sprays operational) by removing all radionuclide activity generated during core-concrete attack.

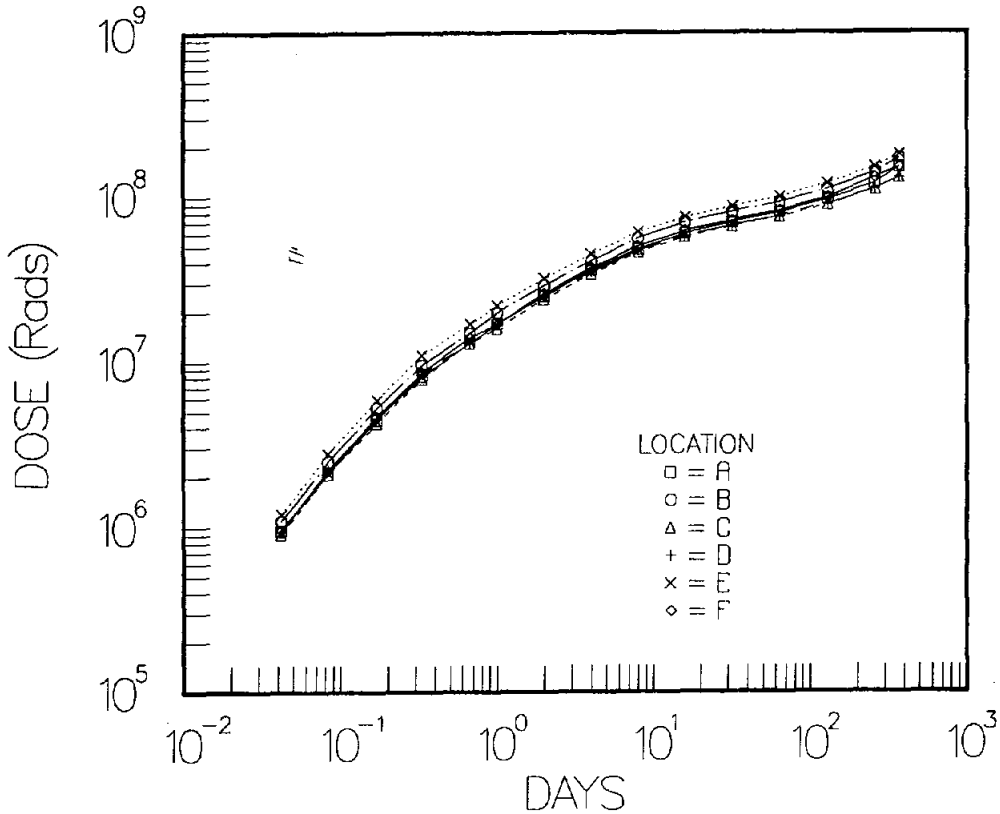
5.2.1 Case 1 Dose Results

Figures 5.2.1 and 5.2.2 show total dose in the Peach Bottom drywell. Gamma doses showed moderate positional dependence for dose points in the drywell bulb; dose was lower for dose points located in the "upper stem" of the drywell bulb. Gamma doses showed minor positional dependence for dose points at the same elevation. The dose at points in the middle of the drywell bulb were greater than the other locations. The floor and wall sources dominated the gamma total dose values; both were within an order of magnitude of each other throughout the entire scenario. The airborne source activity was equal in magnitude to the floor and wall source activities at early scenario times (<16 hours) but rapidly decayed during later scenario times becoming two to three orders of magnitude less than the floor and wall sources (Table C.23).

Beta dose also showed substantial positional dependence in the drywell. Beta dose was highest in the center of the drywell bulb and lowest at the top of the bulb and stem. Dose points near the walls generally had higher dose values than dose points in the bulb interior at the same elevation. Contributions to total beta dose from the airborne, wall, and floor sources were generally within an order of magnitude of one another for locations in the drywell bulb along the wall. Floor contributions were minimal at dose point locations in the drywell stem (Table C.24). Early discontinuities in the beta dose rate plots (Appendix B) reflected drywell gas density changes.

Gamma total dose values ranged from 9.8×10^7 rads to 1.8×10^8 rads in the drywell bulb and from 3.3×10^7 rads to 5.2×10^7 rads in the drywell stem. Beta total dose values ranged from 4.7×10^8 rads to 6.6×10^8 rads at the bottom of the drywell bulb, 1.5×10^9 rads to 1.7×10^9 rads at the middle of the drywell bulb, and 1.8×10^8 to 3.5×10^8 rads at the top of the drywell bulb and in the stem.

Figure 5.2.3 illustrates the gamma total dose due to the radionuclide activity in the toroidal wetwell. The gamma dose was significantly reduced when comparing dose values inside the torus room to dose values inside the corner (quad) room. Total gamma dose at one year in the torus room was calculated to be 1×10^7 rads. Total gamma dose in the quad room was 1.6×10^2 rads. Beta dose was not calculated to occur in the



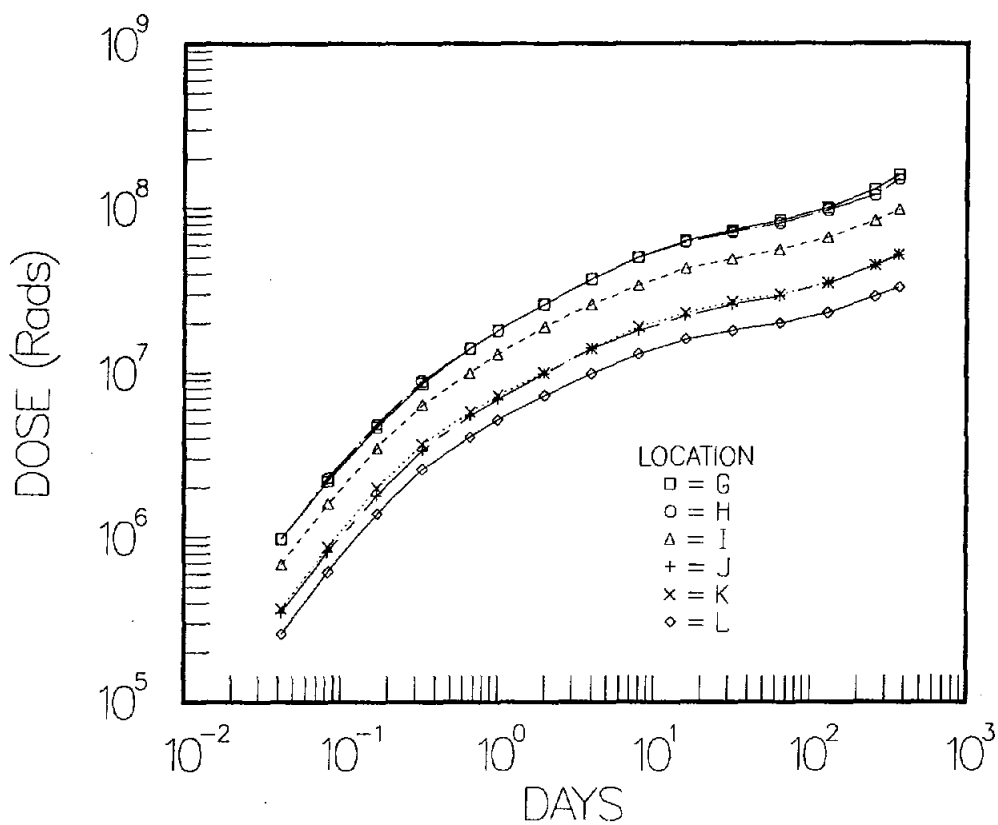
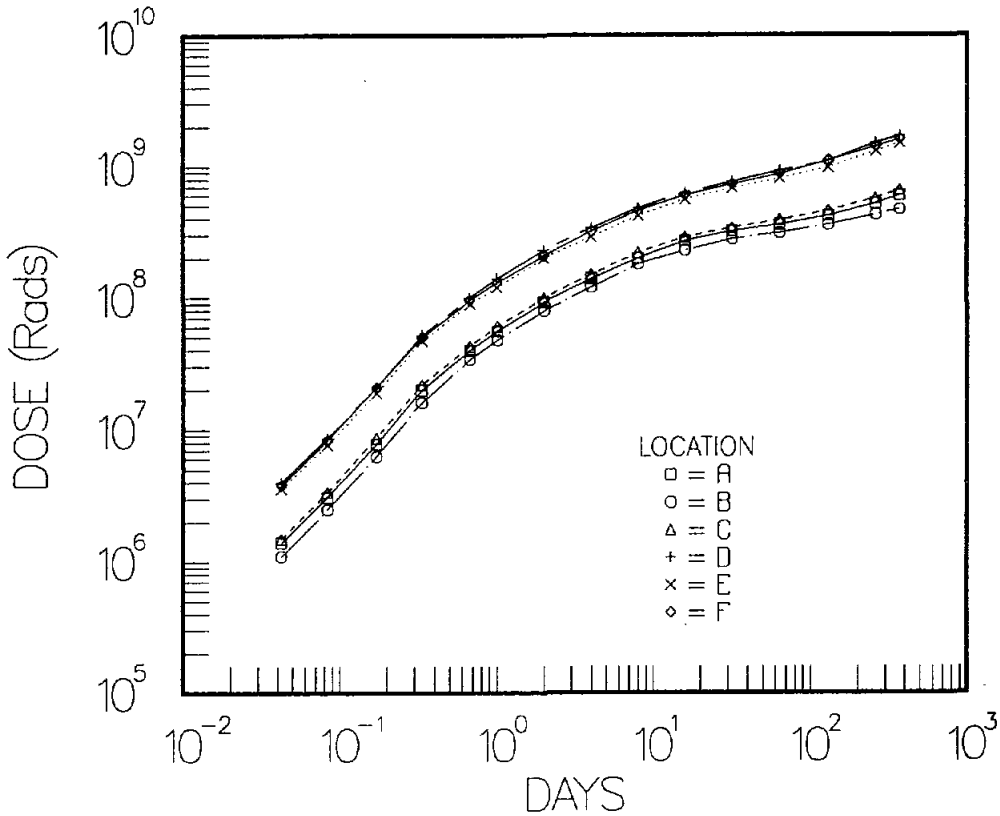


Figure 5.2.1. Peach Bottom Case 1 Drywell Total Gamma Dose



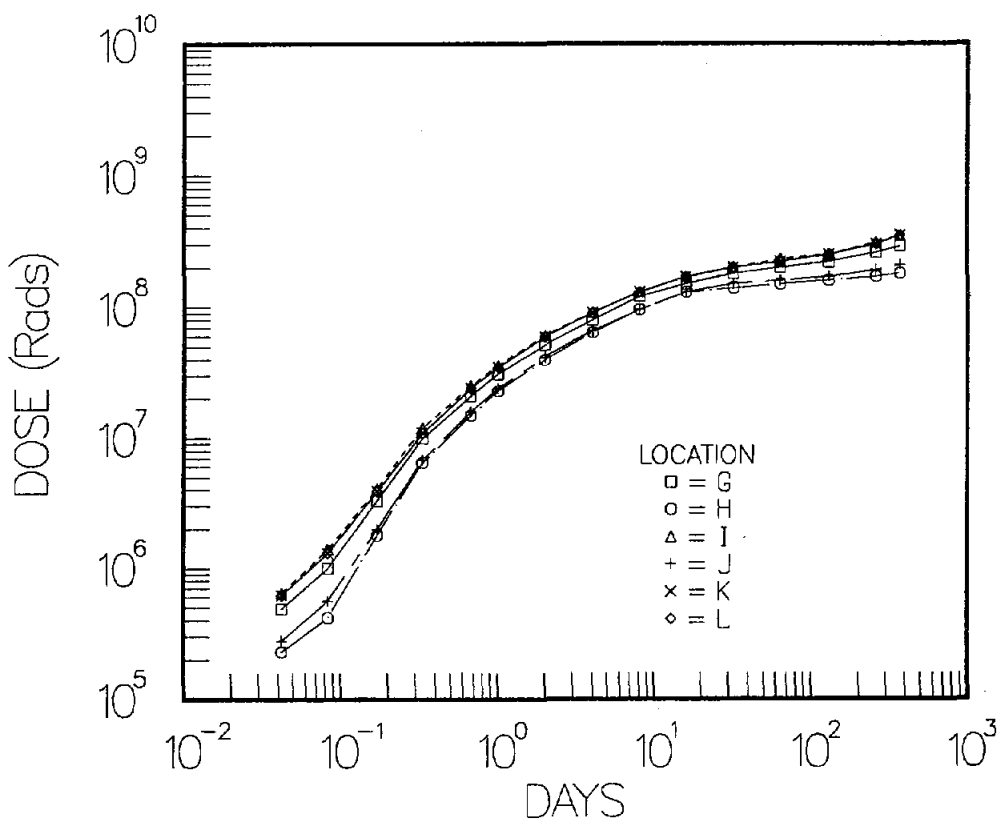


Figure 5.2.2. Peach Bottom Case 1 Drywell Total Beta Dose

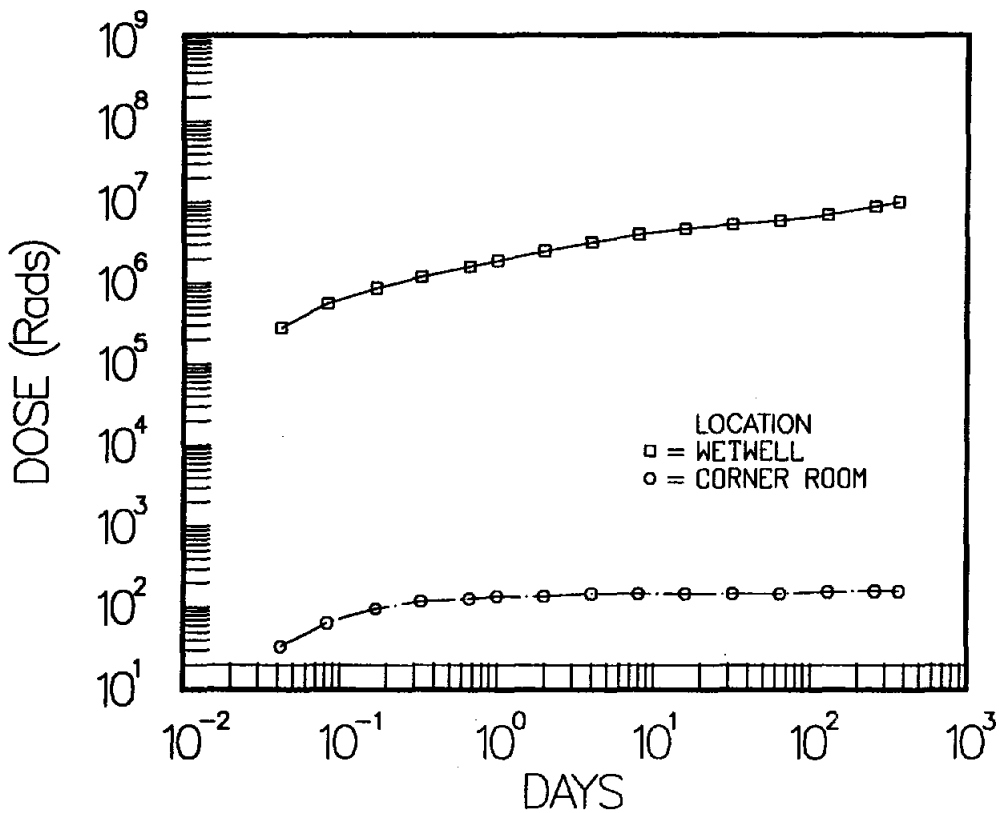


Figure 5.2.3. Peach Bottom Case 1 Wetwell Total Gamma Dose

torus room due to the shielding of the wetwell torus. Dose at the ceiling of the torus room would be approximately equal to that shown in Figure 5.2.3. Dose in the reactor building just above the torus room (elevation 135) should be similar to the dose calculated to occur in the quad room.

Appendix B contains the dose rate plots corresponding to the doses shown in Figures 5.2.1 through 5.2.3.

Table 5.5 summarizes the dose rate at one hour and one year and total dose at one year.

The airborne, floor, and wall contributions for the Case 1 drywell dose rates are listed in Appendix C. The sump, airborne, and wall contributions for the wetwell dose rates are also listed in Appendix C.

Table 5.5

Peach Bottom Case 1 Dose Rate and Dose

Drywell		A	B	C	D	E	F
1h	gr	1.26e6	1.48e6	1.21e6	1.25e6	1.62e6	1.29e6
	br	3.05e6*	2.46e6*	3.39e6*	8.49e6*	7.56e6*	8.15e6*
1y	gr	7.83e3	8.70e3	6.98e3	6.77e3	9.05e3	7.87e3
	br	2.97e4	7.01e3	3.31e4	8.29e4	7.12e4	7.95e4
1y	gt	1.50e8	1.7e8	1.3e8	1.3e8	1.8e8	1.5e8
	bt	6.0e8	4.7e8	6.6e8	1.7e9	1.5e9	1.6e9

		G	H	I	J	K	L
1h	gr	1.30e6	1.31e6	9.15e5	4.62e5	4.89e5	3.42e5
	br	1.84e6*	1.25e6*	2.18e6*	1.24e6*	2.02e6*	2.02e6*
1y	gr	8.53e3	7.63e3	4.95e3	2.74e3	2.67e3	1.59e3
	br	1.22e4	3.92e3	1.56e4	6.66e3	1.84e4	1.84e4
1y	gt	1.60e8	1.5e8	9.8e7	5.2e7	5.2e7	3.3e7
	bt	2.9e8	1.8e8	3.5e8	2.1e8	3.5e8	3.5e8

Wetwell		A	B
1h	gr	3.7e5	4.3e1
		-	-
1y	gr	5.0e2	1.0e3
		-	-
1y	gt	1.0e7	1.6e2
		-	-

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose
*: maximum dose rate occurs at 4 hours

5.2.2 Case 2 Dose Results

Table 5.6 summarizes total dose for the Case 2 calculations. Case 2 gamma doses were essentially the same as those calculated for Case 1; PATH calculated no significant differences between the two cases. Drywell beta dose calculated for Case 2 was lower than that calculated for Case 1, but the fact that these changes can be attributed to scenario radionuclide inventory variations is not clear. The lower beta doses are more likely due to the different thermal-hydraulic conditions (drywell gas temperature, pressure, and density) that were calculated for Case 1 and Case 2. Total maximum beta doses at one year ranged from 2×10^8 rads at the drywell bottom to 6×10^8 rads at the drywell center to 2.1×10^8 rads at the top of the drywell. PATH calculated no difference in wetwell gamma dose rates for Case 1 and Case 2.

Case 2 dose rate and total dose figures are given in Appendix B. The airborne, floor, and wall contributions for the drywell rates are listed in Appendix C. The wetwell sump, airborne, and wall contributions for the wetwell dose rates are also listed in Appendix C.

Table 5.6

Peach Bottom Case 2 Dose Rate and Total Dose

Drywell		A	B	C	D	E	F
1h	gr	1.26e6	1.48e6	1.21e6	1.25e6	1.62e6	1.29e6
	br	2.08e6*	1.67e6*	2.31e6*	4.71e6*	4.67e6*	4.48e6*
1y	gr	8.64e3	9.33e3	7.44e3	7.32e3	9.80e3	8.81e3
	br	2.97e4	7.01e3	3.31e4	8.29e4	7.12e4	7.95e4
1y	gt	1.5e8	1.7e8	1.4e8	1.4e8	1.8e8	1.6e8
	bt	2.7e8	2.0e8	3.1e8	6.1e8	5.0e8	5.7e8

		G	H	I	J	K	L
1h	gr	1.30e6	1.31e6	9.15e5	4.62e5	4.89e5	3.42e5
	br	1.23e6*	8.24e5*	1.5e6*	8.5e5	1.4e6*	1.4e6*
1y	gr	9.82e3	8.59e3	5.54e3	3.40e3	3.29e3	1.91e3
	br	7.39e3	1.91e3	1.04e4	4.01e3	1.04e4	1.04e4
1y	gt	1.7e8	1.5e8	1.0e8	5.9e7	5.9e7	3.6e7
	bt	1.7e8	9.1e7	2.1e8	1.2e8	2.1e8	2.1e8

Wetwell		A	B
1h	gr	3.7e5	4.3e1
		-	-
1y	gr	5.0e2	9.0e4
		-	-
1y	gt	1.e7	1.6e2

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose
*: maximum dose rate occurred at 2 hours

5.2.3 Case 3 and Case 4 Dose Results

Spray operation greatly reduced radionuclide activity in the drywell region. Gamma dose showed a moderate dependence on dose point location; this dependence was less than in Case 1 since surface sources were assumed not to exist in Case 3. Total gamma dose at one year ranged from 6.5×10^6 rads in the drywell stem to 1.7×10^7 rads at mid-elevation in the drywell bulb. Case 3 beta dose was also substantially below the Case 1 beta dose. Total beta dose in the drywell was calculated to be 0.93×10^8 rad at one year. Since only uniform airborne activity was assumed to occur in Case 3, a one volume drywell model was used for Case 3. Therefore, there is no data on beta dose dependence with drywell position.

Total gamma dose in the torus room was 1×10^7 rads. Total gamma dose at one year in the quad room was 1.5×10^2 rads. No beta dose was calculated to occur in the torus room of the wetwell because the steel toroid shielded the torus room from electron activity inside the wetwell torus.

PATH and ITS Case 4 gamma and beta dose rates were almost identical to those calculated for Case 3. Case 4 dose rate and dose value figures are located in Appendix B.

Table 5.7 summarizes dose rate values at one hour and one year as well as total dose values at one year for Cases 3 and 4.

Case 3 and Case 4 sump, airborne, and wall contributions to the wetwell dose rates are listed in Appendix C.

Table 5.7

Peach Bottom Case 3 and Case 4 Dose Rate and Total Dose

Drywell		A	B	C	D	E	F
1h	gr	7.23e4	9.05e4	7.64e4	9.96e4	1.20e5	8.64e4
	br	7.45e4	7.45e4	7.45e4	7.45e4	7.45e4	7.45e4
1y	gr	6.13	7.67	6.48	8.44	1.10e1	7.33
	br	1.9e3	1.9e3	1.9e3	1.9e3	1.9e3	1.9e3
1y	gt	1.0e7	1.30e7	1.1e7	1.4e7	1.7e7	1.2e7
	bt	9.3e7	9.3e7	9.3e7	9.3e7	9.3e7	9.3e7

		G	H	I	J	K	L
1h	gr	7.77e4	1.01e5	8.30e4	4.95e4	5.74e4	4.64e4
	br	7.45e4	7.45e4	7.45e4	7.45e4	7.45e4	7.45e4
1y	gr	6.6	8.54	7.03	4.0	4.70	3.88
	br	1.9e3	1.9e3	1.9e3	1.9e3	1.9e3	1.9e3
1y	gt	1.1e7	1.4e7	1.2e7	6.9e6	8.0e6	6.5e6
	bt	9.3e7	9.3e7	9.3e7	9.3e7	9.3e7	9.3e7

Wetwell		A	B
1h	gr	3.8e5	4.1e1
		-	-
1y	gr	5.e2	1.0e-3
		-	-
1y	gt	1.e7	1.6e2
		-	-

h: hour
y: year
gr: gamma dose rate
br: beta dose rate
gt: gamma total dose
bt: beta total dose

5.3 Comments on Surry and Peach Bottom Case 1 and Case 2 Dose Results

The Surry and Peach Bottom Case 1 total dose values are relatively high at certain containment locations when compared to current DBA total dose equipment qualification levels. Locations at which high doses are calculated generally occur where two or more of the airborne, wall, and floor sources have a significant effect on dose rate.

The dose rate tables in Appendix C show that the floor and wall sources are the major contributors to the gamma dose rate values. The gamma floor and wall source dose rates diminish slowly and are significantly higher than the airborne source dose rate after 1 to 4 days into the scenario analysis. At one year, floor and wall gamma dose rate values have been calculated to be in the 10^3 rads/hour range.

The same general trend between airborne, wall, and floor sources for beta dose was also observed. Beta airborne sources did not diminish as rapidly as the gamma airborne sources, but the beta wall and floor sources resulted in year end dose rates to be roughly an order of magnitude larger than year end dose rates due to the airborne source. At one year, floor and wall beta dose rate values have been calculated to be in the 10^3 to 10^4 rads/hour range.

The primary reason for the high calculated gamma and beta total dose is due to the radionuclide inventory makeup of the floor and wall sources at latter time periods in the analysis. When compared to the airborne isotopes, the floor and wall sources have isotopes with long lived and relatively high activities combined with large energy decays per particle. The top three isotopes for the floor and wall sources at late time periods included CS 134, BA 137M (a daughter of CS 137), and NB 95. The top three isotopes and their contributions to dose for the Surry and Peach Bottom calculations are listed in Appendix D. The major isotopes are listed for airborne, wall, floor, and sump source terms.

Surry Case 1 total gamma and beta dose was calculated to range from 1.17 x 10^9 rads to 3 x 10^9 rads in the basement, 3.22 x 10^8 rads to 1.29 x 10^9 rads in the annulus, 2.7 x 10^8 rads to 1.86 x 10^9 rads in the dome, and 2.38 x 10^8 rads to 1.99 x 10^9 rads in the steam generator A cubicle (containment interior). Reg Guide 1.89, Appendix D, suggests an equipment qualification dose of 2.2 x 10^8 rads. Therefore, Reg Guide 1.89, Appendix D levels are exceeded by 530 to 1360 percent in the basement, 146 to 590 percent in the annulus, 125 to 845 percent in the dome, and 108 to 904 percent in the steam generator A cubicle. The wall and floor sources were the major contributors to the higher doses calculated in this study.

Surry Case 2 total gamma and beta dose was less than the Case 1 total dose. Given the uncertainties in the source calculations, PATH, and ITS codes, the agreement between total calculated dose and the 2.2 x 10^8 rad Reg Guide 1.89, Appendix D dose is not bad. Appendix D levels were exceeded by 136 to 645 percent in the basement, 0 to 142 percent in the annulus, 0 to 231 percent in the dome, and 0 to 353 percent in steam generator cubicle A.

Peach Bottom Case 1 drywell total gamma and beta dose was calculated to range from 2.35 x 10^8 rads to 1.83 x 10^9 rads. These calculated doses exceed the Reg Guide 1.89, Appendix D level by 107 to 832 percent. Case 2 drywell total gamma and beta dose ranged from 1.79 x 10^8 rads to 7.50 x 10^8 rads; Appendix D test levels were exceeded by 0 to 340 percent.

The beta wall and floor dose rate calculations used relatively simple and symmetric zoning of the Surry and Peach Bottom containments. Wall and floor sources were frequently cylindrical, circular, or spherical in nature; therefore zones of concentric cylinders or spheres were often chosen for the containment zones. Nonuniform dose rate variation between adjacent zones has been observed in these calculations and is demonstrated in Table C.2 for a wall source calculation. The beta dose rates for location F under column W were calculated for the zone adjacent to the reactor cavity wall in Figure A.1. Dose rates under column w' were calculated for the second zone from the reactor cavity wall. We believe that the simple and symmetric zoning used and the nonuniform dose rates indicate that the current models may provide somewhat conservative wall and floor beta dose rates. Further parametric studies using finer zone nodalizations in regions of containment with calculated high beta dose should be performed.

5.4 Comments on PATH and ITS Isotope Inventory

Many gamma shielding codes are limited by the number of radionuclides which they can use for shielding calculations; some problems can occur when the number of radionuclides determined to occur in a simulation exceeds those used by the shielding code.

PATH has a standard gamma energy group structure library to convert an isotopic source into a gamma source energy spectrum. The PATH library can handle 125 isotopes. The source term radionuclide inventory calculated by BCL contains 152 isotopes. Isotopes common to both PATH and the BCL list were limited to 81 of the 152 isotopes. Table 5.8 lists the BCL isotopes; isotopes common to BCL and PATH are noted in Table 5.8.

To quantify the relative contribution of isotopes missing from PATH, beta and gamma decay energies per particle were obtained for all of the BCL isotopes from the ENDF/B-V[8] data for fission products and actinides. The activity of each isotope for each time period of each case was multiplied by their respective decay energies to get the total energy associated with each isotope as a function of time. The energies of the missing isotopes were then compared with the energies of the isotopes used by PATH. Table 5.9 presents the sum of the isotope energies used by PATH divided by the sum of missing and PATH isotope energies. Table 5.9 only addresses the gamma energies. Table 5.9 shows that the missing gamma isotopes contribute less than 5 percent of the total energies.

Beta energy spectra were available for 131 of the 152 isotopes during the ITS calculations. Table 5.8 also lists the isotopes common to the BCL output and ITS calculations. ENDF/B-V energy calculations similar to

those discussed above for the gamma energies were also performed for the beta energies. Energies of the missing isotopes contributed less than 2 percent of the total energies.

Table 5.8

Radionuclide Inventory Calculated by BCL

U237		TC99M		I133	-a,b	ND151	-a,b
U239		MO101	-a,b	XE133	-a,b	PM151	-a,b
NP238		TC101	-a,b	XE133M	-a,b	SM151	-b
NP239		MO102	-b	TE134	-a,b	ND152	-b
NP240		TC102	-b	I134	-a,b	PM152	-a,b
PU238		RU103	-a,b	CS134	-a,b	SM153	-b
PU239		RH103M		CS134M		EU154	-a,b
PU240		TC104	-a,b	I135	-a,b	SM155	-b
PU241		TC105	-a,b	XE135	-a,b	EU155	-b
PU243		RU105	-a,b	XE135M	-a,b	SM156	-b
SE79M		RH105	-b	CS135M		EU156	-b
SE81	-b	RH105M	-b	CS136	-a,b	EU157	-b
SE81M		RU106	-b	BA136M		SM158	-b
BR82	-b	RH106	-a,b	CS137	-b	EU158	-b
SE83	-a,b	RH106M	-b	BA137M	-a,b	EU159	-b
BR83	-b	RH107	-a,b	XE138	-a,b		
KR83M		PD109	-b	CS138	-a,b		
BR84	-a,b	PD111	-b	CS139	-a,b		
KR85	-a,b	PD111M	-b	BA139	-b		
KR85M	-a,b	PD112	-b	BA140	-a,b		
RB86	-b	SB122	-b	LA140	-a,b		
KR87	-a,b	SB124	-b	BA141	-a,b		
KR88	-a,b	SB125	-a,b	LA141	-b		
RB88	-a,b	TE125M	-b	CE141	-b		
RB89	-a,b	SB126	-b	BA142	-a,b		
SR89	-b	SB127	-a,b	LA142	-a,b		
SR90	-b	TE127	-b	PR142	-b		
Y90	-b	TE127M	-b	PR142M			
SR91	-a,b	SB128	-a,b	LA143	-a,b		
Y91	-b	SB128M	-a,b	CE143	-a,b		
Y91M	-a,b	I128	-b	PR143	-b		
SR92	-a,b	SB129	-a,b	CE144	-b		
Y92	-a,b	TE129	-a,b	PR144	-a,b		
SR93	-a,b	TE129M	-a,b	PR144M			
Y93	-a,b	SB130	-a,b	PR145	-b		
Y94	-a,b	I130	-b	CE146	-a,b		
Y95	-a,b	SB131	-a,b	PR146	-a,b		
ZR95	-a,b	TE131	-a,b	PR147	-a,b		
NB95	-a,b	TE131M	-a,b	ND147	-a,b		
NB95M	-b	I131	-a,b	PM147	-b		

Table 5.8

Radionuclide Inventory Calculated by BCL (Continued)

NB96	-a,b	XE131M	-b	PM148	-a,b
ZR97	-a,b	TE132	-a,b	PM148M	-a,b
NB97	-a,b	I132	-a,b	ND149	-a,b
NB97M	-a,b	TE133	-a,b	PM149	-b
MO99	-a	TE133M	-a,b	PM150	-b

a: isotopes used in PATH
b: isotopes used in ITS

Table 5.9

Gamma Total Energies Used by PATH

		Surry			
		C1	C2	C3	C4
1h	a	0.995	0.995	0.999	0.999
	w	0.994	0.994	-	-
	f	0.994	0.994	-	-
	s	-	-	0.994	0.994
4h	a	0.945	0.992	0.999	0.999
	w	0.985	0.991	-	-
	f	0.975	0.991	-	-
	s	-	-	0.966	0.990
16h	a	0.992	0.999	0.999	0.999
	w	0.973	0.990	-	-
	f	0.950	0.990	-	-
	s	-	-	0.956	0.990
2d	a	0.998	0.998	0.998	0.998
	w	0.973	0.993	-	-
	f	0.948	0.992	-	-
	s	-	-	0.955	0.993
8d	a	0.995	0.995	0.995	0.995
	w	0.980	0.995	-	-
	f	0.964	0.994	-	-
	s	-	-	0.968	0.994
32d	a	0.956	0.956	0.956	0.956
	w	0.977	0.988	-	-
	f	0.971	0.987	-	-
	s	-	-	0.972	0.987
128d	a	0.972	0.972	0.972	0.972
	w	0.985	0.987	-	-
	f	0.983	0.987	-	-
	s	-	-	0.983	0.987
1y	a	1.	1.	1.	1.
	w	0.984	0.985	-	-
	f	0.983	0.985	-	-
	s	-	-	0.983	0.985

Table 5.9

Gamma Total Energies Used by PATH (Continued)

		Peach Bottom			
		C1	C2	C3	C4
1h	da	0.996	0.996	0.999	0.999
	dw	0.995	0.995	-	-
	df	0.995	0.995	-	-
	wa	0.999	0.999	0.999	0.999
	ww	0.995	0.995	0.995	0.995
	ws	0.995	0.995	0.995	0.995
4h	da	0.998	0.999	0.999	0.999
	dw	0.978	0.994	-	-
	df	0.979	0.994	-	-
	wa	0.999	0.999	0.999	0.999
	ww	0.994	0.994	0.994	0.994
	ws	0.989	0.994	0.988	0.994
16h	da	0.999	0.999	0.999	0.999
	dw	0.994	0.994	-	-
	df	0.990	0.994	-	-
	wa	0.999	0.998	0.999	0.998
	ww	0.994	0.994	0.994	0.994
	ws	0.991	0.994	0.986	0.994
2d	da	0.998	0.998	0.998	0.998
	dw	0.996	0.996	-	-
	df	0.992	0.997	-	-
	wa	0.998	0.997	0.998	0.997
	ww	0.997	0.997	0.997	0.997
	ws	0.993	0.997	0.987	0.996
8d	da	0.995	0.995	0.995	0.995
	dw	0.997	0.997	-	-
	df	0.994	0.997	-	-
	wa	0.994	0.996	0.995	0.996
	ww	0.997	0.997	0.997	0.997
	ws	0.994	0.997	0.989	0.997
32d	da	0.956	0.956	0.956	0.956
	dw	0.988	0.988	-	-
	df	0.985	0.988	-	-
	wa	0.956	0.965	0.956	0.965
	ww	0.989	0.989	0.989	0.989
	ws	0.985	0.988	0.981	0.987

Table 5.9

Gamma Total Energies Used by PATH (Concluded)

		Peach Bottom			
		C1	C2	C3	C4
128d	da	0.973	0.976	0.976	0.976
	dw	0.985	0.985	-	-
	df	0.984	0.985	-	-
	wa	0.974	0.979	0.974	0.974
	ww	0.985	0.985	0.985	0.985
	ws	0.985	0.985	0.984	0.984
1y	da	1.0	1.0	1.0	1.0
	dw	0.982	0.982	-	-
	df	0.982	0.982	-	-
	wa	0.984	0.984	0.999	0.984
	ww	0.982	0.982	0.982	0.982
	ws	0.982	0.982	0.983	0.982

a: airborne
w: wall
f: floor
s: sump
da: drywell airborne
dw: drywell wall
df: drywell floor
wa: wetwell airborne
ww: wetwell wall
ws: wetwell sump

5.5 Other Dose Rate and Dose Work

Appendix D of Regulatory Guide 1.89 presents methodology and sample calculations for equipment qualification radiation dose. This appendix discusses the staff model for calculating dose rates and integrated doses for equipment qualification purposes. Gamma and beta doses were calculated at the midpoint of containment for a PWR plant with a free containment volume of 2.5×10^6 cubic feet and a power rating of 4,100 MWt (Surry has a free containment volume of 1.75×10^6 cubic feet and a power rating of 2,441 MWt). ESF fans and sprays were modeled to be operational. The staff assumed that 50 percent of the iodine core activity inventory and 100 percent of the core noble gas activity inventory were released instantaneously to the containment atmosphere. The reader is referred to Reg Guide 1.89 for further details and assumptions used in the analysis.

The Reg Guide 1.89 airborne noble gas gamma and beta dose are shown in Figure 5.4.1. The Surry Case 4 annulus and dome integrated gamma and beta dose are shown in Figures 5.4.2 and 5.4.3. No direct comparison is intended since both reactors analyzed are different, but both analyses do show the dose due to noble gas activity. The gamma and beta doses for each analysis have roughly equivalent values; the Surry minimum and maximum dose values bound the staff dose values.

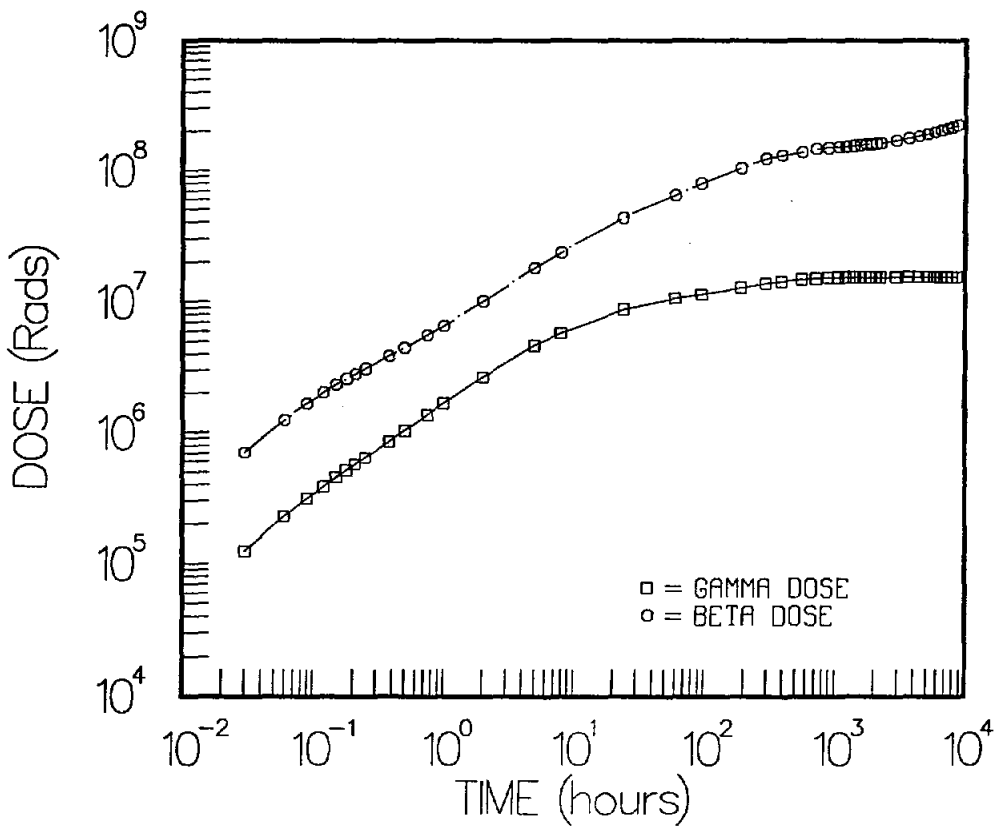
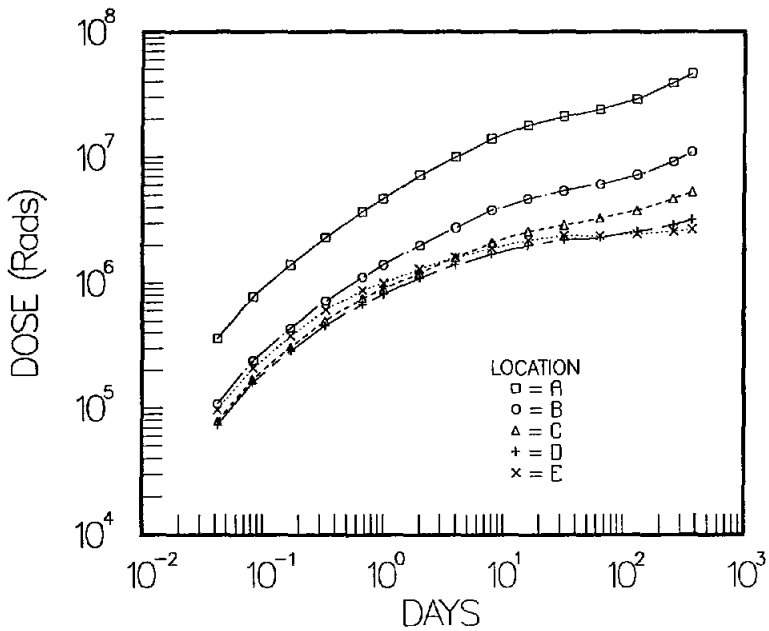


Figure 5.4.1. Reg Guide 1.89 Noble Gas Gamma and Beta Dose



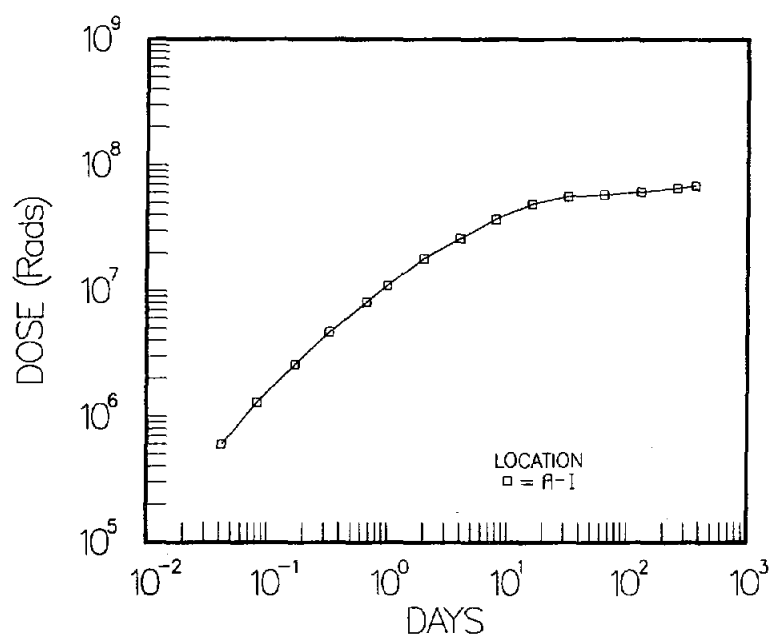
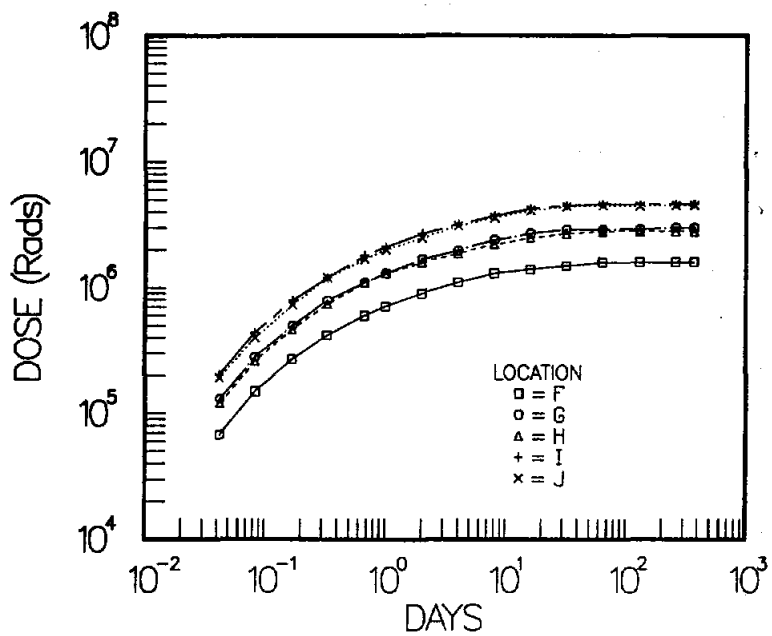


Figure 5.4.2. Surry Case 4 Annulus Total Gamma and Beta Dose



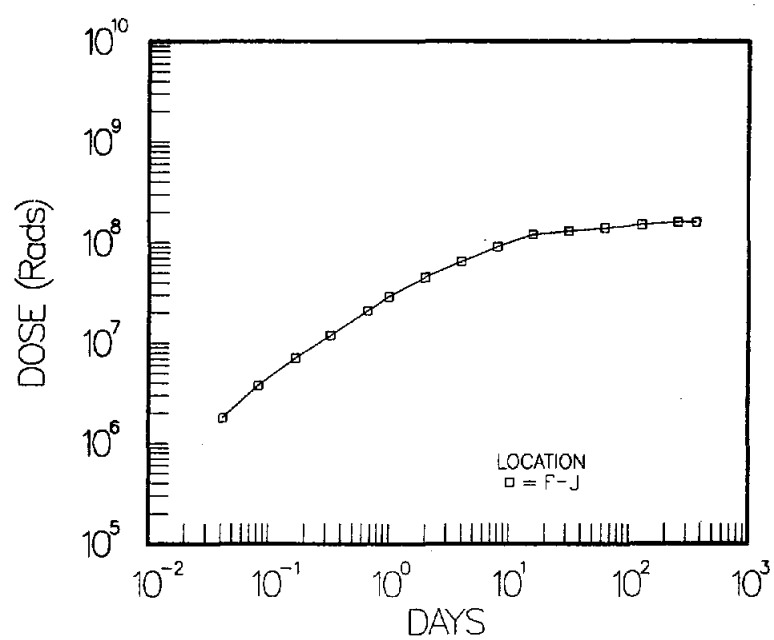


Figure 5.4.3. Surry Case 4 Dome Total Gamma and Beta Dose

6.0 SUMMARY AND RECOMMENDATIONS

Dose rates and total dose have been calculated for the Surry and Peach Bottom containments using radionuclide sources which have been developed as a function of time with the Source Term Code Package. The AB epsilon scenario and three variations were used to calculate dose rate for Surry and the AE scenario and three variations were used for Peach Bottom. For each plant, the variations involved (1) an arrested core meltdown, (2) operation of containment sprays and meltdown, and (3) an arrested sequence with operation of containment sprays. The base case for each plant resulted in the highest dose rates and total dose. Surry total gamma and beta dose exceeded the Reg Guide 1.89 Appendix D dose of 2.2×10^8 rads by as much as 1360 percent, and Peach Bottom total gamma and beta dose exceeded the Appendix D dose by as much as 832 percent. Therefore, equipment qualified to Appendix D levels may not be qualified for the base case severe accident levels. The Case 2 arrested sequence dose calculations for both Surry and Peach Bottom resulted in substantial total dose reduction throughout the containments. The majority of dose point locations studied were within a factor of 2 to 3 above the Appendix D levels. Case 3 and 4 scenarios resulted in total gamma and beta doses well below the Appendix D levels; Appendix D qualified equipment exposed to these environments should maintain their functional integrity.

Dose rate calculations in containment are highly dependent on the source term calculations. BCL staff believe that source term analysis uncertainties have been adequately bounded by the case variations selected for this study. Therefore, bounding source terms will give bounding dose rates. BCL staff also believes that the source terms are representative of the increased data base and improved calculational tools.

The BCL Surry source term analysis treated the containment as a single volume, and the Peach Bottom analysis treated the containment as two volumes (the drywell and wetwell). Deposition of radionuclides to walls, floors, and sumps was also characterized for the two reactor containment models. Calculations of physical transport of radionuclides in a multicompartment containment during and after the accident was beyond the scope of this study. BCL staff believed that the limited containment nodalization was adequate to reasonably predict deposition, but that additional modeling was needed to characterize the effects of compartmentalization.

The Surry dose rate calculations used actual compartment models. Dose rates were calculated for the dome region, operating floor region, basement, annulus, steam generator A cubicle, steam generator B cubicle, RHR cubicle, and incore instrumentation room. Uniform distribution of source terms was assumed for this calculation. This method could result in underestimating dose rate in compartments into which the source is released early in the accident and overestimating dose rate in compartments away from the source release point. Operation of ESFs such as sprays and fans could enhance source mixing in containment. Physical

transport of radionuclides in a multicompartment containment during the accident should be one area of future work.

Peach Bottom dose rate calculations modeled the drywell as one region and the wetwell as two regions (the wetwell torus and the torus room). Uniform distribution of radionuclides was also assumed during and after the accident; the uniform distribution assumption should be reasonable for the drywell since it is a relatively open volume. . Operation of drywell sprays should also enhance mixing in the drywell. Uniform distribution in the wetwell torus may also be reasonable due to the mixing action of drywell gas/liquid injection into the torus.

Gamma dose rate calculations for Surry and Peach Bottom were true three-dimensional calculations. Volume sources and surface sources had to be approximated by a series of point sources. PATH calculations become prohibitively expensive as volume or surface sources are approximated by increasing number of point sources. Although care was taken to characterize the function of dose rate versus source point number, gamma dose rates could vary by as much as ± 10 percent depending on the source point scheme used. One Peach Bottom and Surry case each should be selected from the eight examined and studied in greater detail assuming that further quantification of radionuclide transport in a multicompartment containment would be available.

ITS beta dose rate calculations for Surry and Peach Bottom were also three-dimensional calculations but were not as versatile as the PATH calculations for containment applications. Three-dimensional containment models are made by combining simple geometric shapes into a number of containment zones. Electron transport can be tracked three-dimensionally from zone to zone. Dose rate calculations are presented in terms of average electron energy deposition in each containment zone from specified electron sources. Finely dividing or nodalizing a containment into small zones would approach true three-dimensional electron dose rate calculations but would also result in prohibitive computing expenses. The Case 1 Surry and Peach Bottom wall and surface source dose rate calculations should be repeated with finer containment nodalization in locations which have high calculated beta doses.

BCL stated the Case 1 scenarios for Peach Bottom and Surry represented worst case radionuclide release. Case 2 scenarios were arrested sequences and radionuclide activity due only to core-concrete attack was removed from the radionuclide output; the removal of only the core-concrete contribution implies that 100 percent core degradation occurred. Therefore, Case 2 could also represent a worst case scenario for radionuclide release when compared to accident sequences with less core damage. Other lesser core degradation percentages may be more likely to occur during accidents and may result in smaller dose calculations.

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APPENDIX A

ITS CONTAINMENT BUILDING ZONES

Beta dose calculations required that the compartments listed in Table 4.1 (for gamma dose calculations) be further subdivided because of the shorter range of beta dose when compared to gamma dose. Subdividing the containment too finely would result in exorbitant ITS computing costs. Figure A.1 shows the Surry containment subdivision used when dose rates caused by surface sources were calculated. Figure A.2 shows containment subdivision for floor source calculations. Figure A.3 shows the steam generator A cubicle subdivision; subdivision of the steam generator B cubicle, RHR cubicle, and incore instrumentation room are similar.

Figure A.4 shows the Peach Bottom drywell subdivision for wall surface sources. The Peach Bottom drywell subdivision for floor surface sources is shown in Figure A.5.

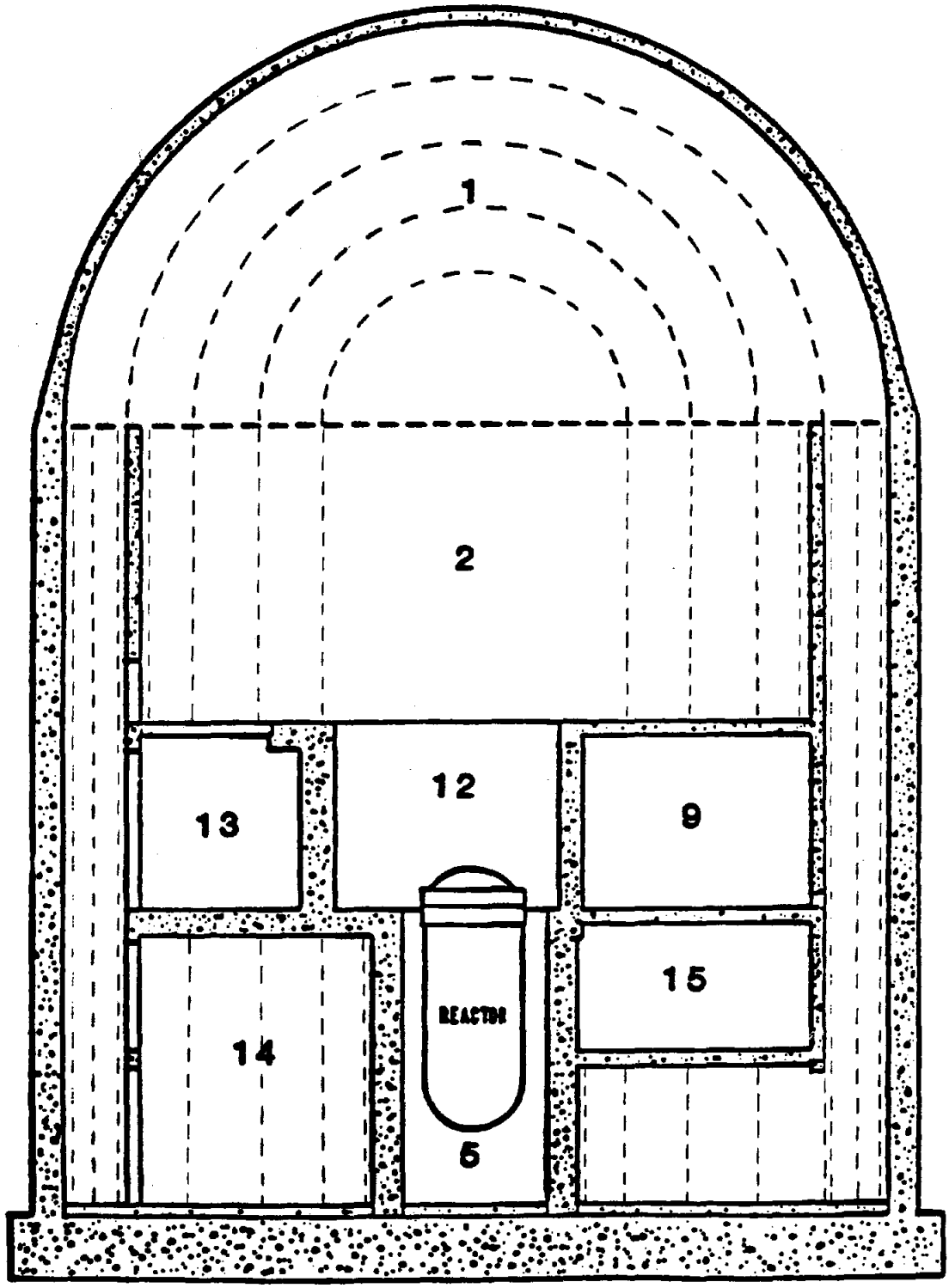


Figure A.1. Surry Containment Zones for Surface Sources

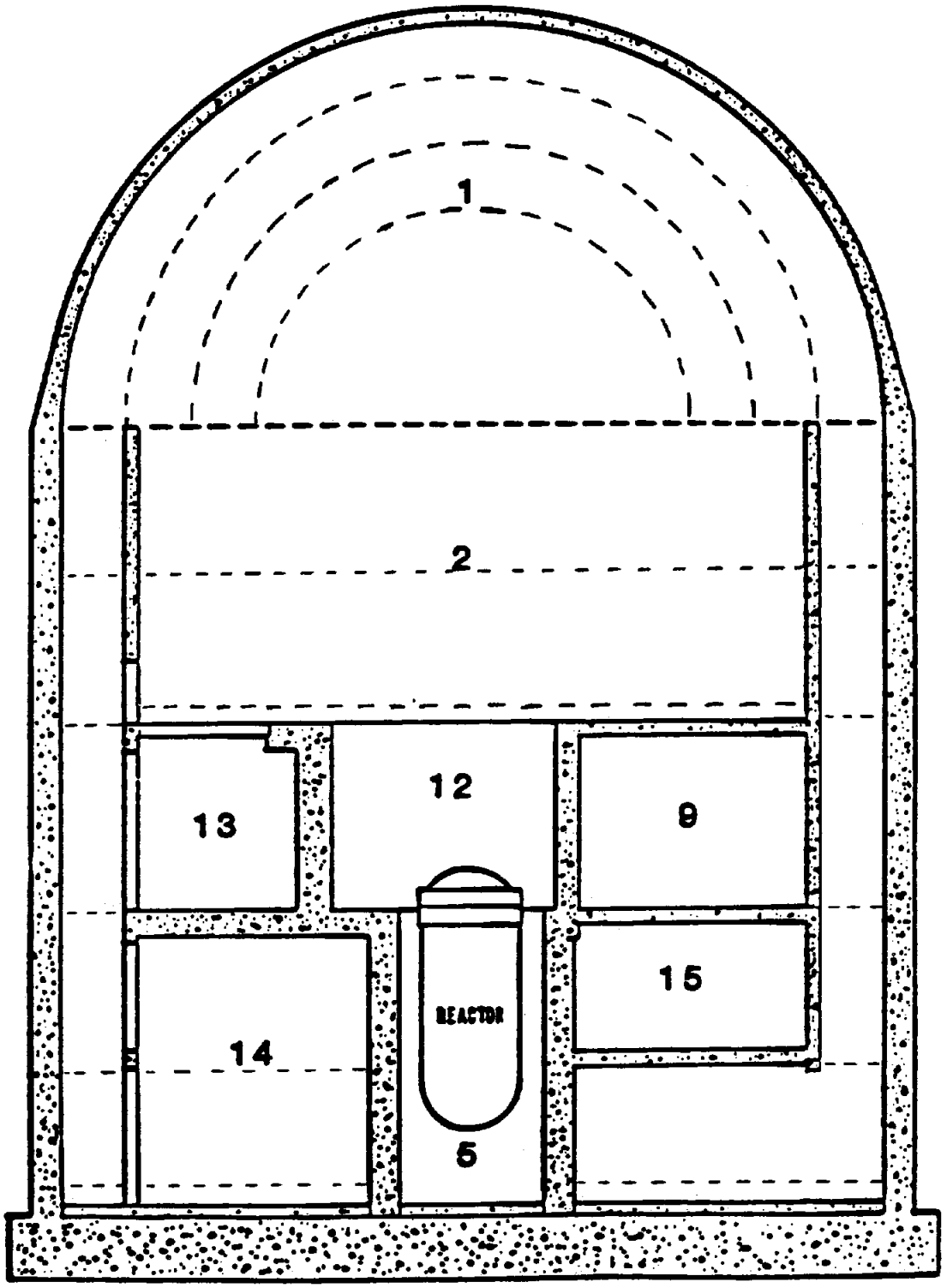


Figure A.2. Surry Containment Zones for Floor Sources

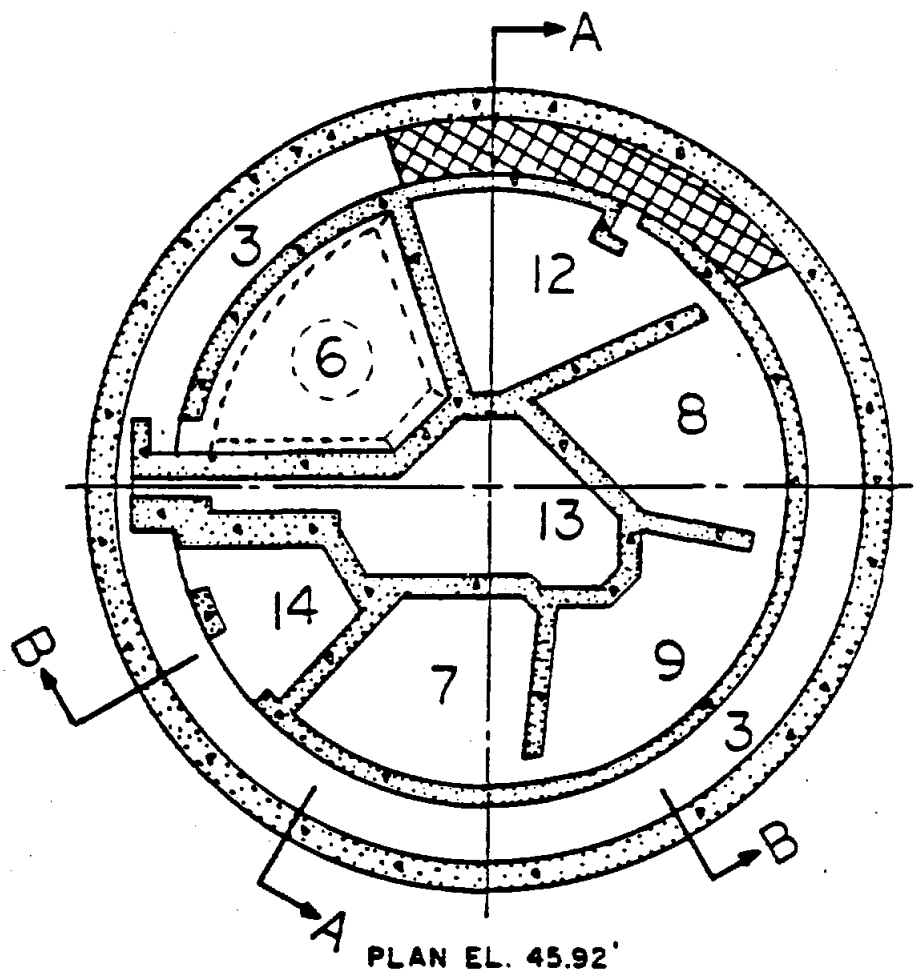


Figure A.3. Surry Steam Generator A Cubicle Zones

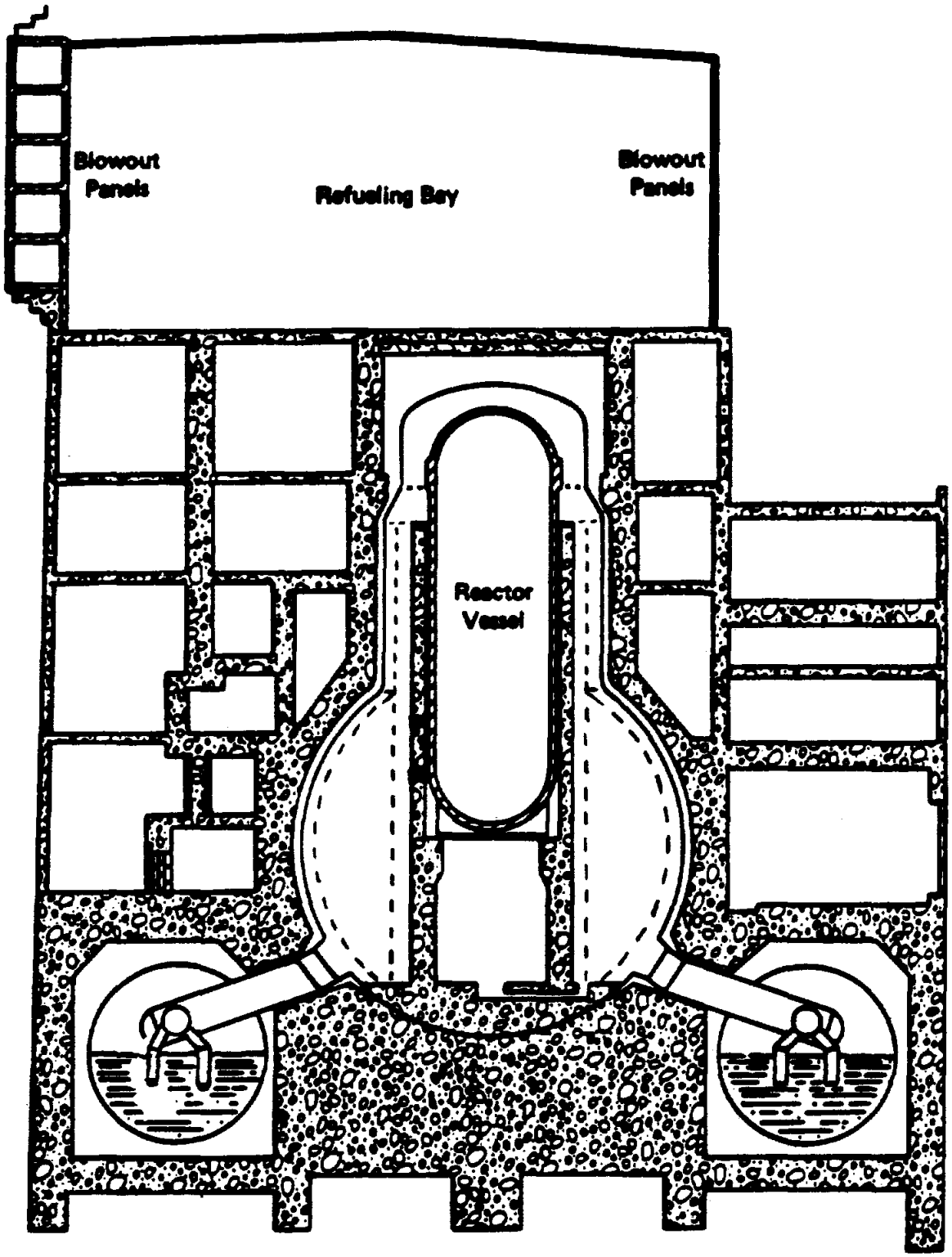


Figure A.4. Peach Bottom Drywell Zones for Surface Sources

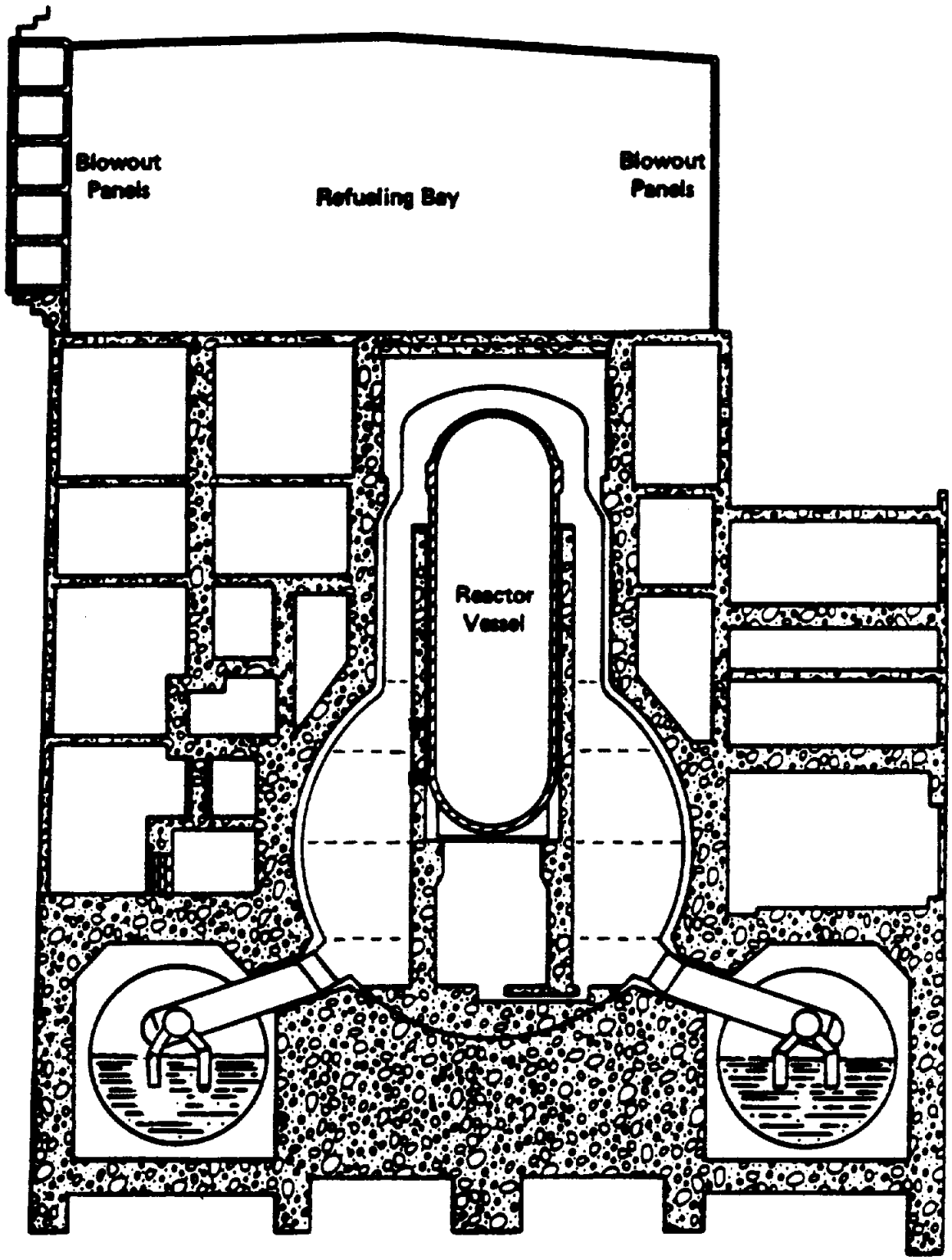
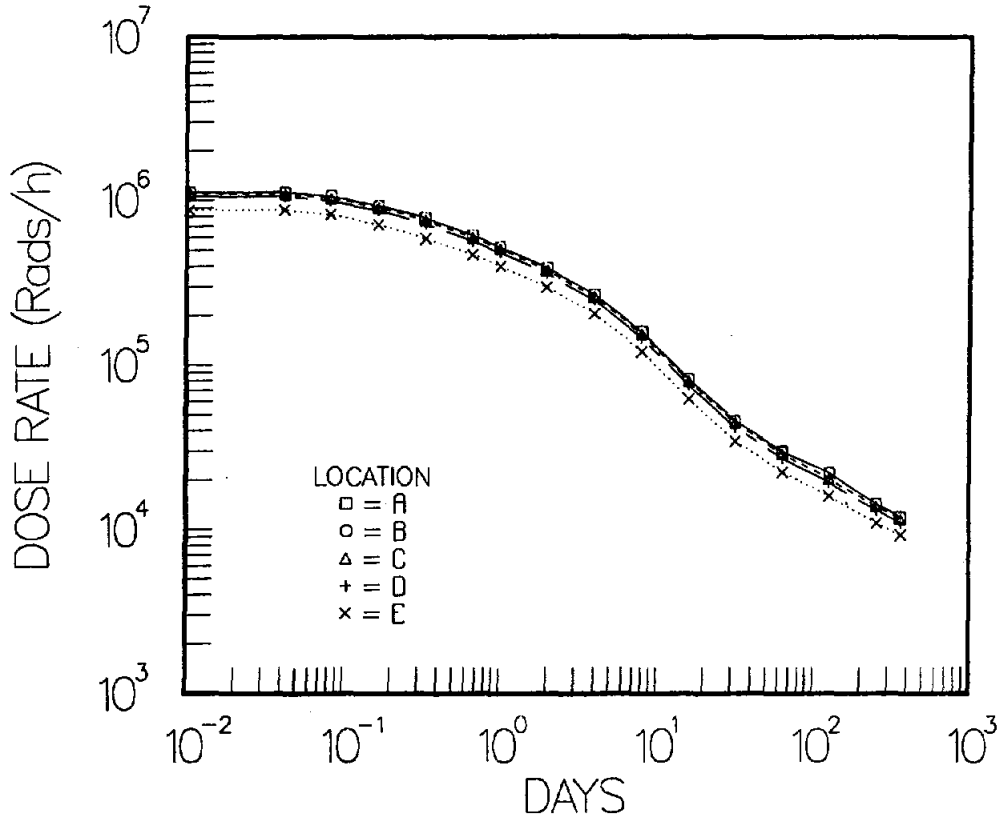


Figure A.5. Peach Bottom Drywell Zones for Floor Sources

APPENDIX B

ADDITIONAL DOSE RATE AND DOSE FIGURES



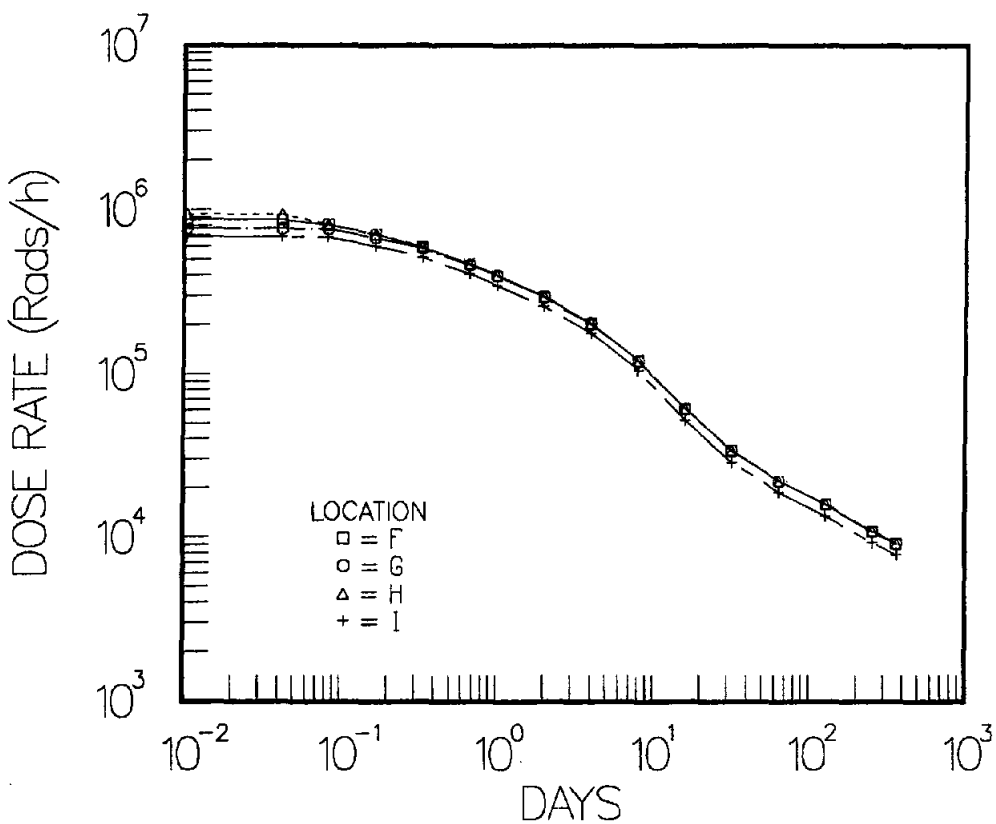
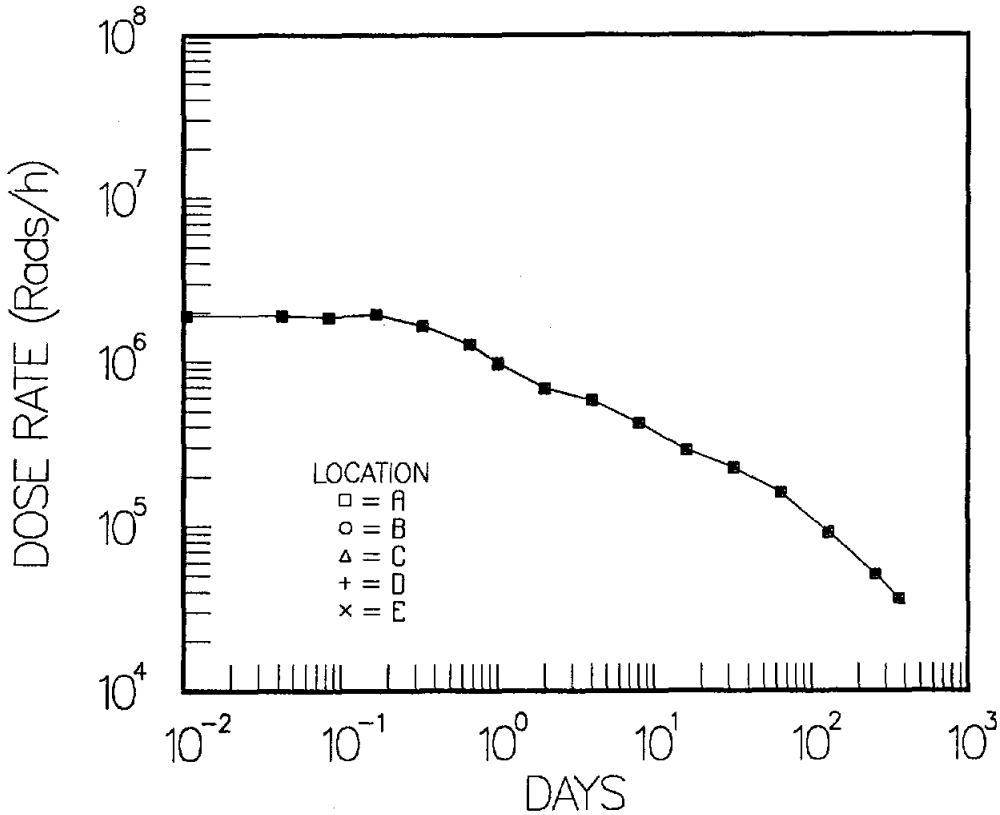


Figure B.1. Surry Case 1 Basement Gamma Dose Rate



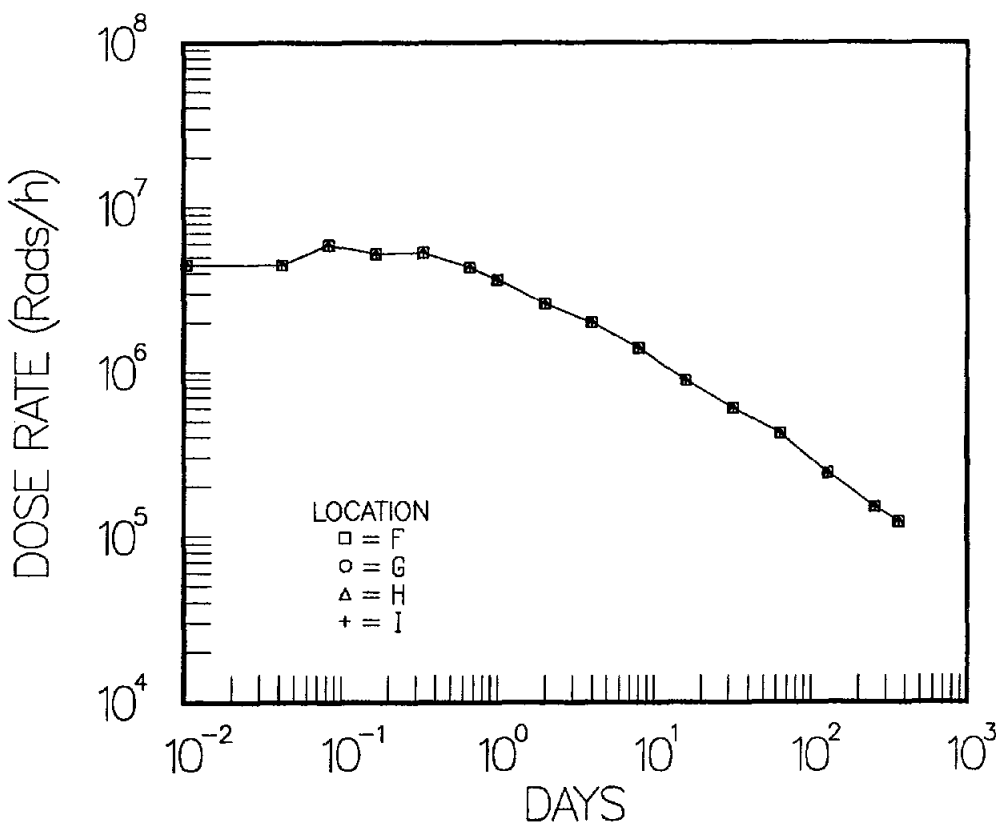


Figure B.2. Surry Case 1 Basement Beta Dose Rate

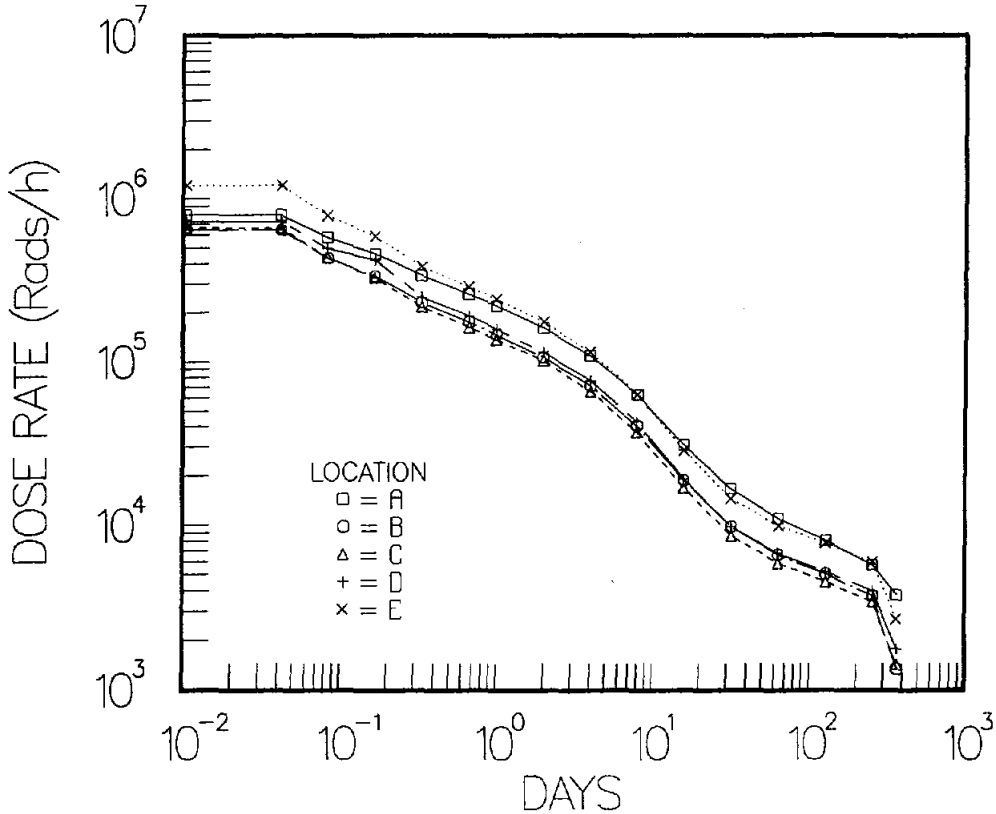


Figure B.3. Surry Case 1 Annulus Gamma Dose Rate

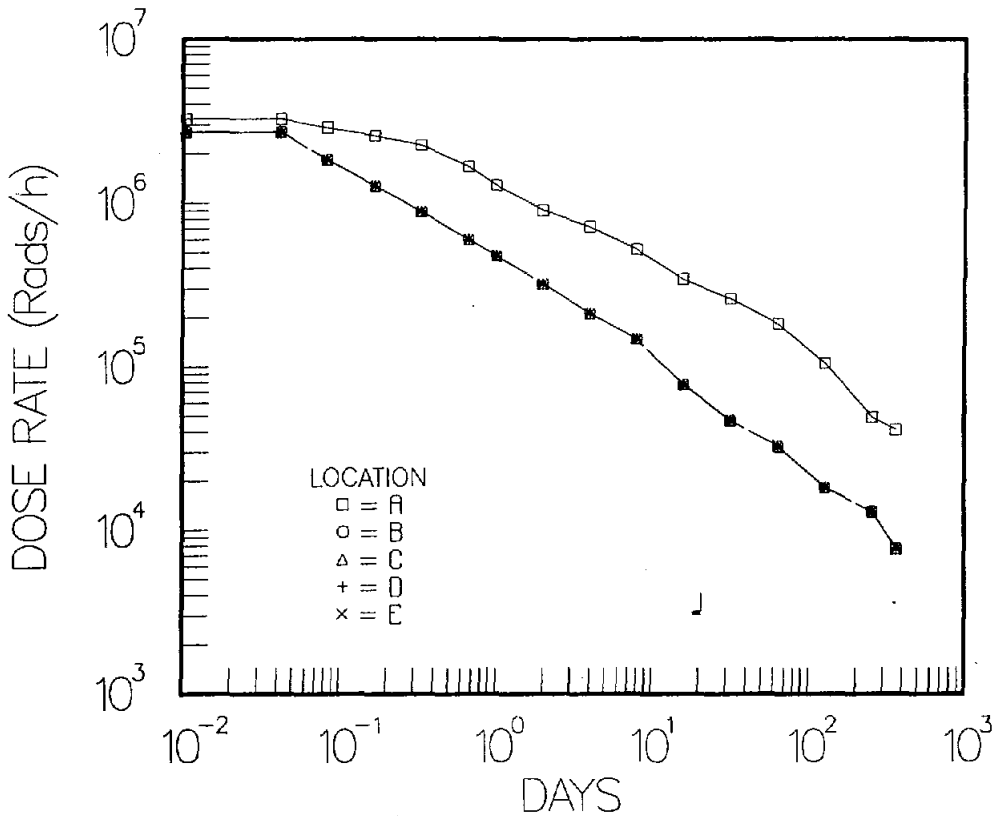


Figure B.4. Surry Case 1 Annulus Beta Dose Rate

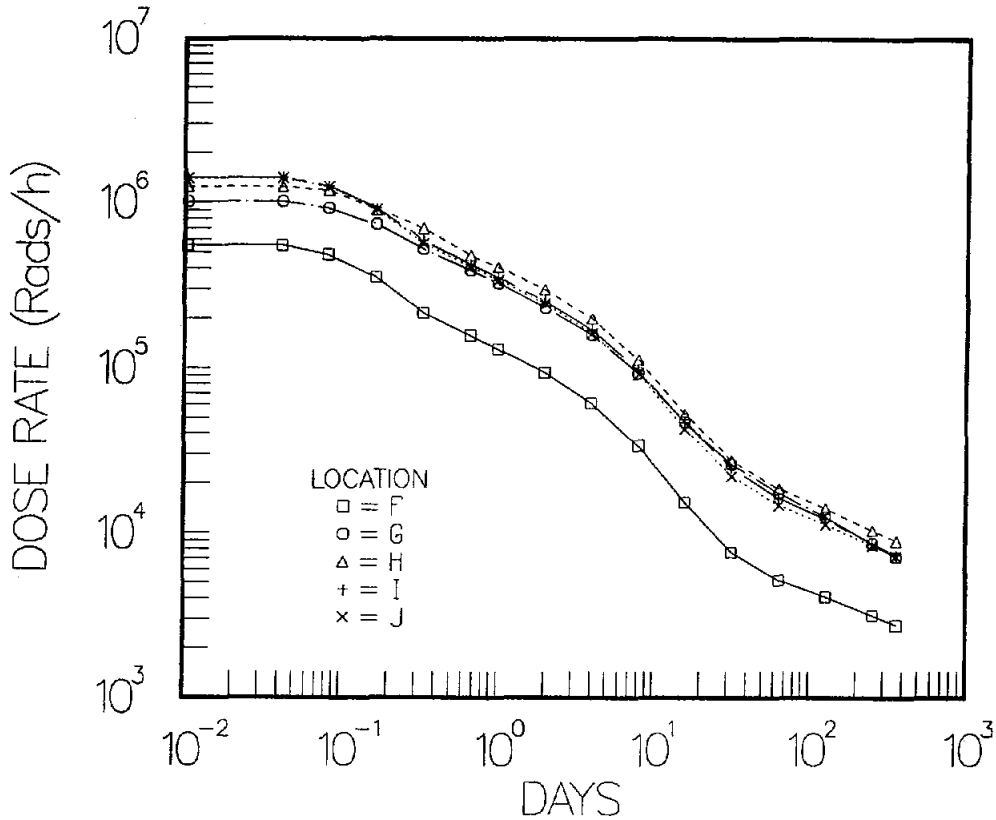


Figure B.5. Surry Case 1 Operating Floor and Dome Gamma Dose Rates

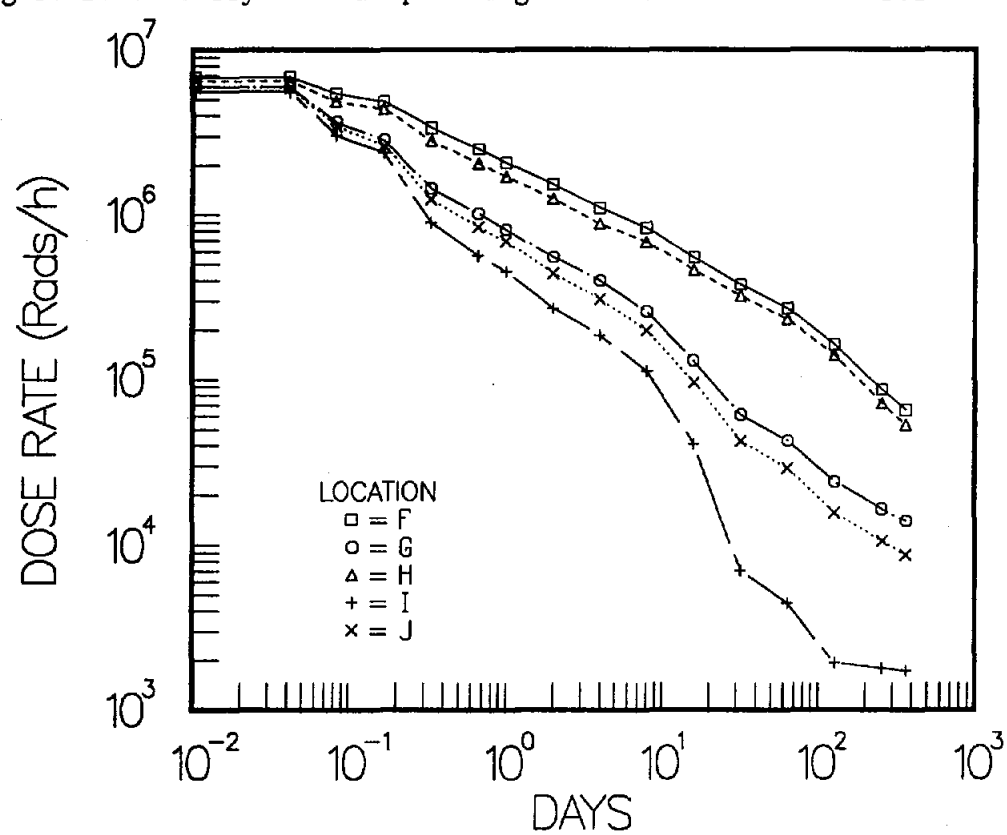


Figure B.6. Surry Case 1 Operating Floor and Dome Beta Dose Rates

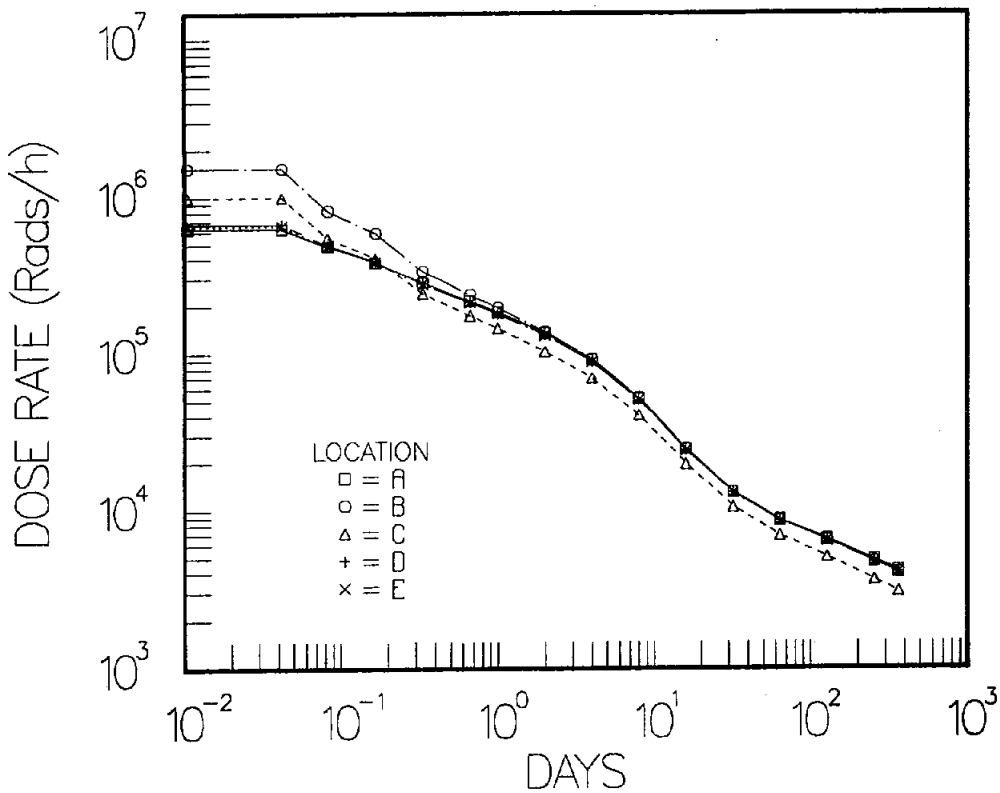


Figure B.7. Surry Case 1 Steam Generator A Cubicle Gamma Dose Rates

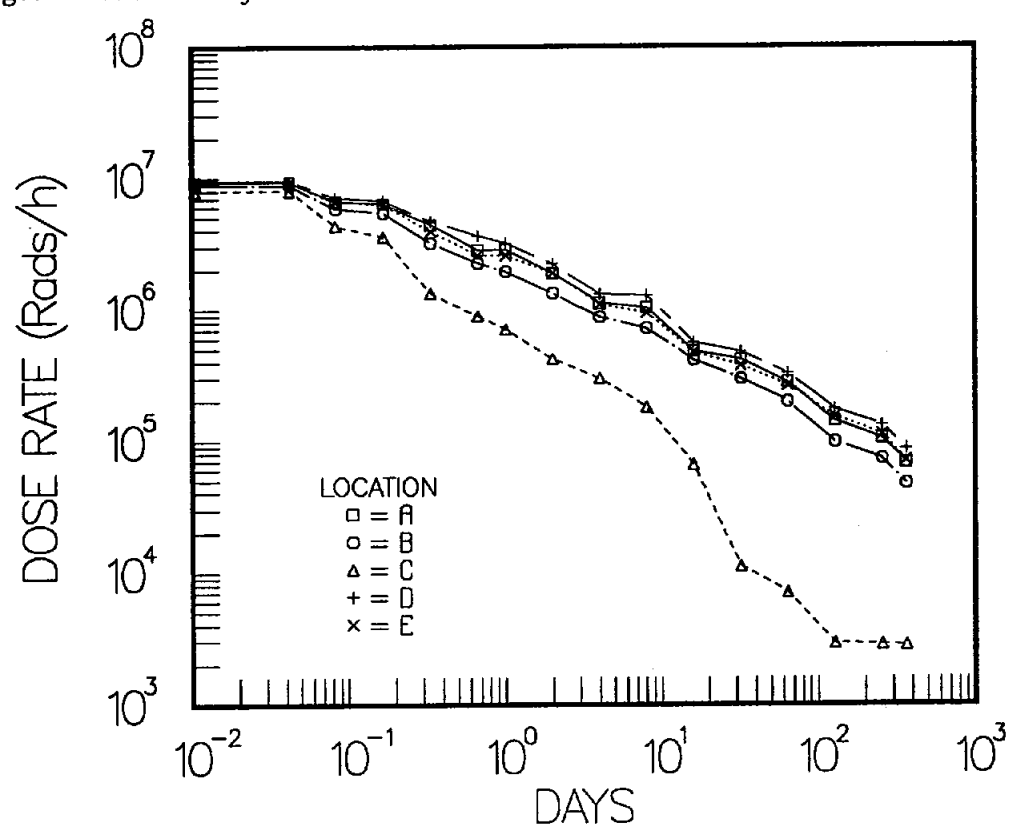


Figure B.8. Surry Case 1 Steam Generator A Cubicle Beta Dose Rates

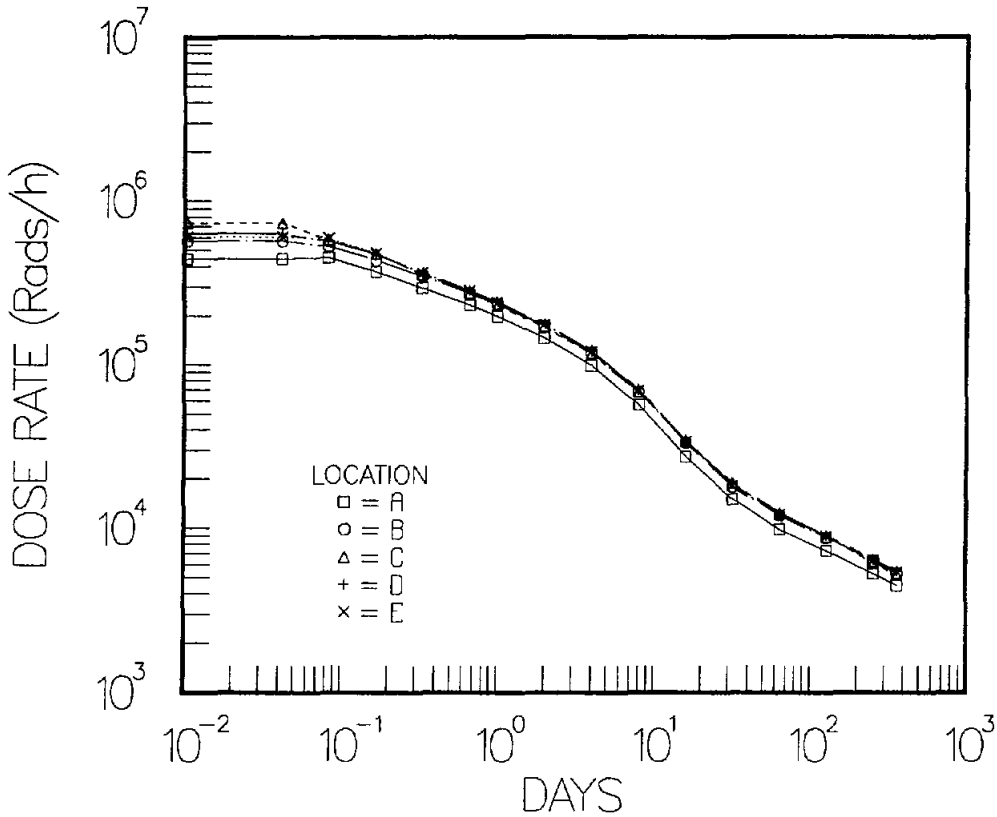


Figure B.9. Surry Case 1 RHR Cubicle Gamma Dose Rates

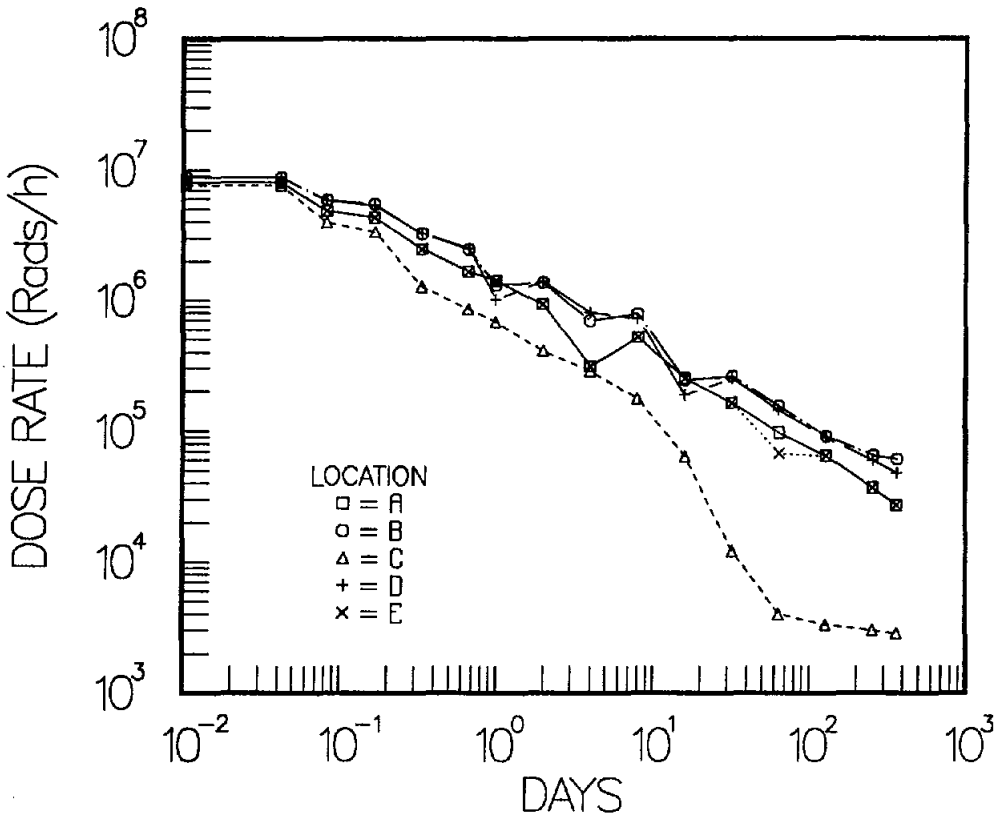


Figure B.10. Surry Case 1 RHR Cubicle Beta Dose Rates

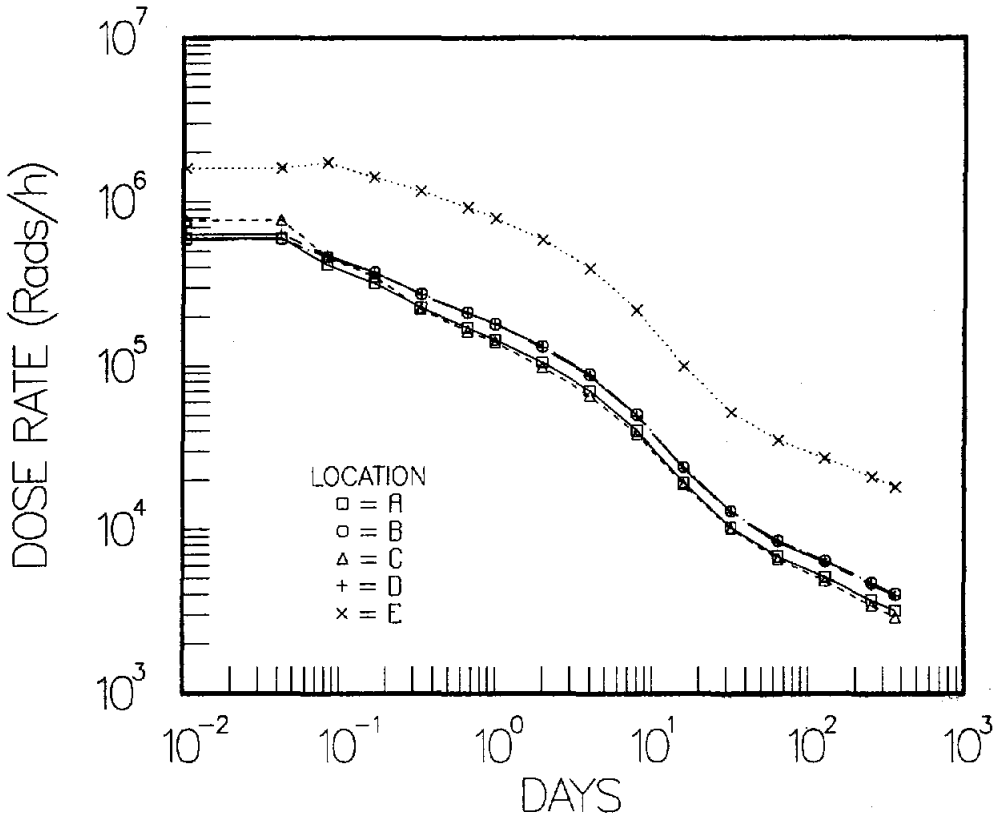


Figure B.11. Surry Case 1 Steam Generator B Gamma Dose Rate

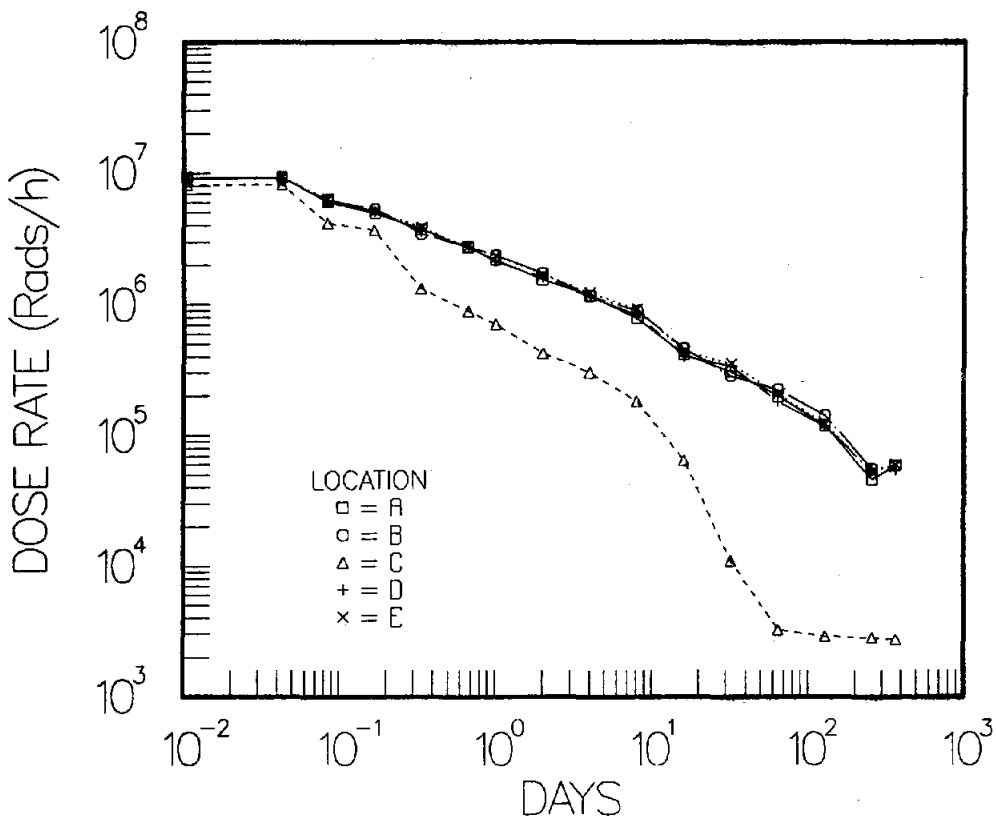


Figure B.12. Surry Case 1 Steam Generator B Beta Dose Rate

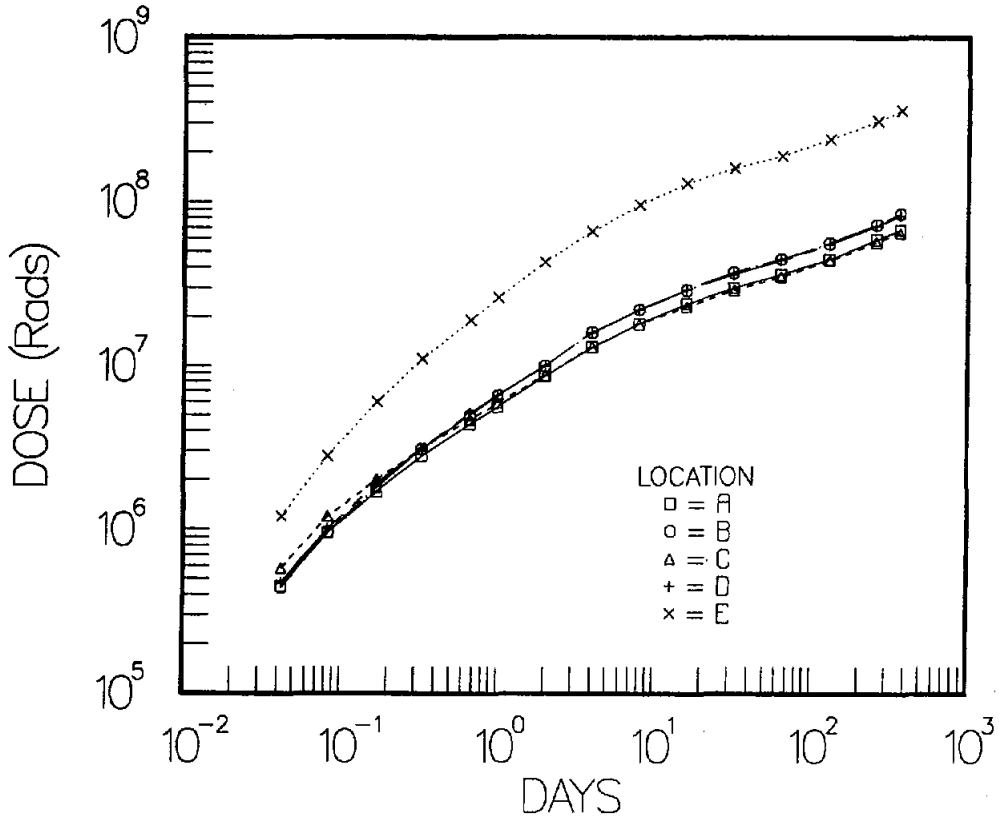


Figure B.13. Surry Case 1 Steam Generator B Total Gamma Dose

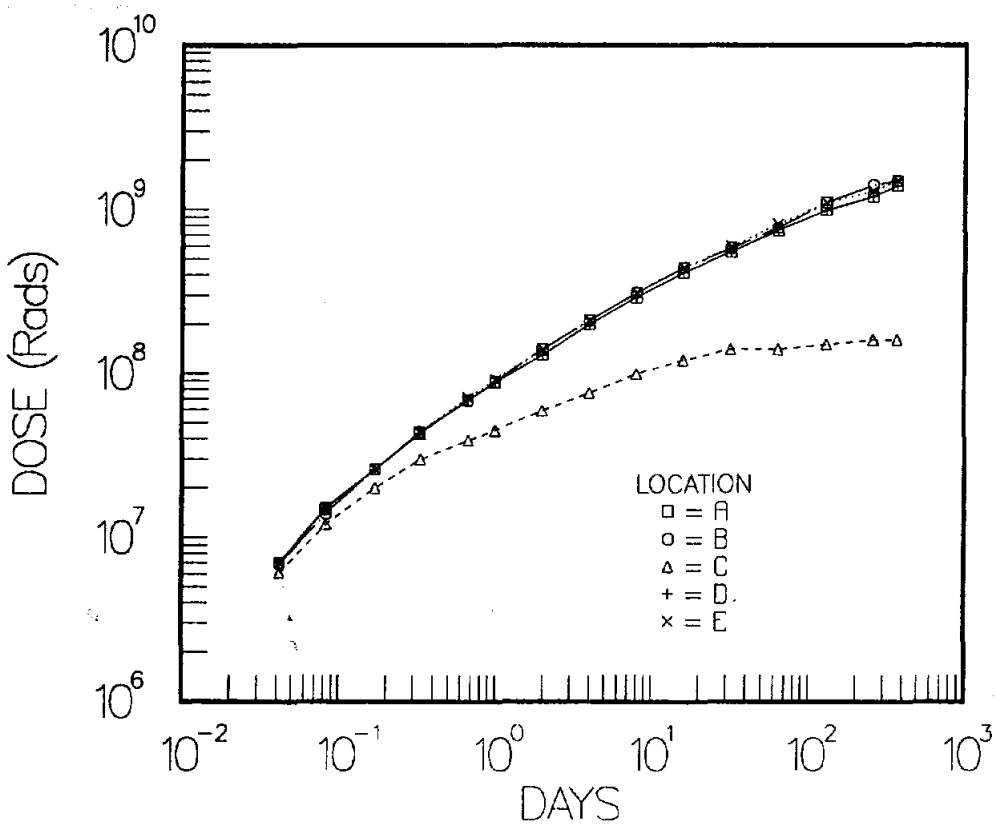


Figure B.14. Surry Case 1 Steam Generator B Total Beta Dose

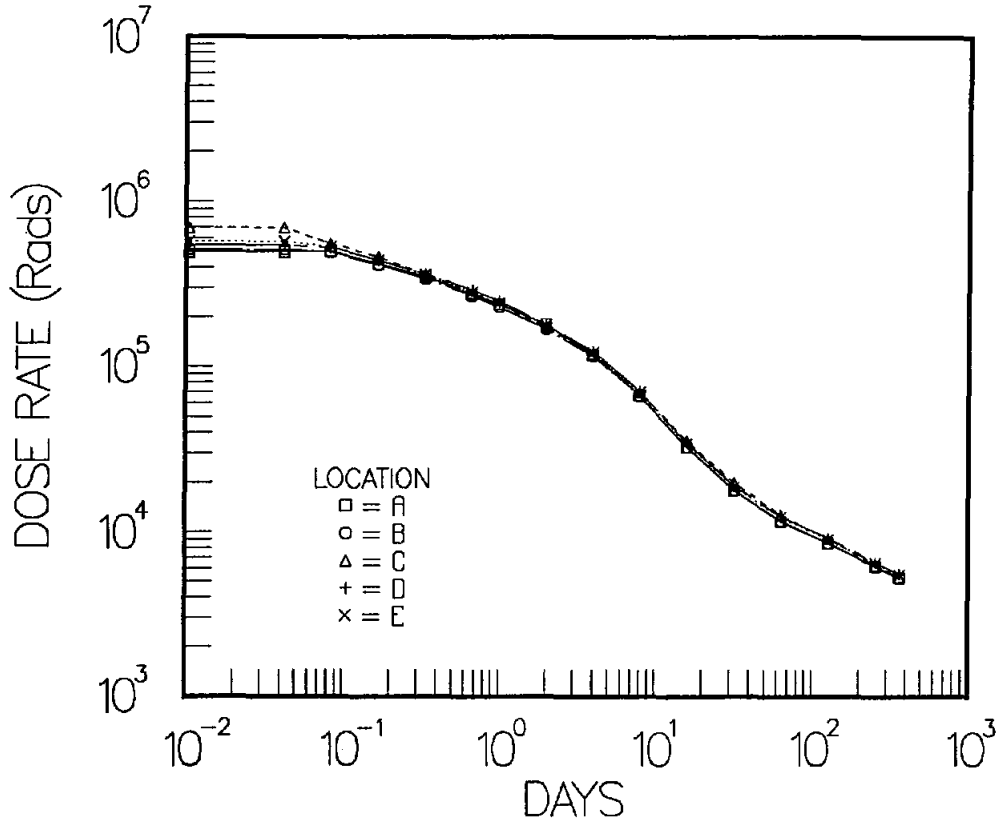


Figure B.15. Surry Case 1 In-Core Instrumentation Room Gamma Dose Rate

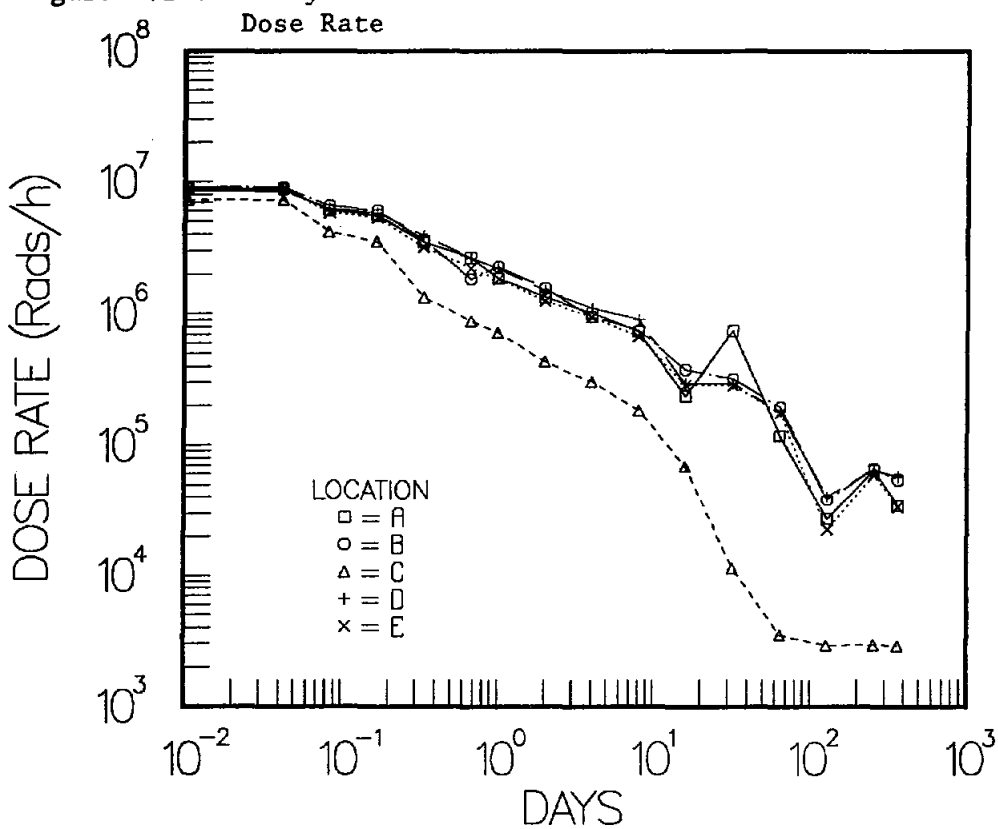


Figure B.16. Surry Case 1 In-Core Instrumentation Room Beta Dose Rate

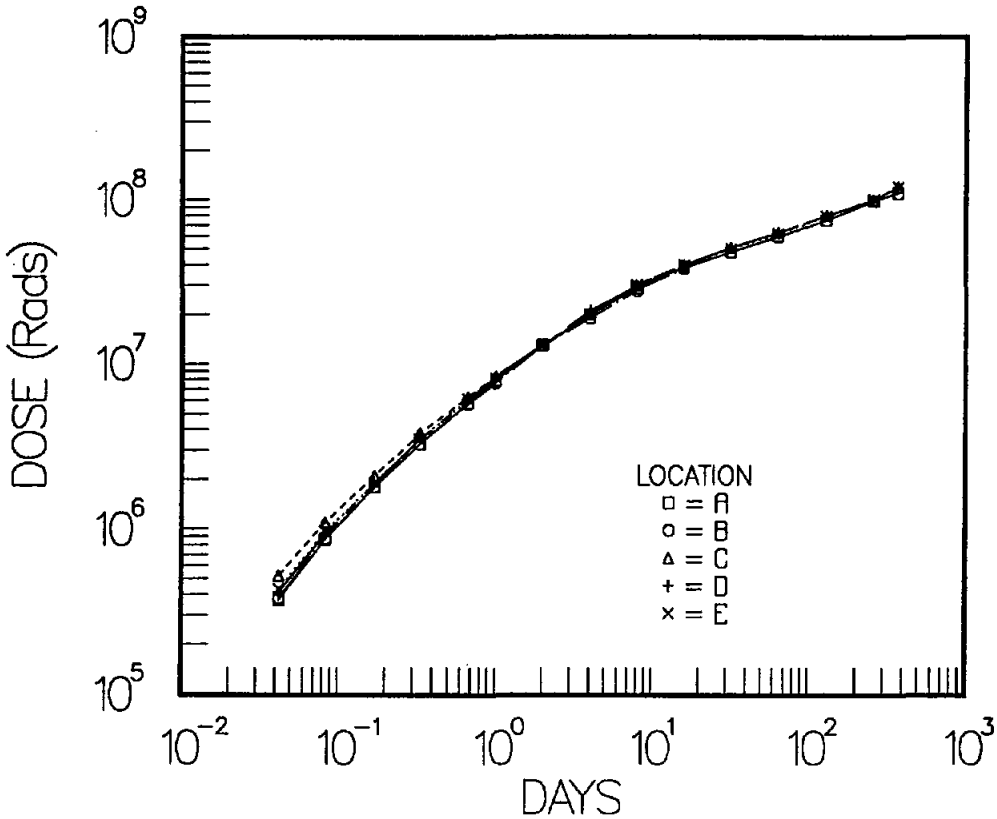


Figure B.17. Surry Case 1 In-Core Instrumentation Room Total Gamma Dose

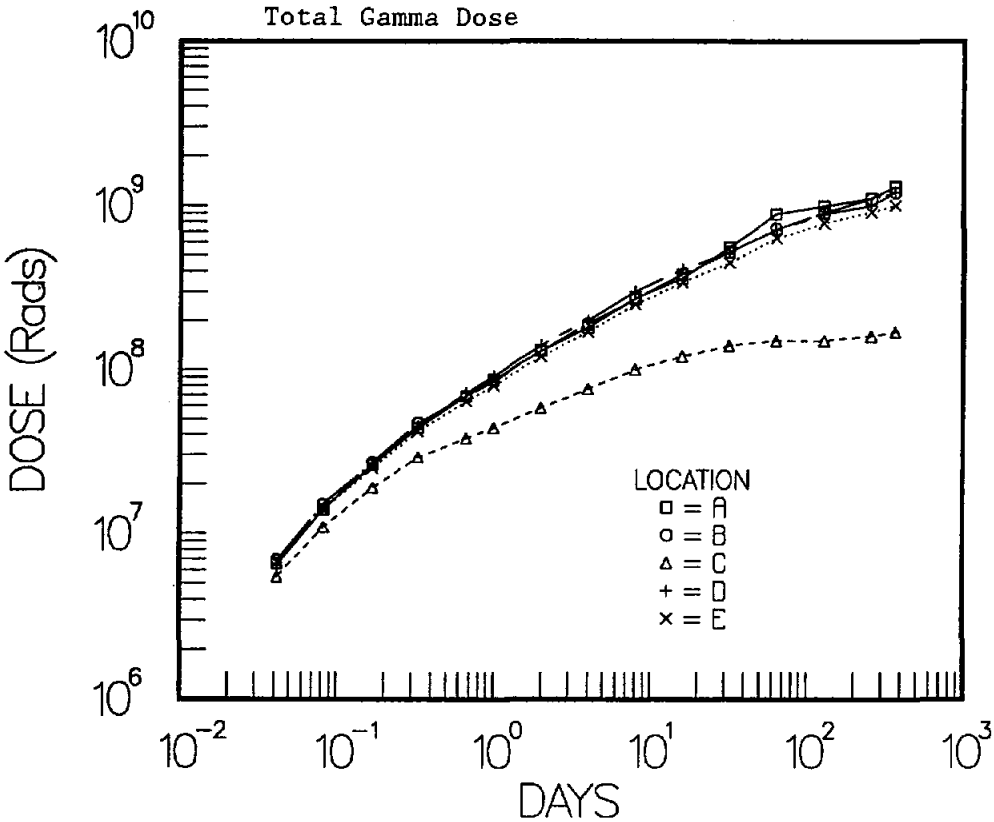


Figure B.18. Surry Case 1 In-Core Instrumentation Room Total Beta Dose

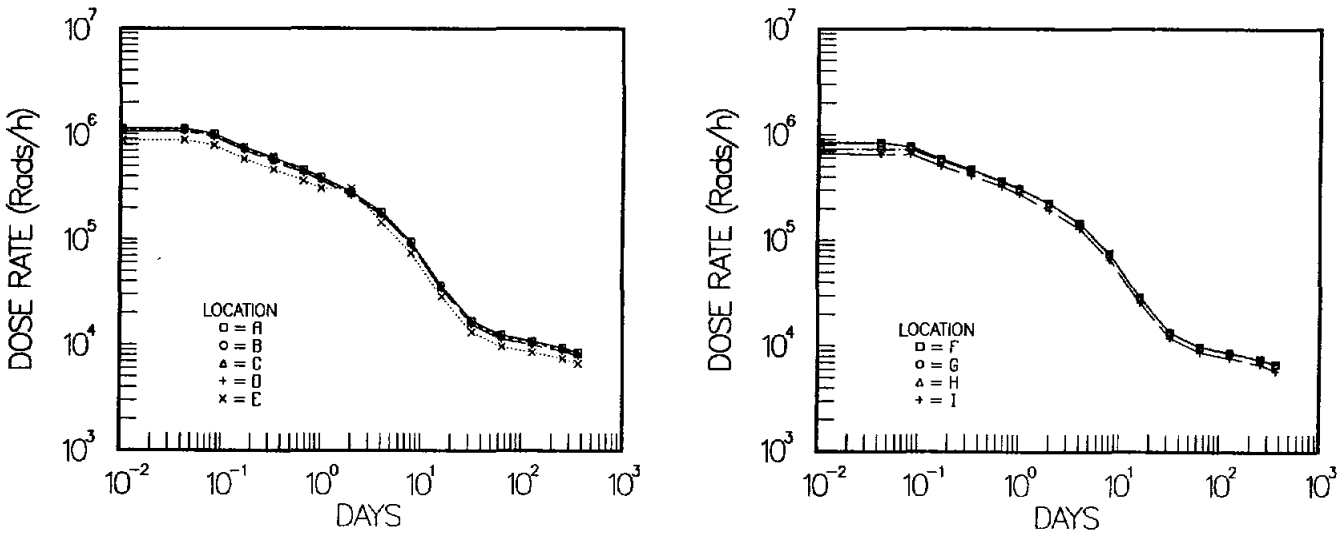


Figure B.19. Surry Case 2 Basement Gamma Dose Rate

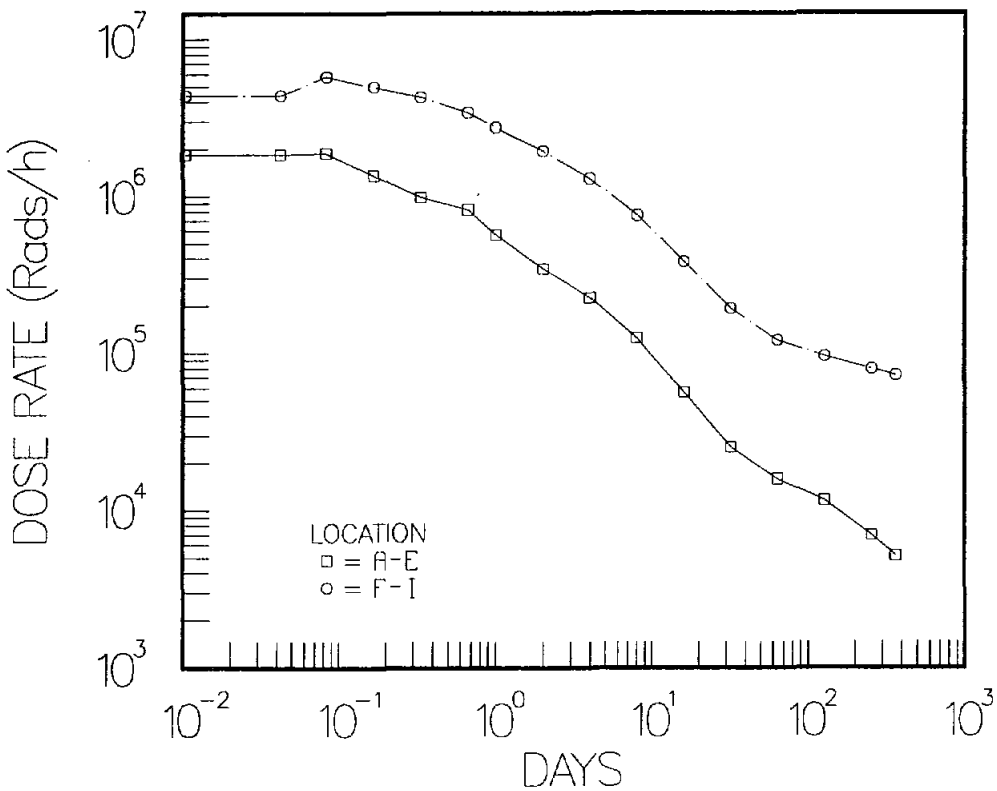


Figure B.20. Surry Case 2 Basement Beta Dose Rate

96

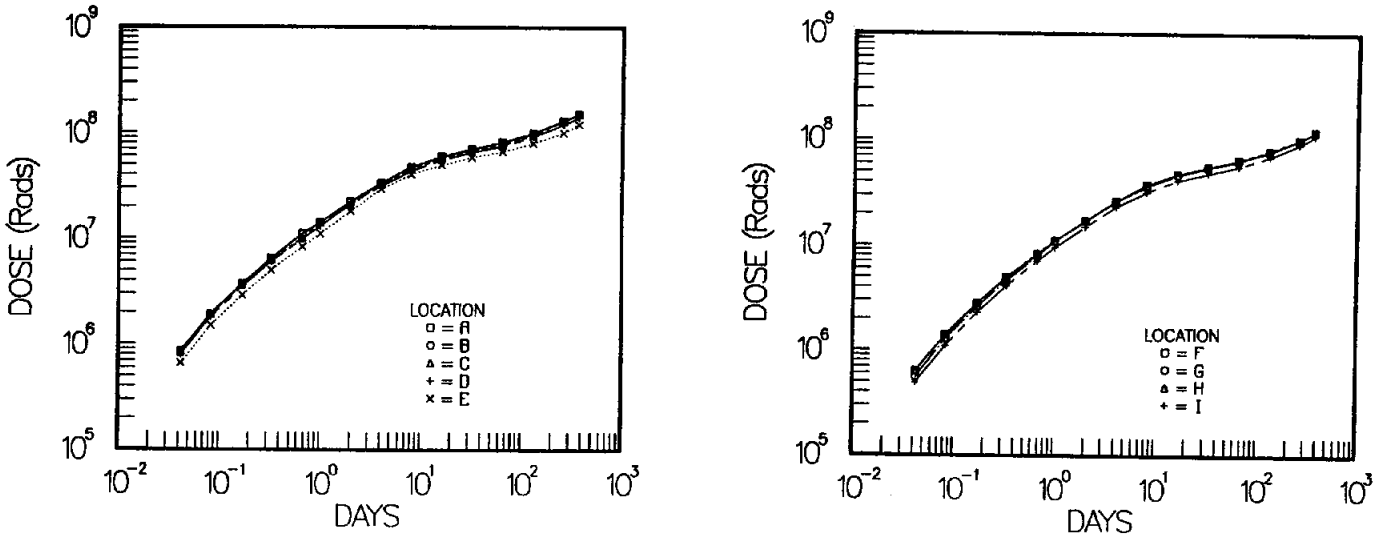


Figure B.21. Surry Case 2 Basement Total Gamma Dose

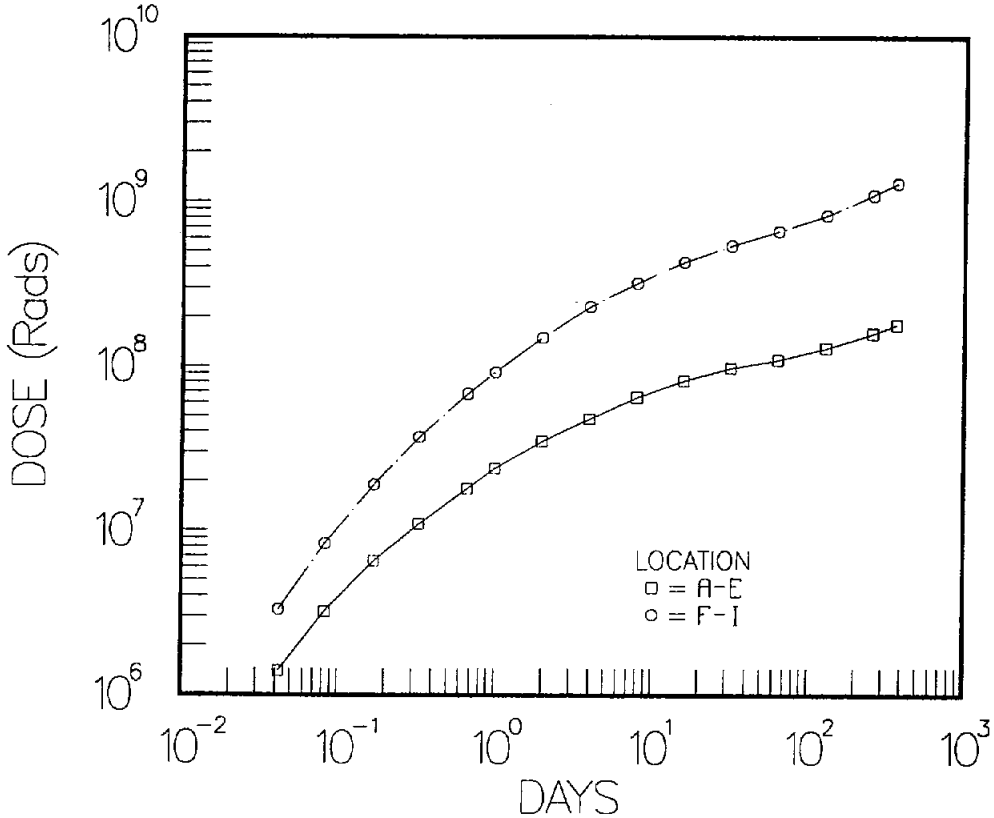


Figure B.22. Surry Case 2 Basement Total Beta Dose

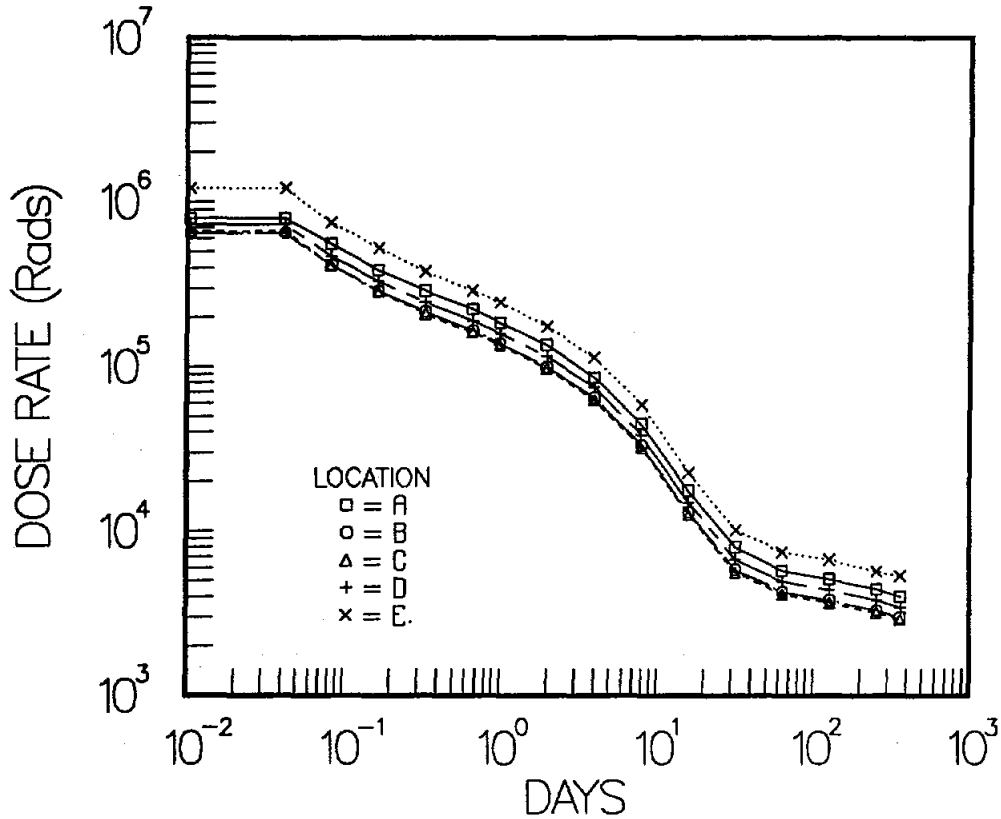


Figure B.23. Surry Case 2 Annulus Gamma Dose Rate

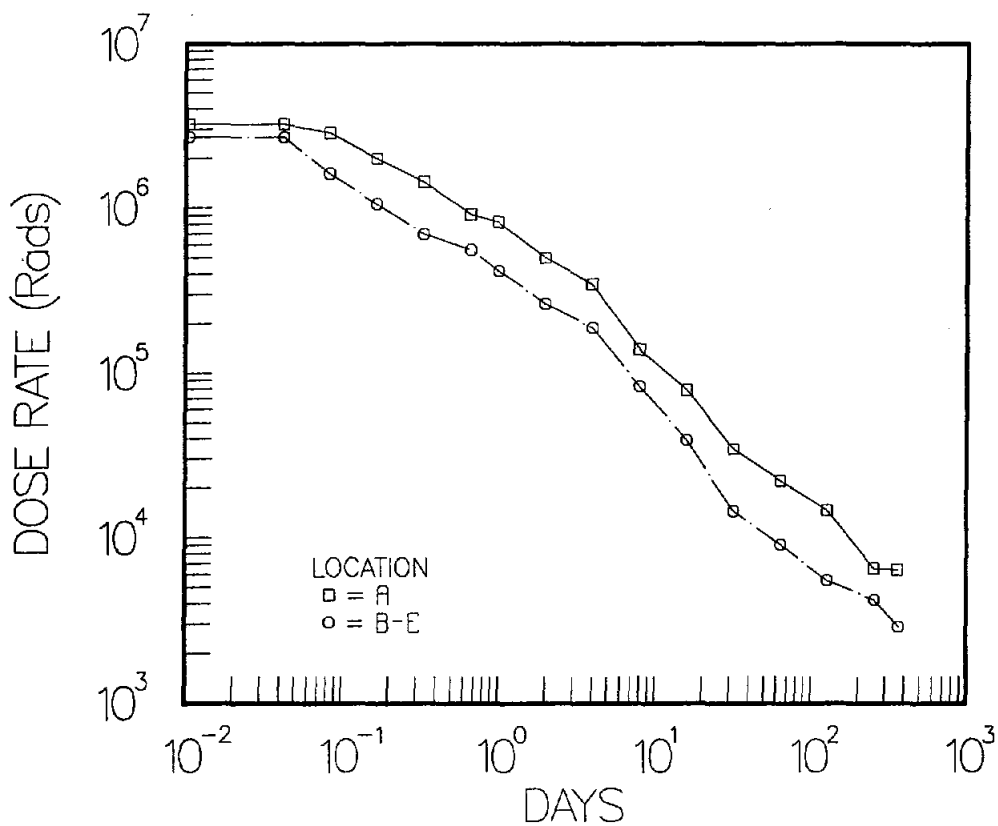


Figure B.24. Surry Case 2 Annulus Beta Dose Rate

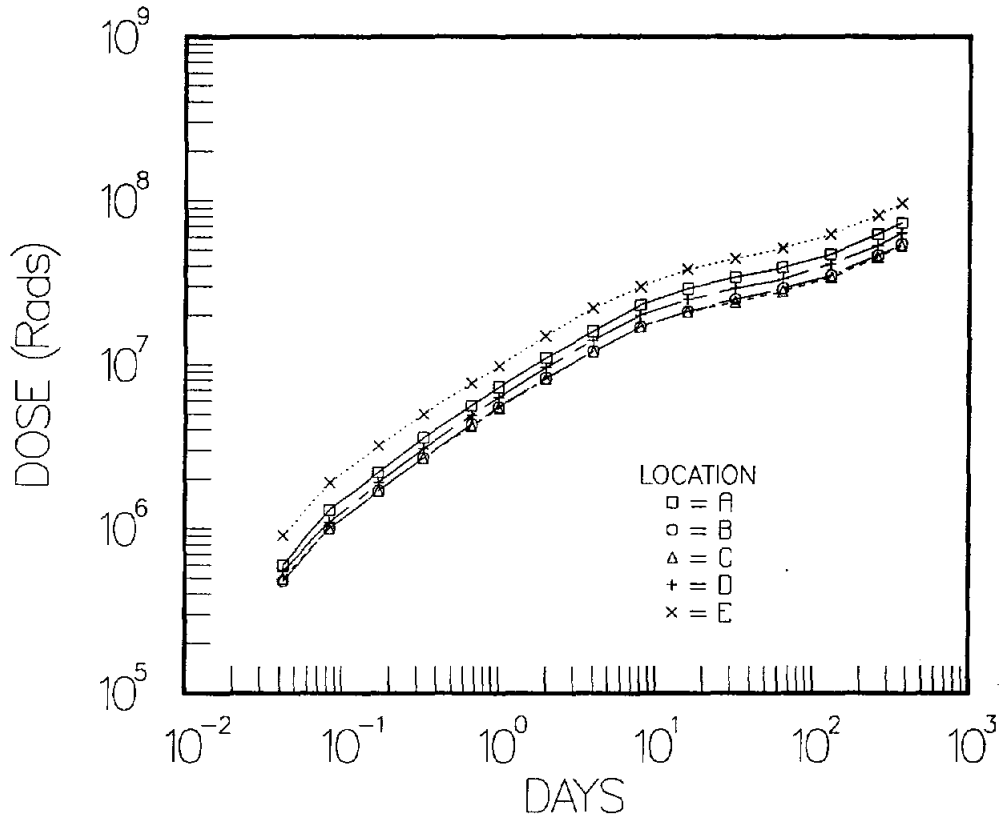


Figure B.25. Surry Case 2 Annulus Total Gamma Dose

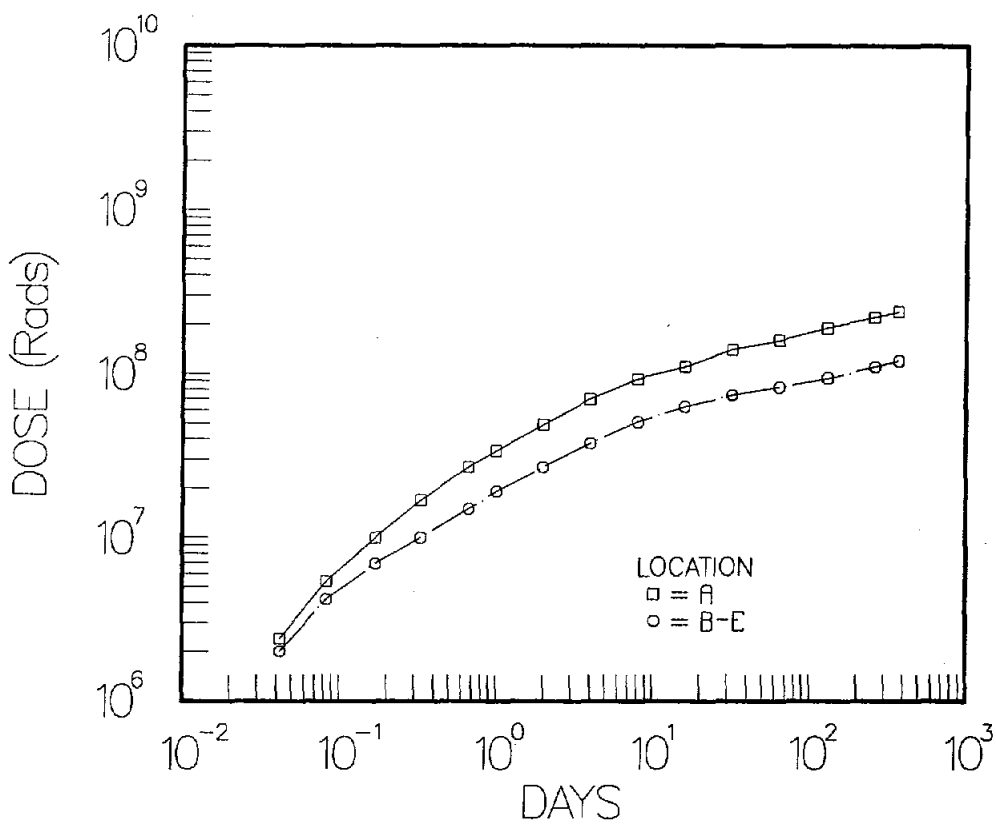


Figure B.26. Surry Case 2 Annulus Total Beta Dose

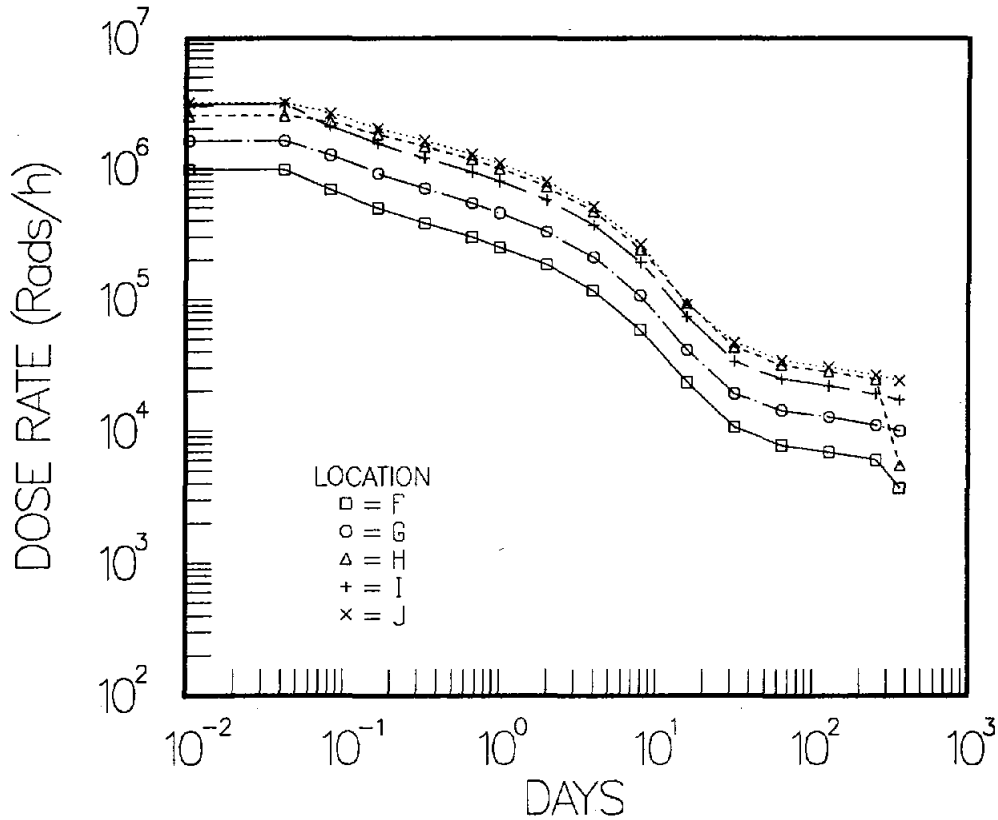


Figure B.27. Surry Case 2 Operating Floor and Dome Gamma Dose Rate

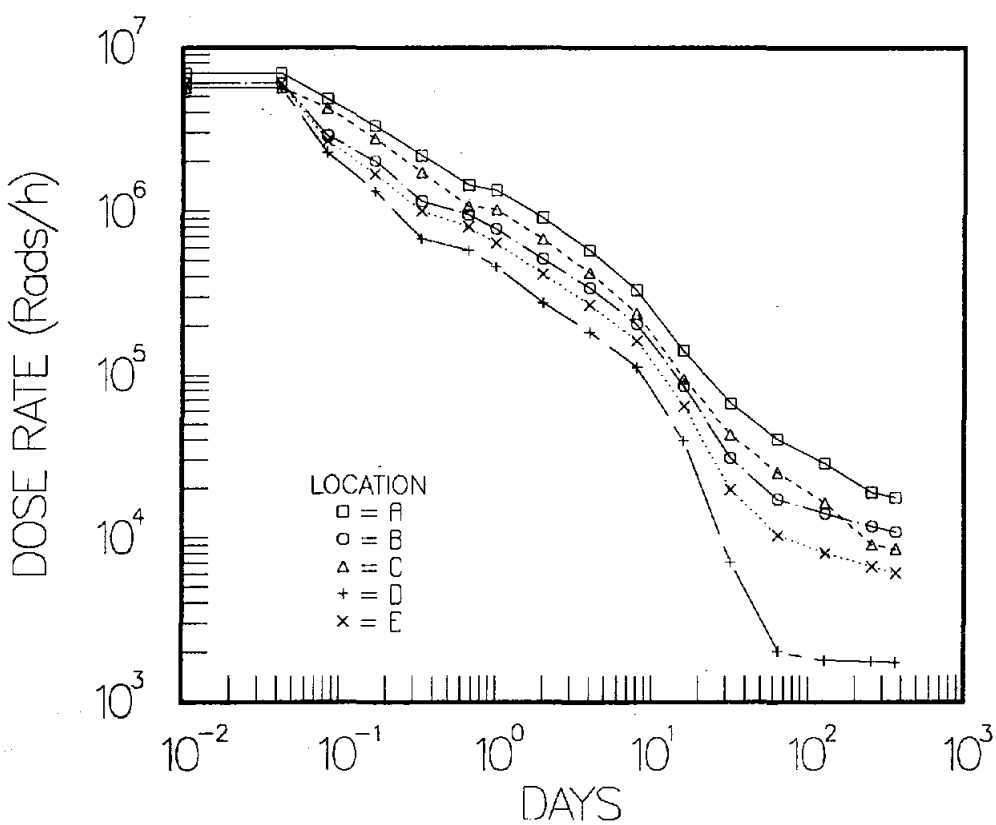


Figure B.28. Surry Case 2 Operating Floor and Dome Beta Dose Rate

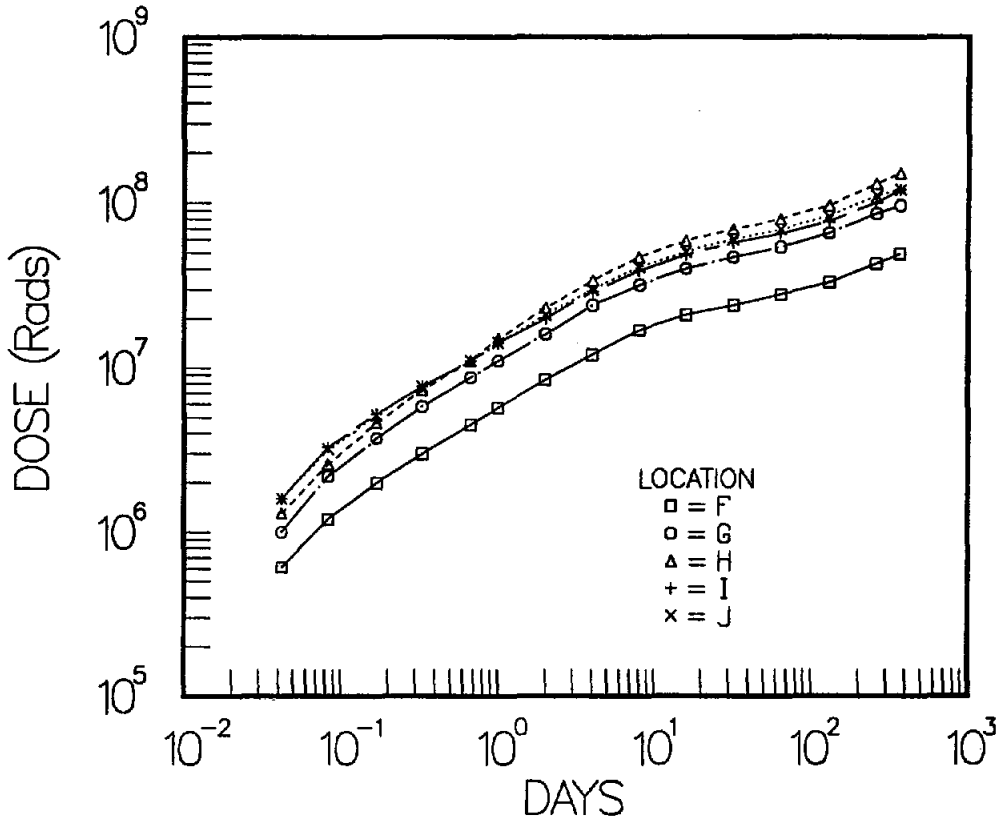


Figure B.29. Surry Case 2 Operating Floor and Dome Total Gamma Dose

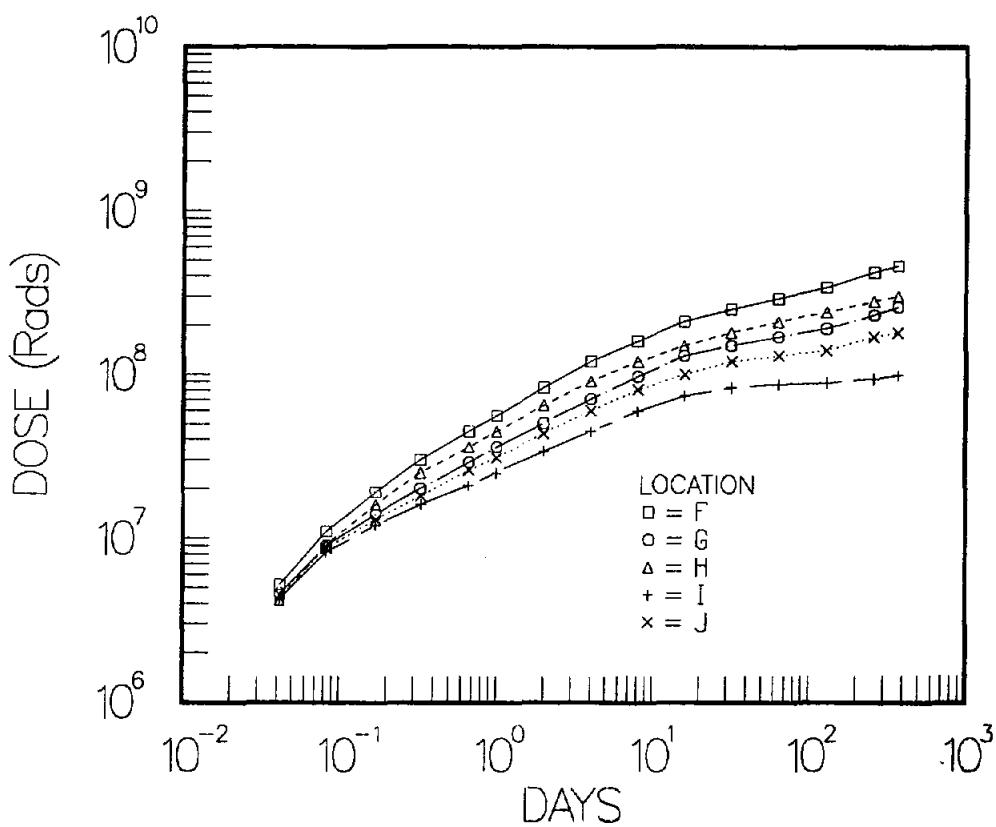


Figure B.30. Surry Case 2 Operating Floor and Dome Total Beta Dose

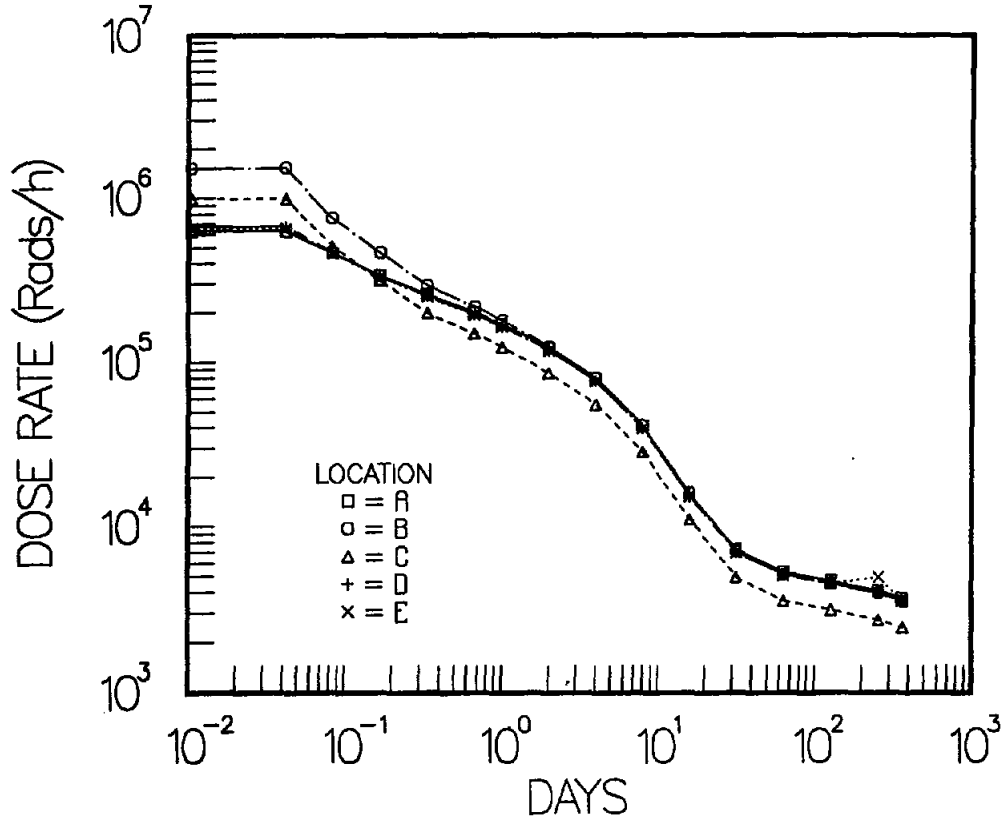


Figure B.31. Surry Case 2 Steam Generator A Gamma Dose Rate

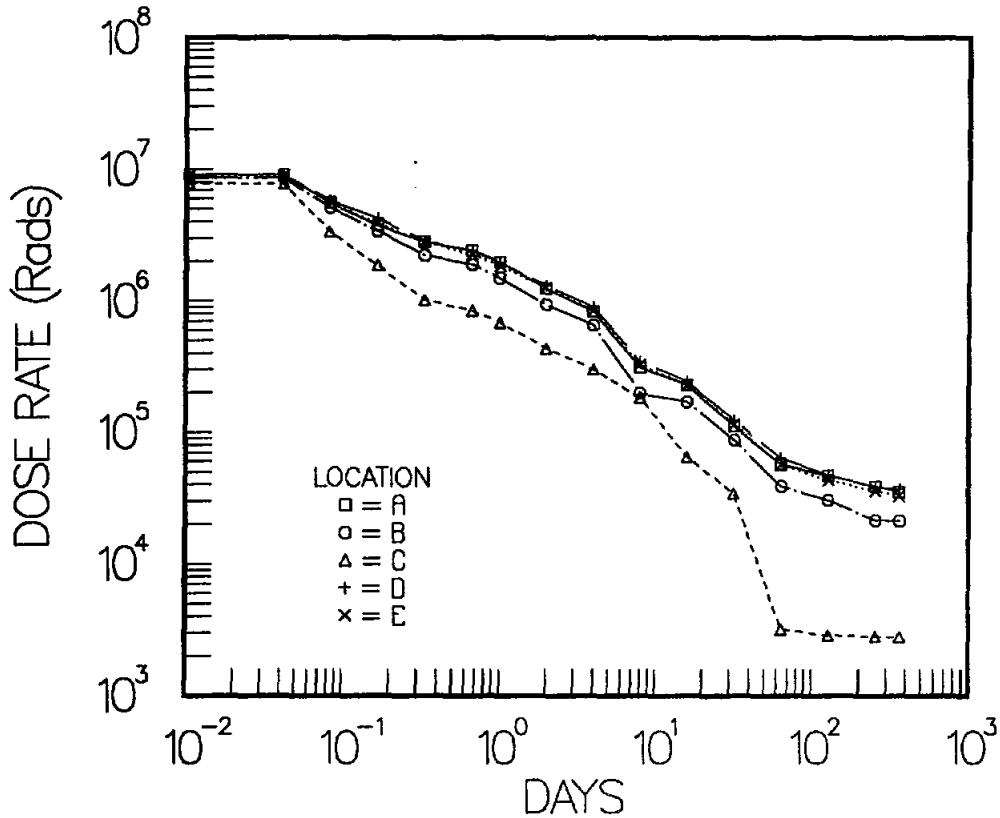


Figure B.32. Surry Case 2 Steam Generator A Beta Dose Rate

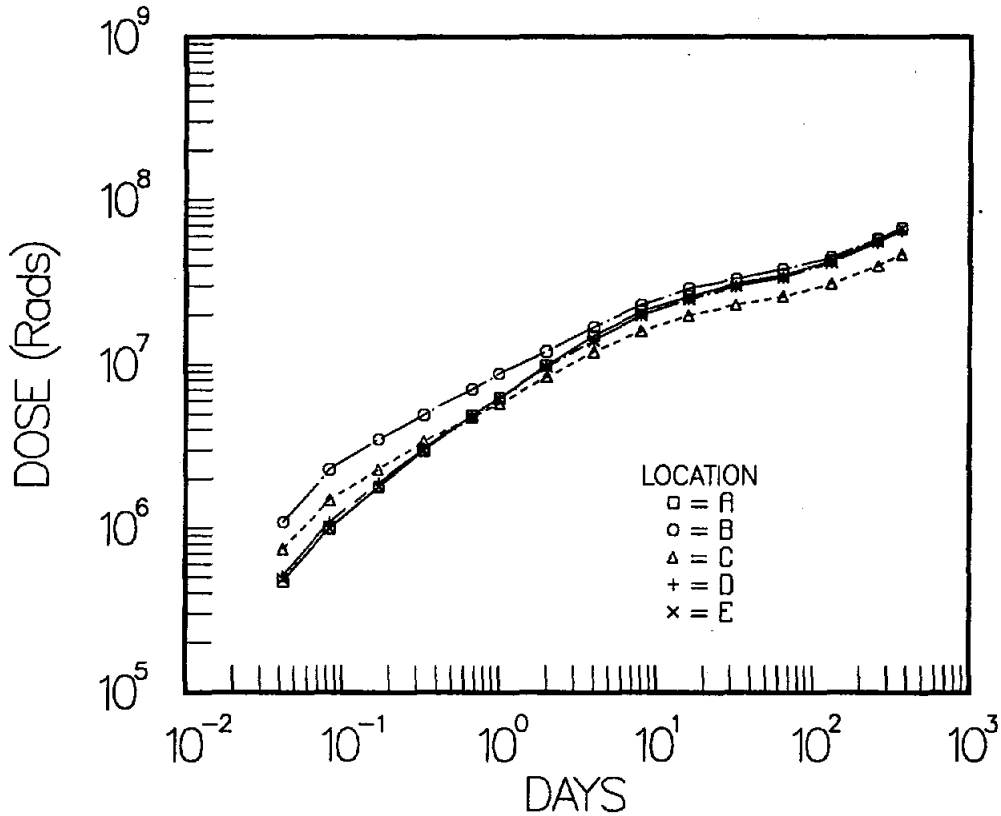


Figure B.33. Surry Case 2 Steam Generator A Total Gamma Dose

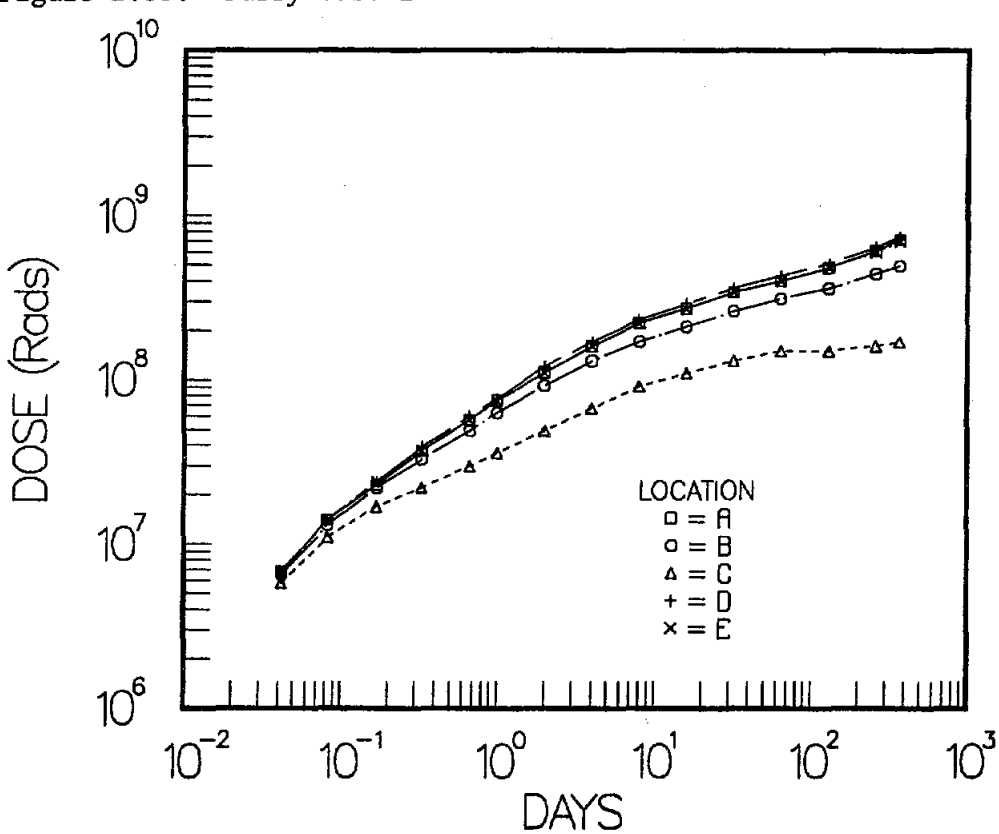


Figure B.34. Surry Case 2 Steam Generator A Total Beta Dose

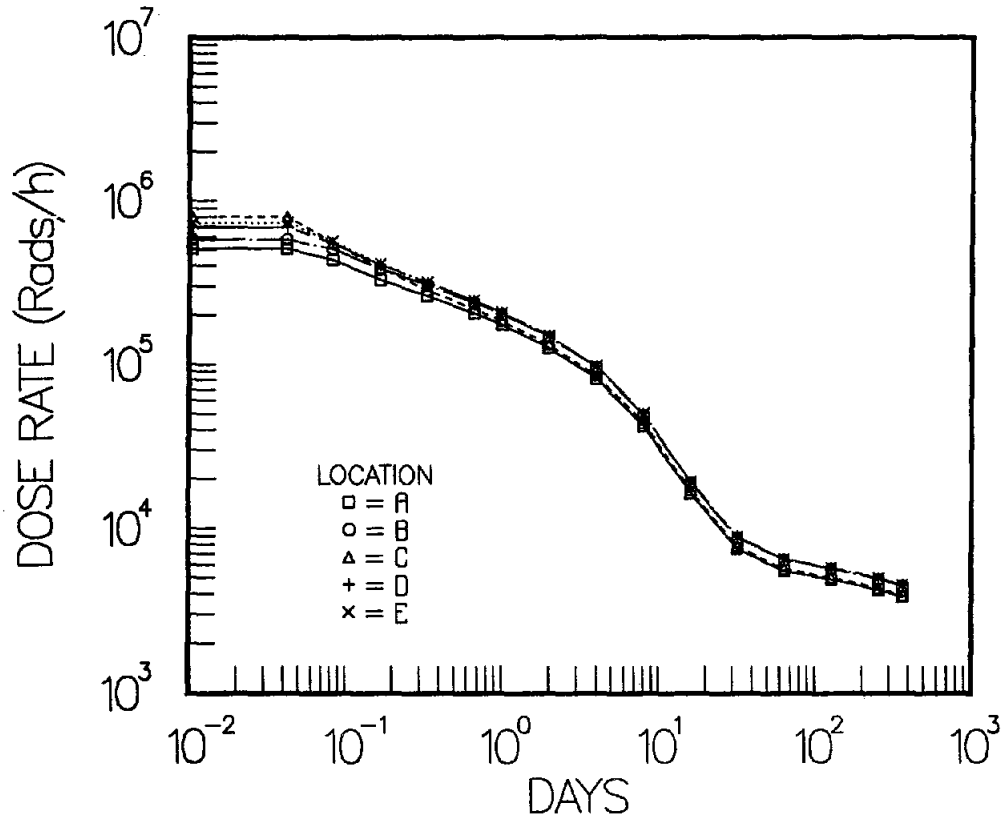


Figure B.35. Surry Case 2 RHR Cubicle Gamma Dose Rate

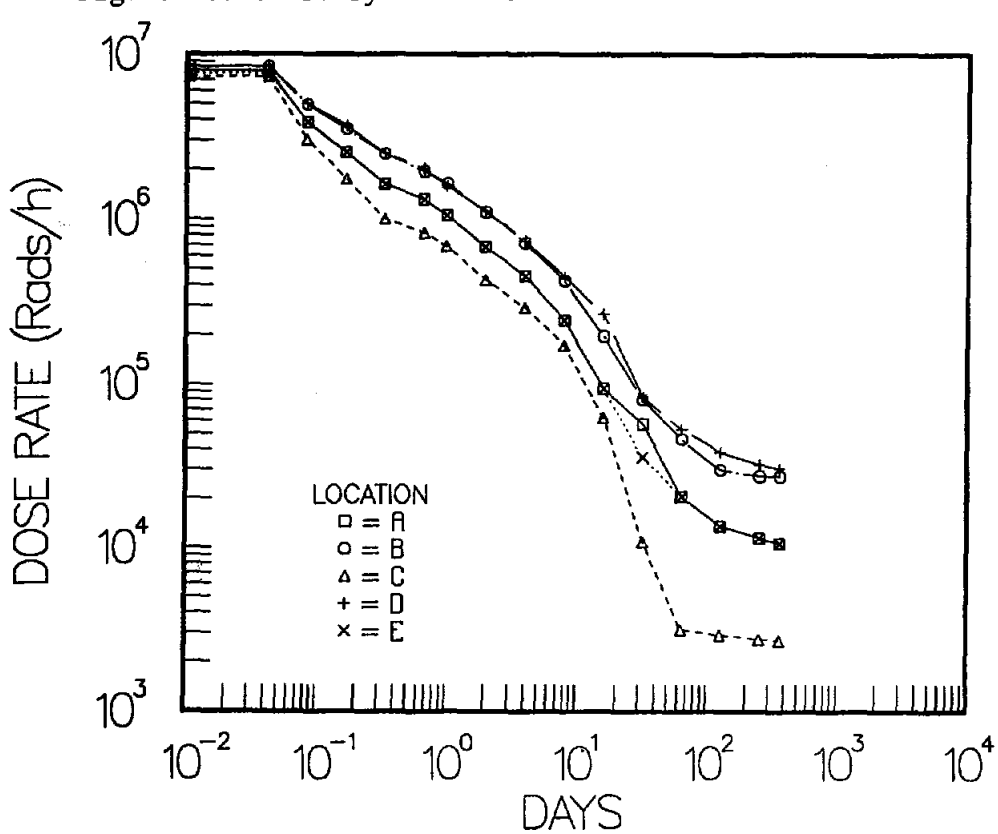


Figure B.36. Surry Case 2 RHR Cubicle Beta Dose Rate

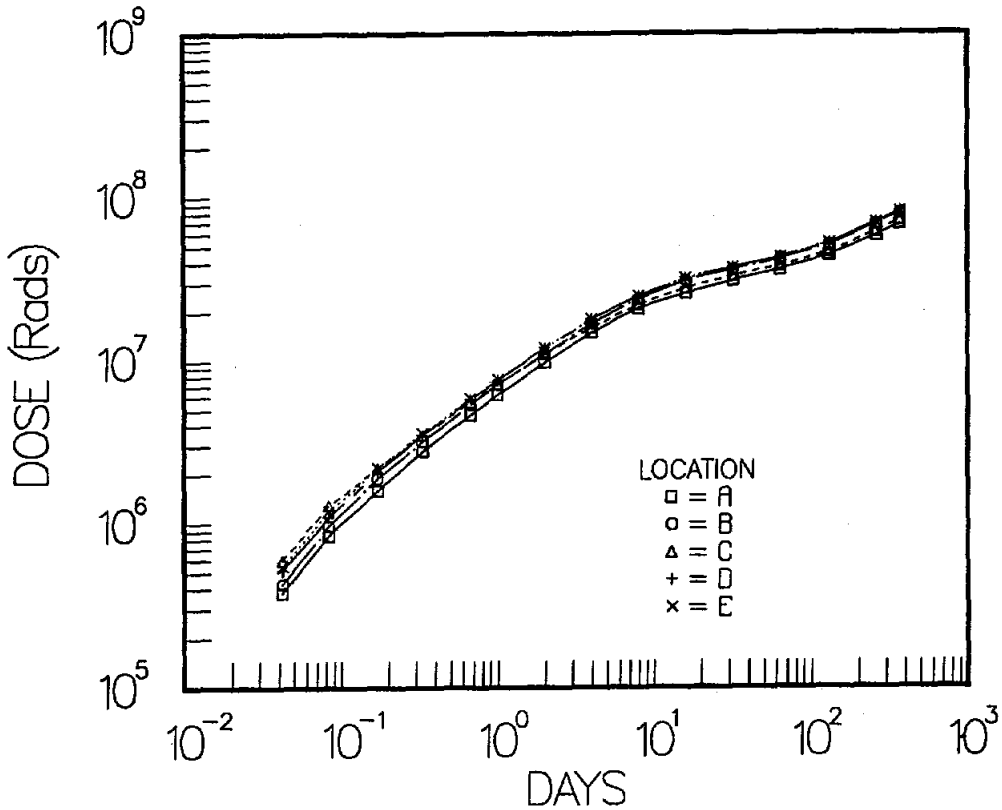


Figure B.37. Surry Case 2 RHR Cubicle Total Gamma Dose

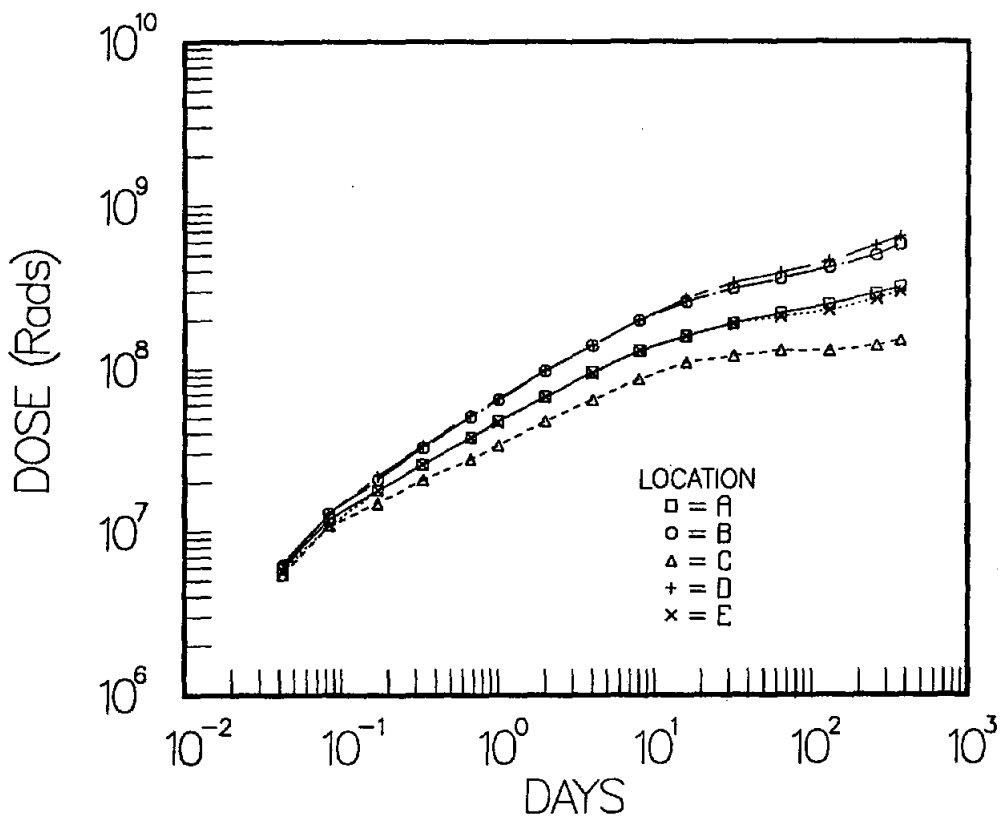


Figure B.38. Surry Case 2 RHR Cubicle Total Beta Dose

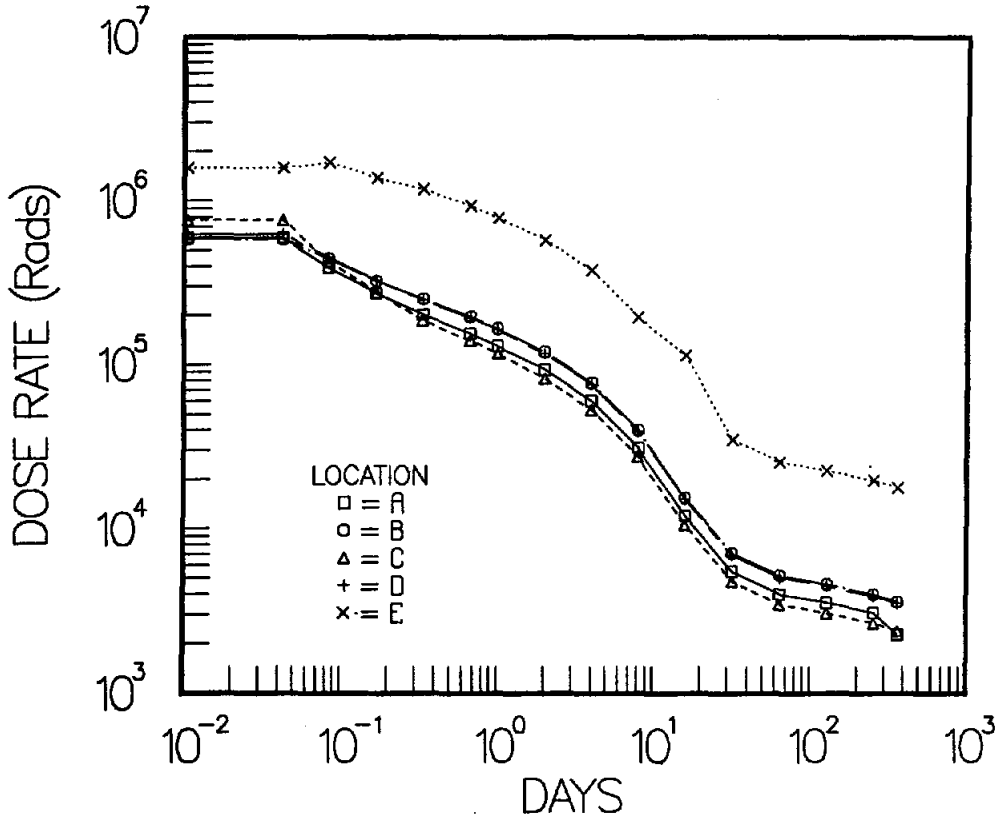


Figure B.39. Surry Case 2 Steam Generator B Gamma Dose Rates

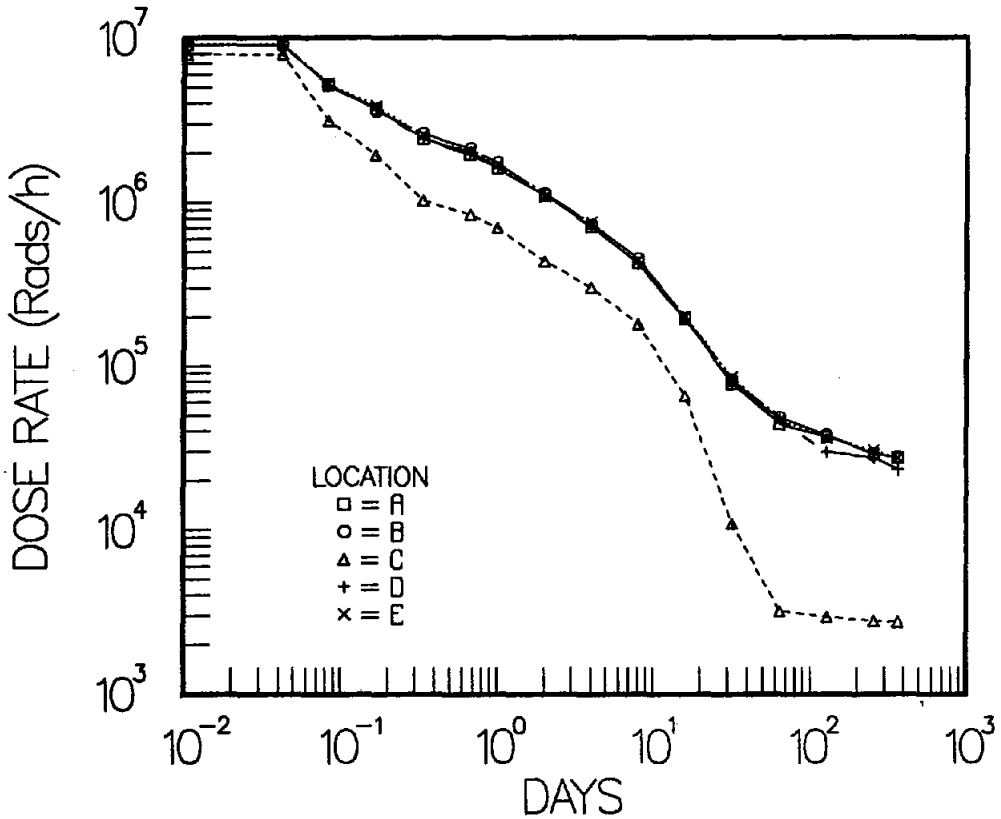


Figure B.40. Surry Case 2 Steam Generator B Beta Dose Rates

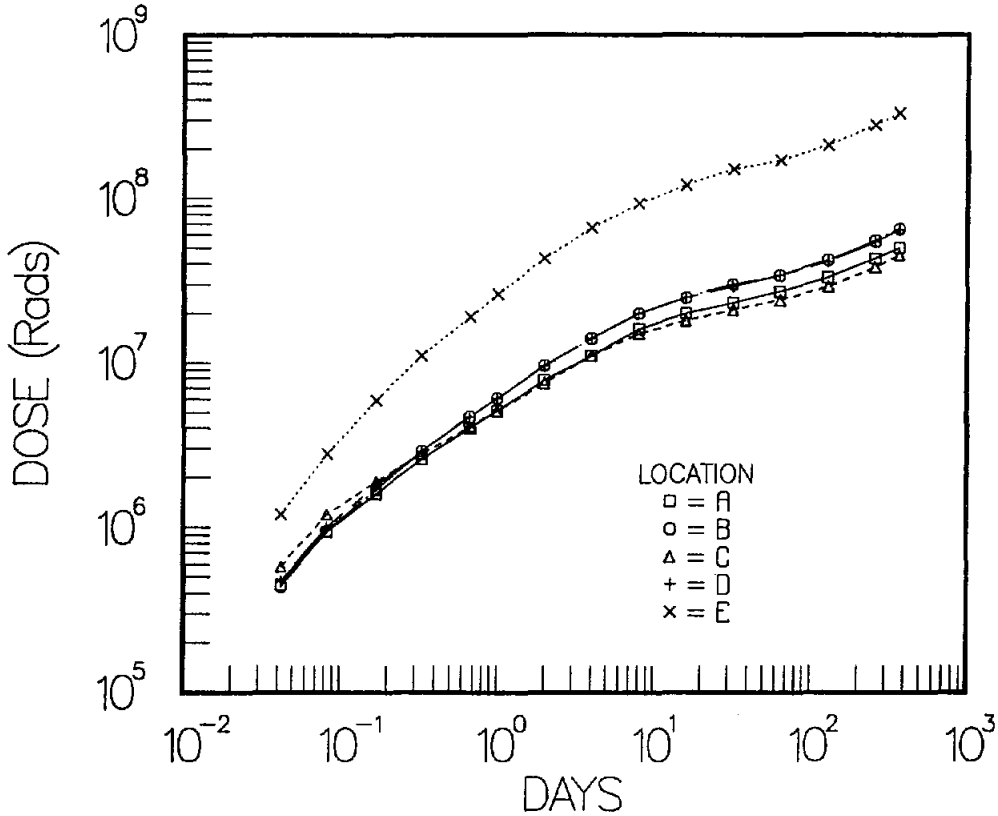


Figure B.41. Surry Case 2 Steam Generator B Total Gamma Dose

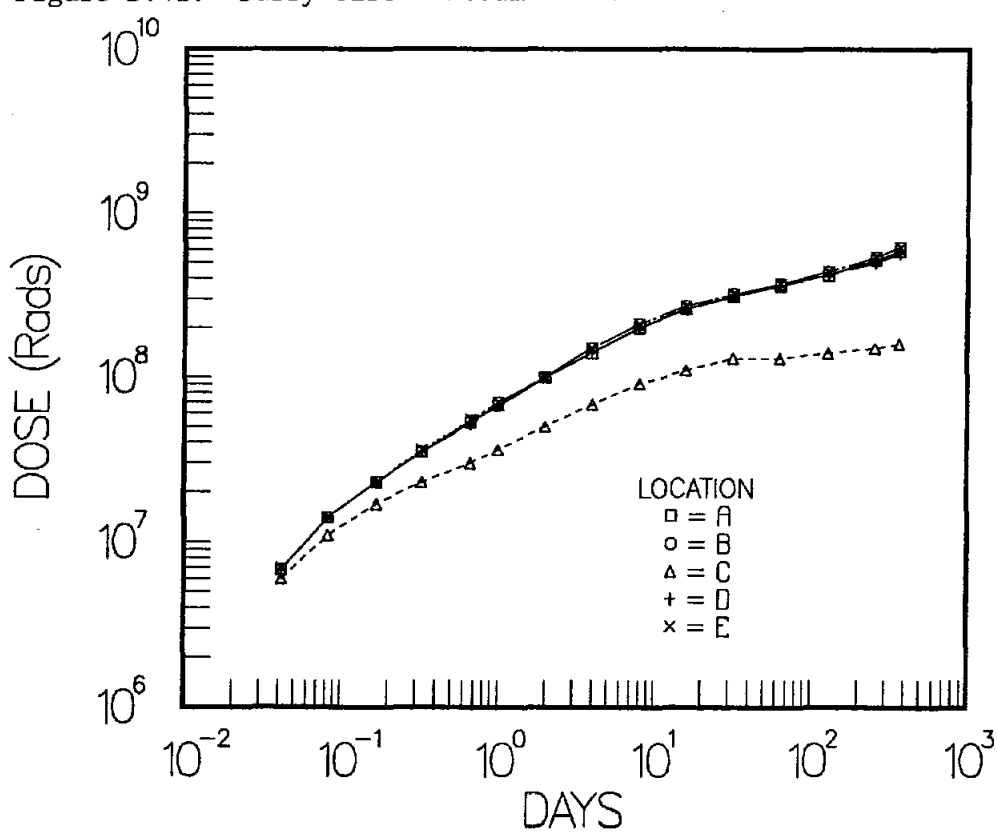


Figure B.42. Surry Case 2 Steam Generator B Total Beta Dose

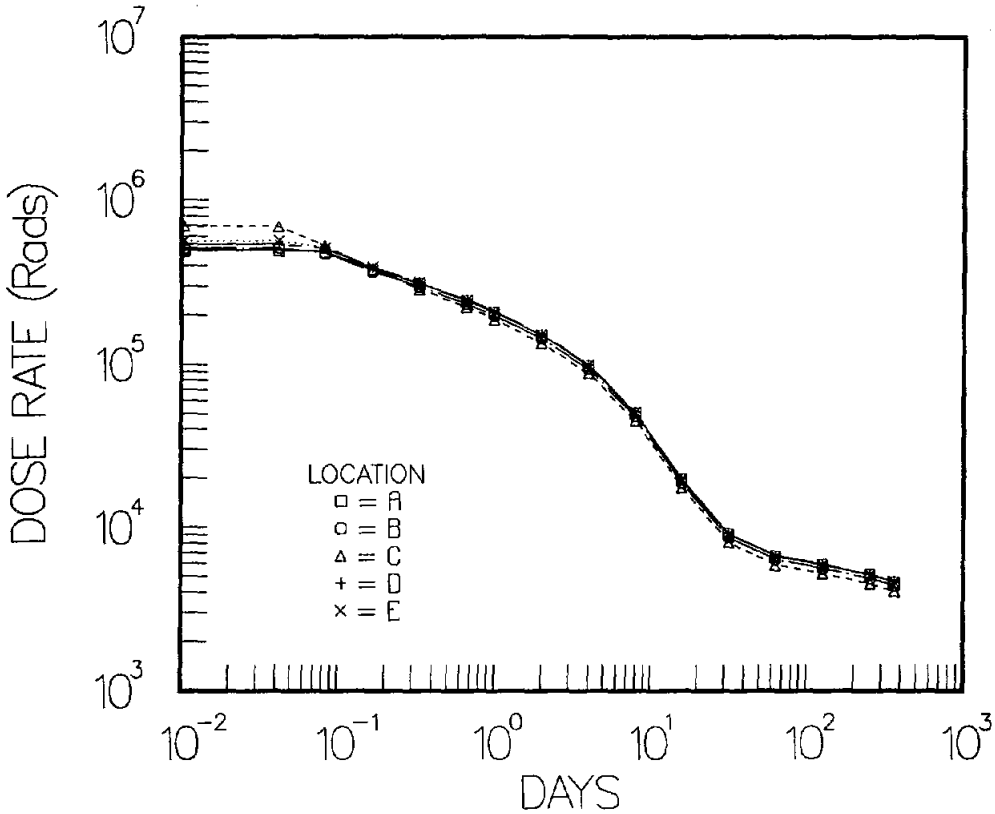


Figure B.43. Surry Case 2 In-Core Instrumentation Room Gamma Dose Rates

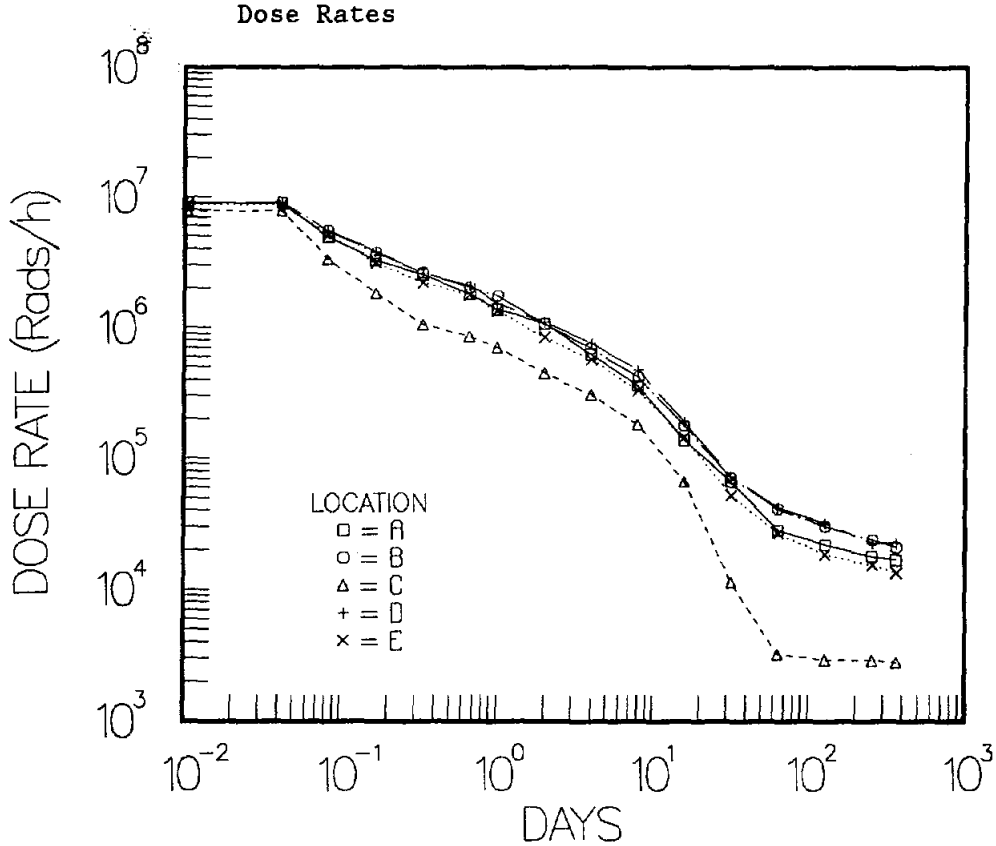


Figure B.44. Surry Case 2 In-Core Instrumentation Room Beta Dose Rates

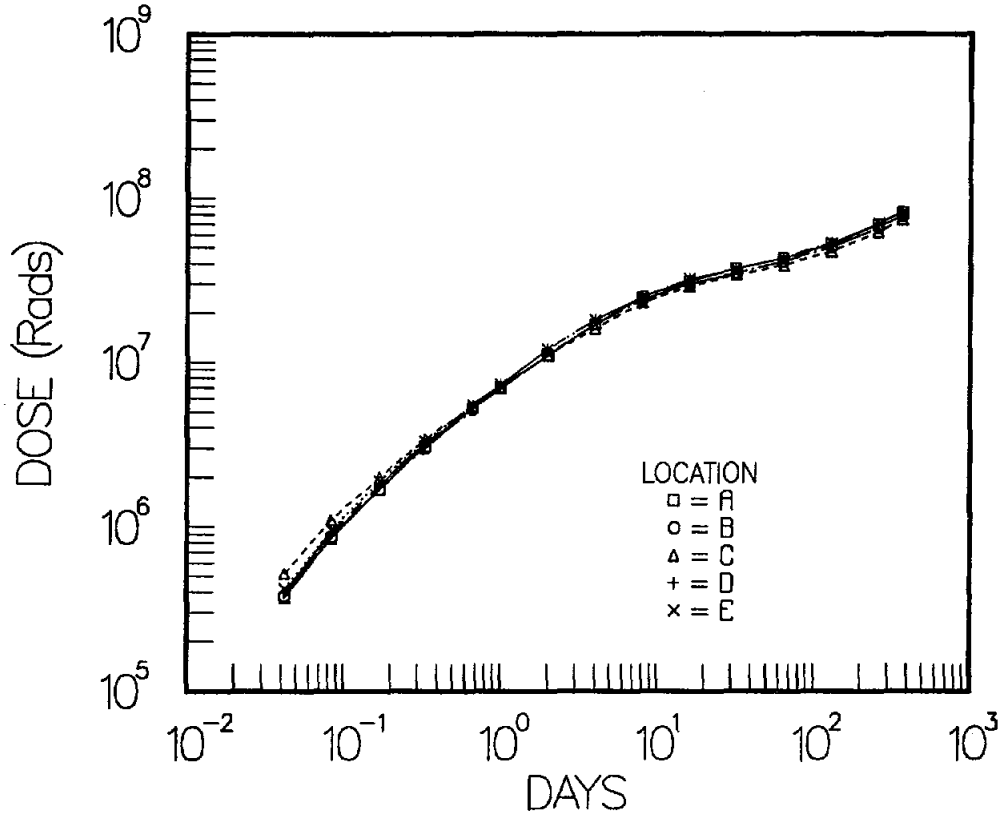


Figure B.45. Surry Case 2 In-Core Instrumentation Room Total Gamma Dose

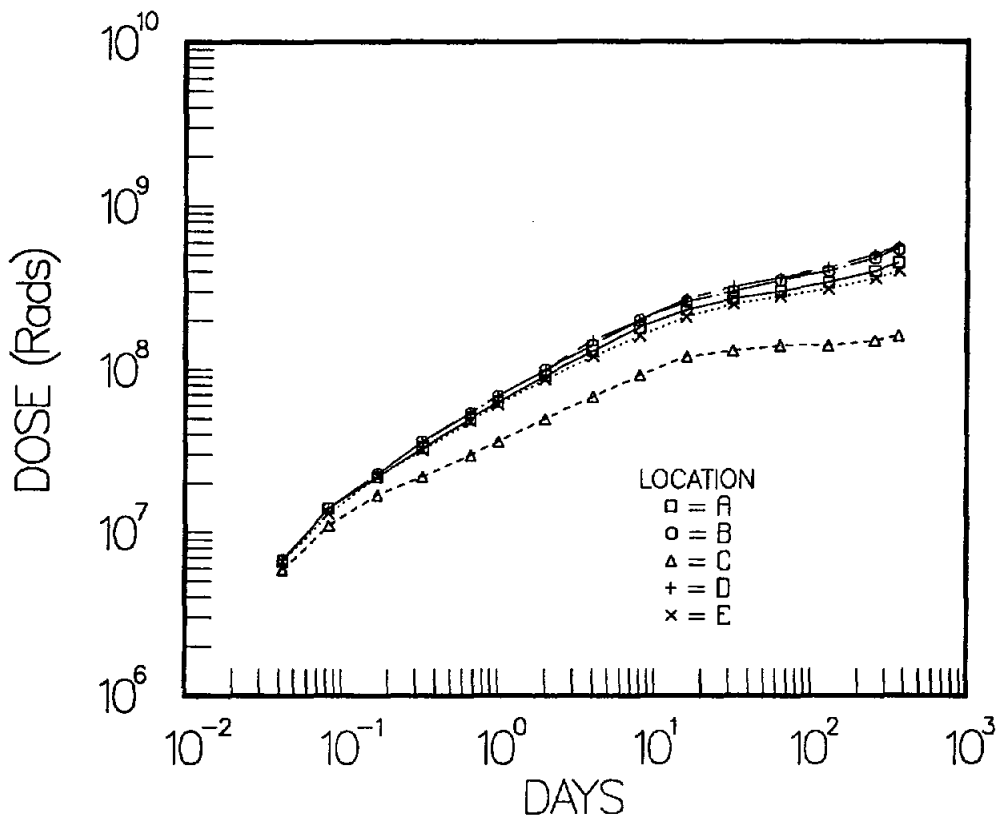


Figure B.46. Surry Case 2 In-Core Instrumentation Room Total Beta Dose

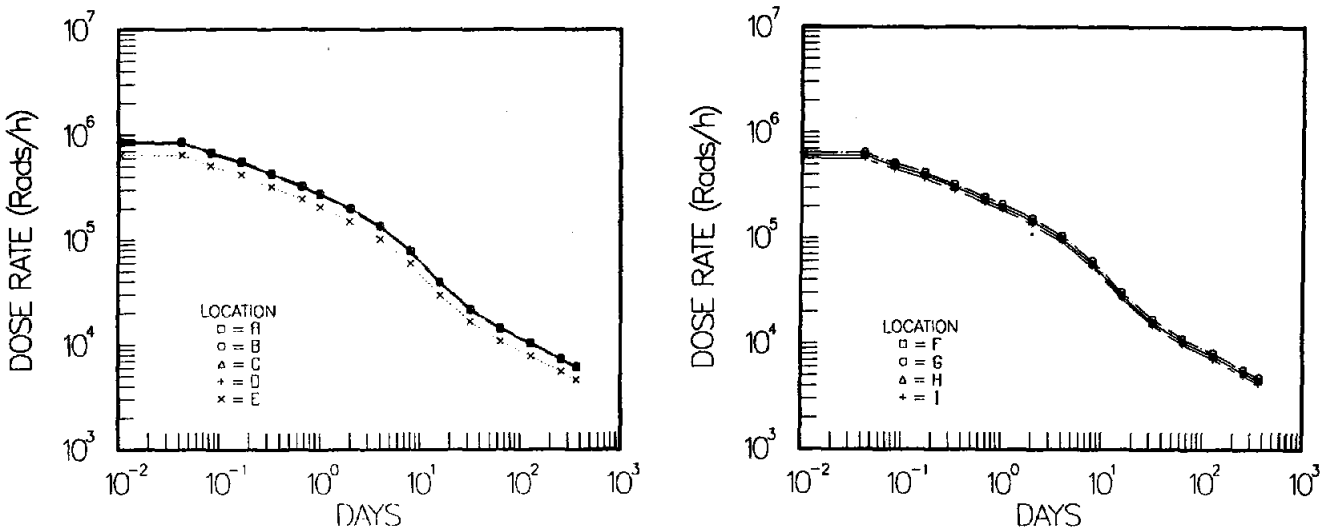


Figure B.47. Surry Case 3 Basement Gamma Dose Rate

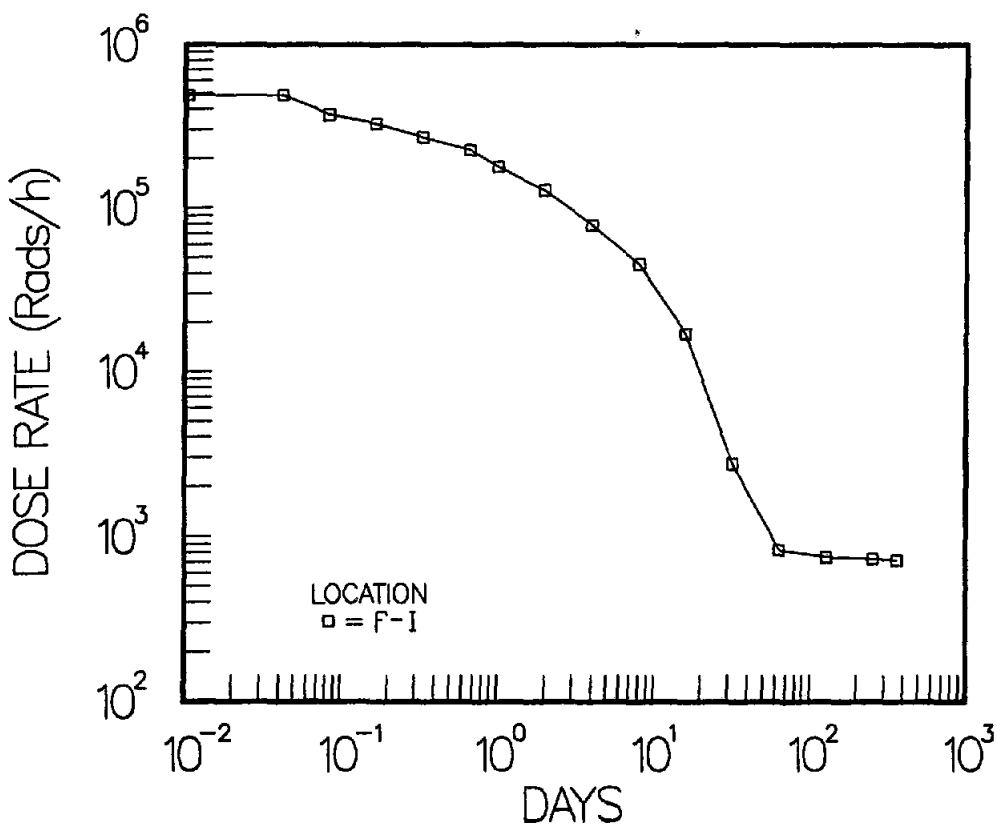


Figure B.48. Surry Case 3 Basement Beta Dose Rate

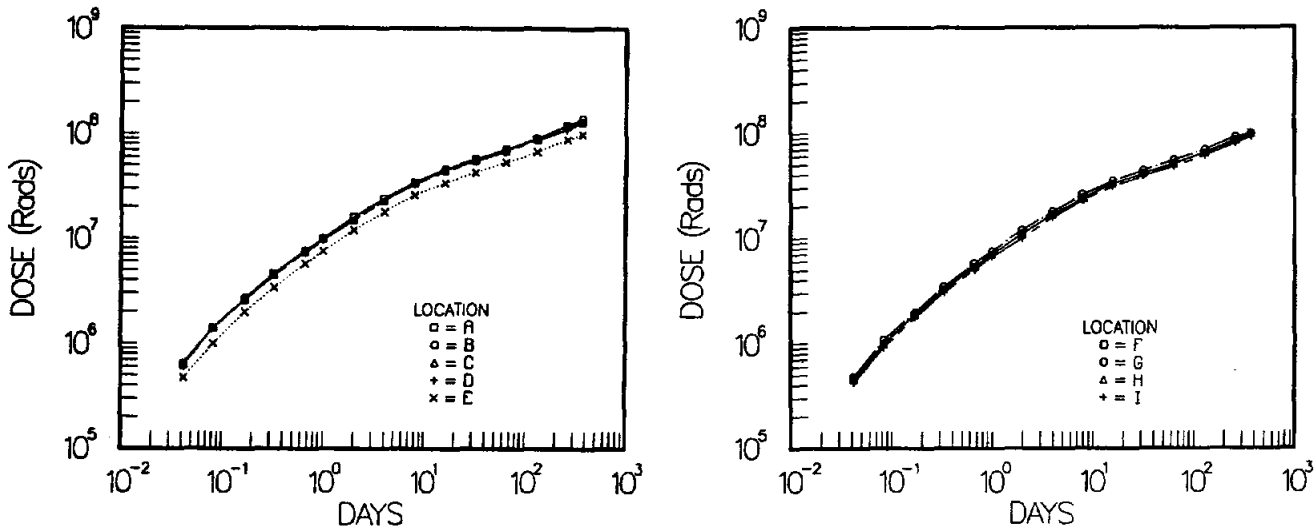


Figure B.49. Surry Case 3 Basement Total Gamma Dose

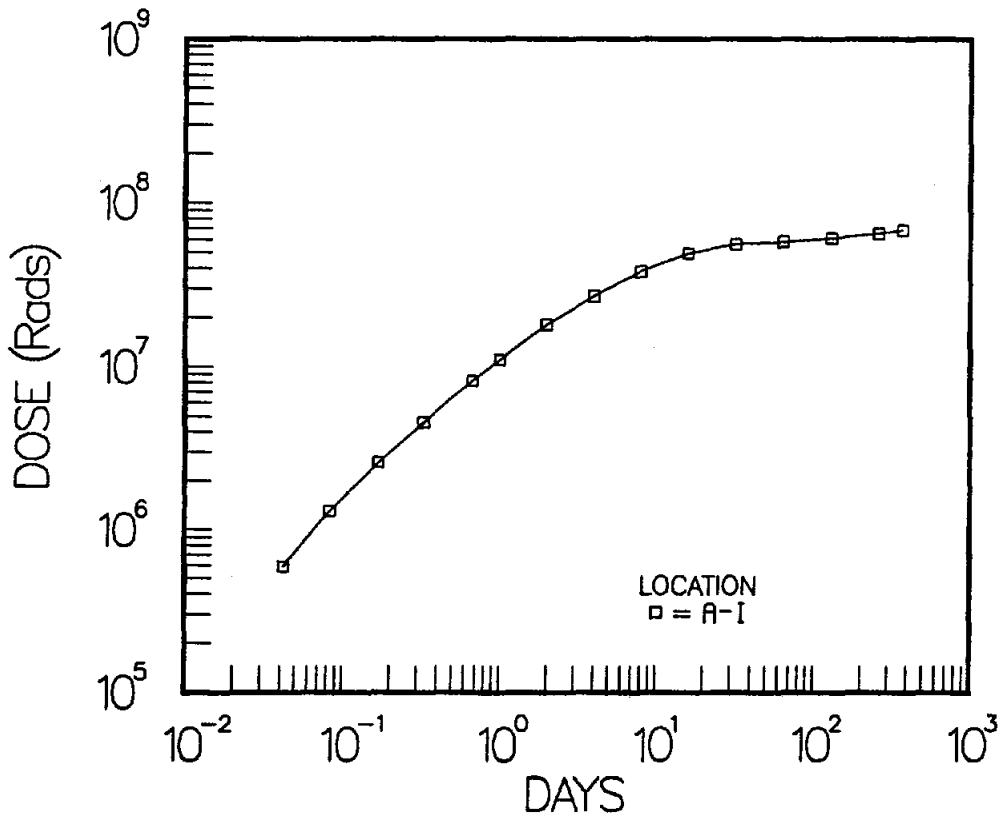


Figure B.50. Surry Case 3 Basement Total Beta Dose

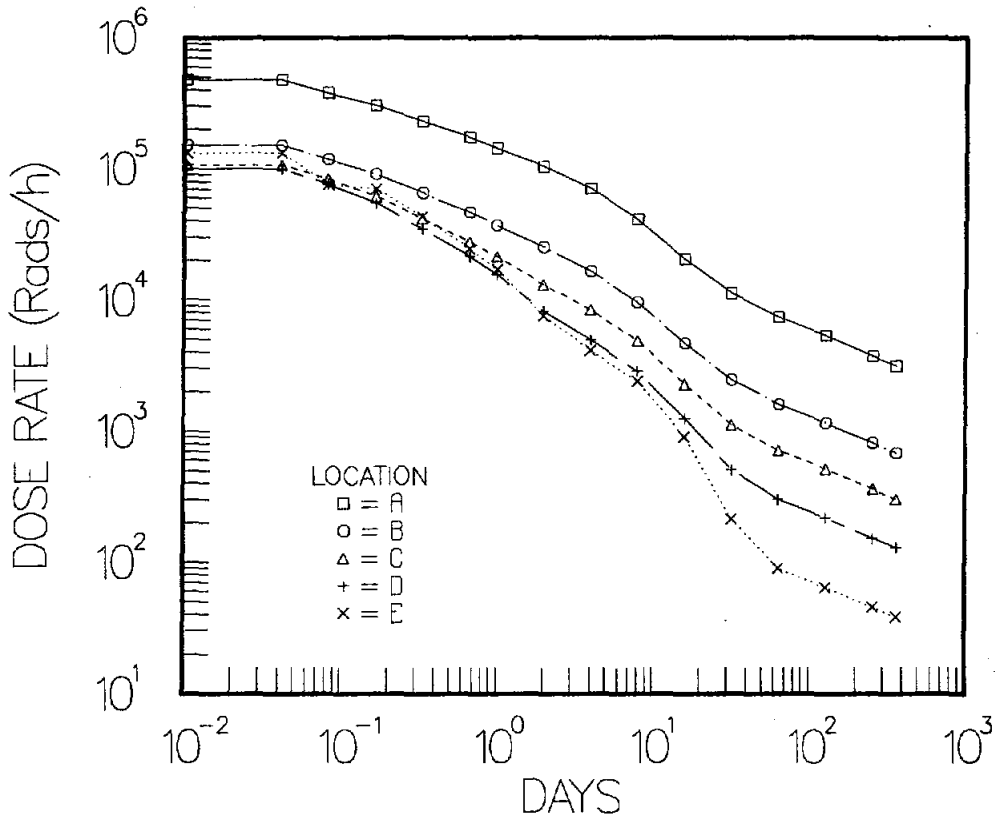


Figure B.51. Surry Case 3 Annulus Gamma Dose Rate

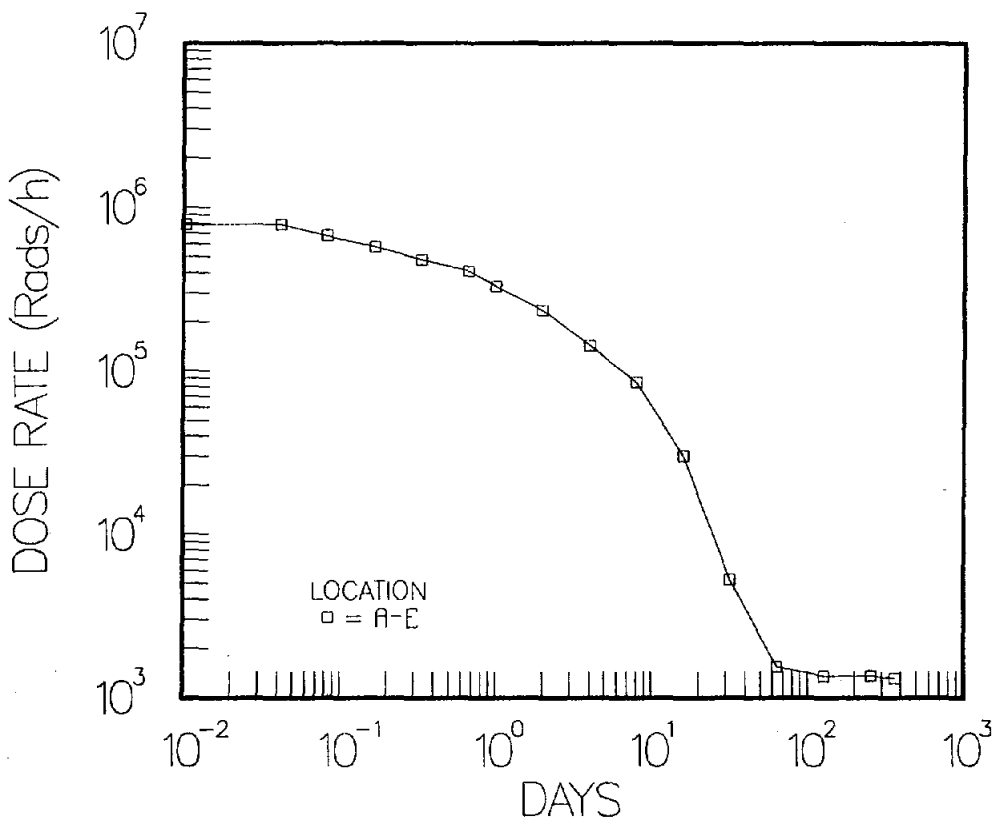


Figure B.52. Surry Case 3 Annulus Beta Dose Rate

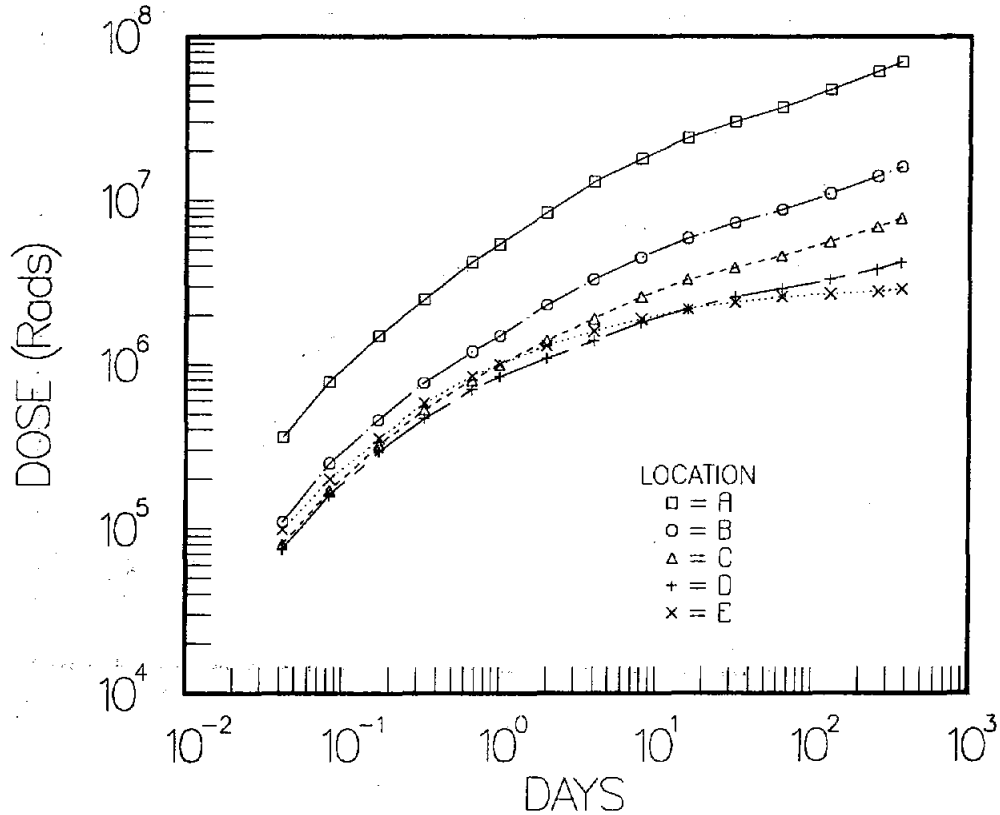


Figure B.53. Surry Case 3 Annulus Total Gamma Dose

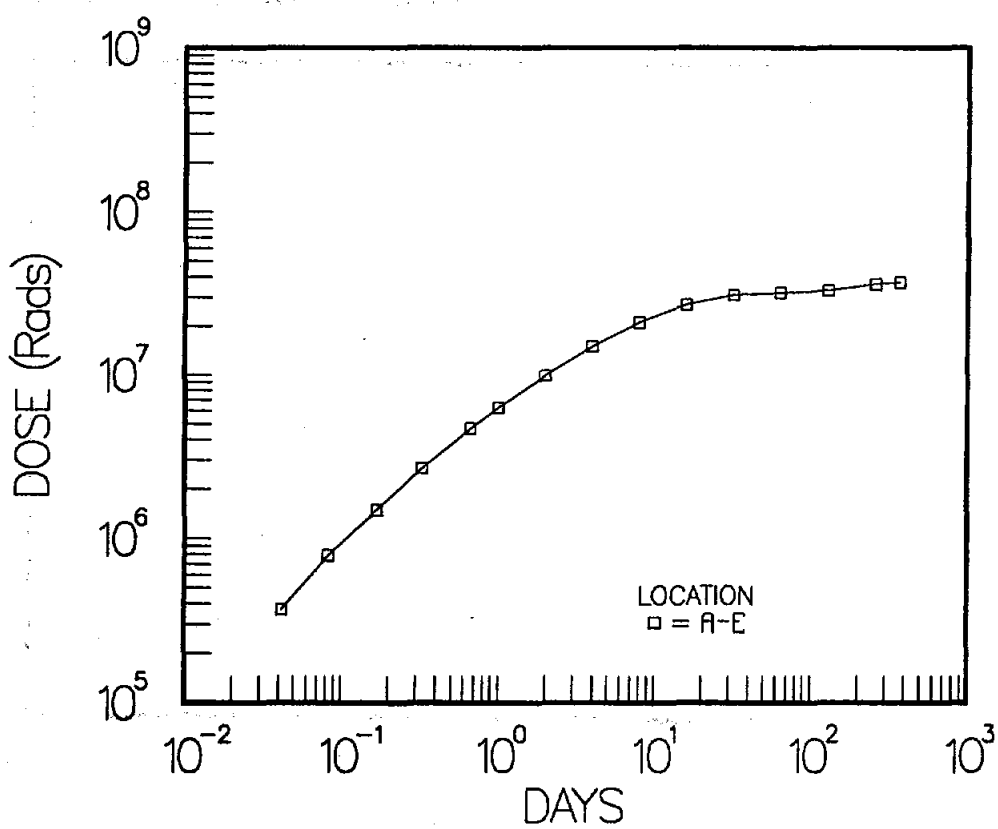


Figure B.54. Surry Case 3 Annulus Total Beta Dose

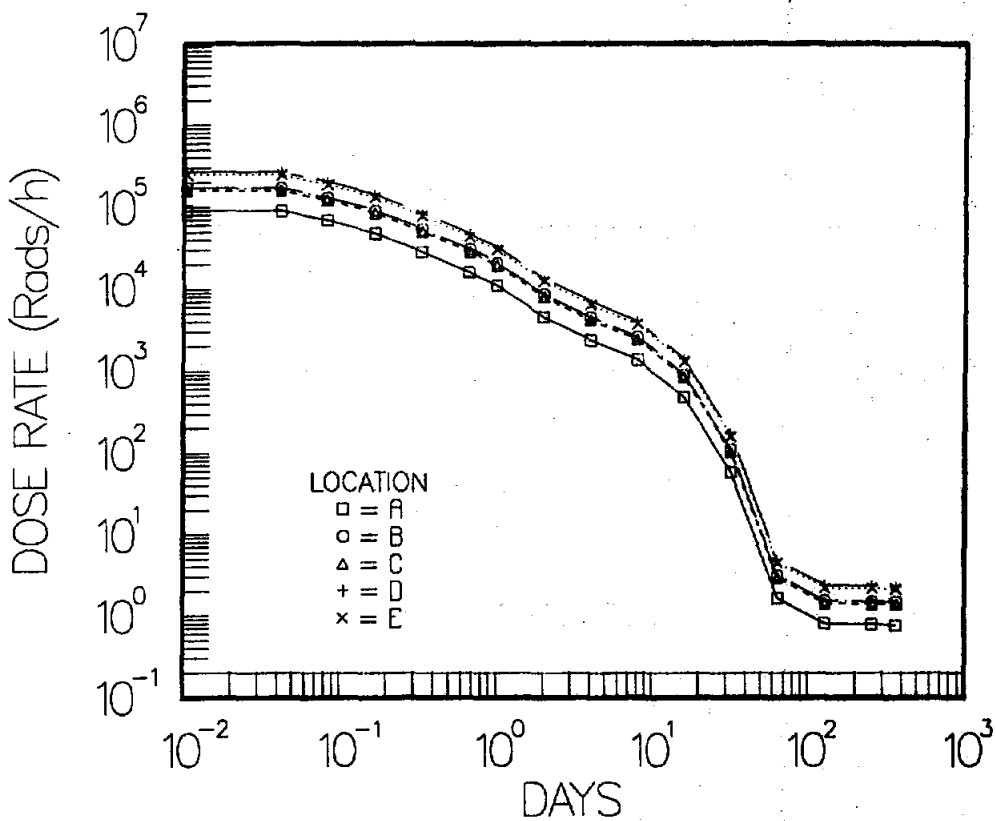


Figure B.55. Surry Case 3 Operating Floor and Dome Gamma Dose Rate

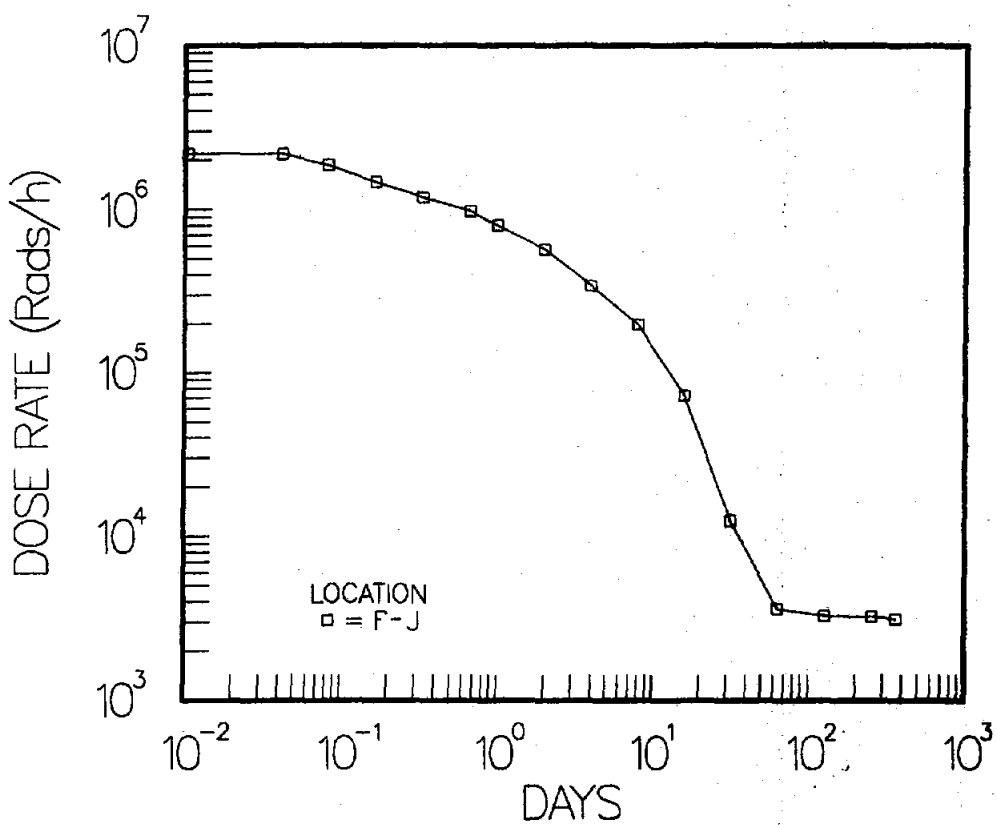


Figure B.56. Surry Case 3 Operating Floor and Dome Beta Dose Rate

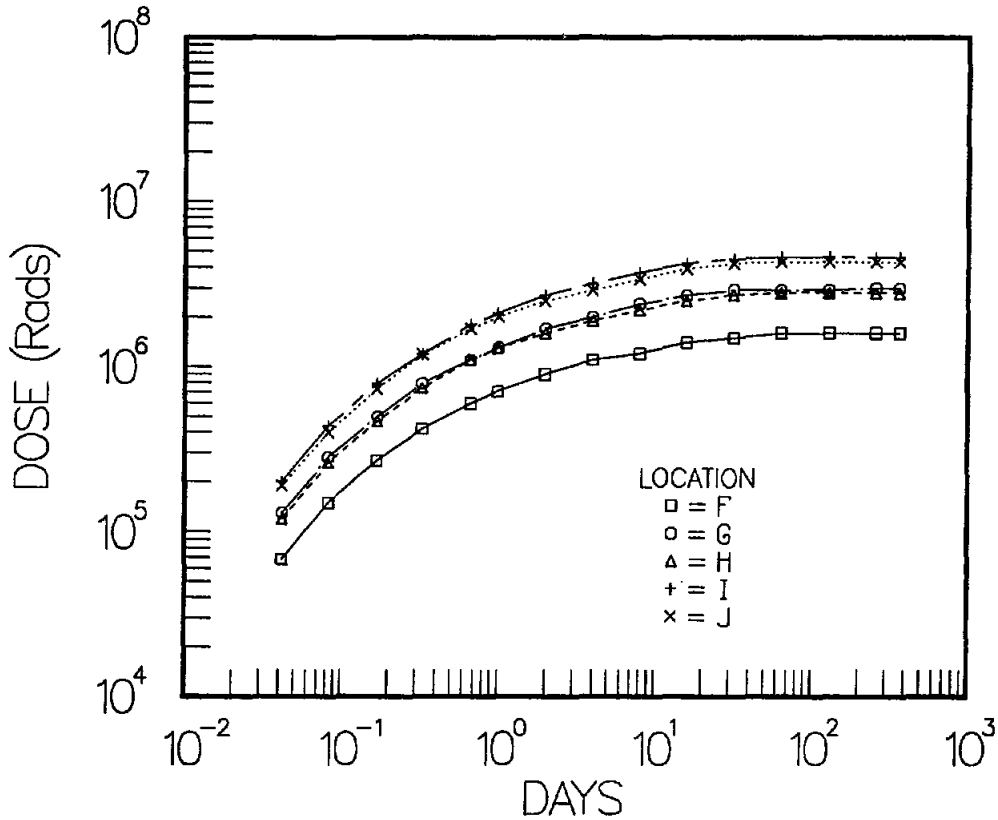


Figure B.57. Surry Case 3 Operating Floor and Dome Total Gamma Dose

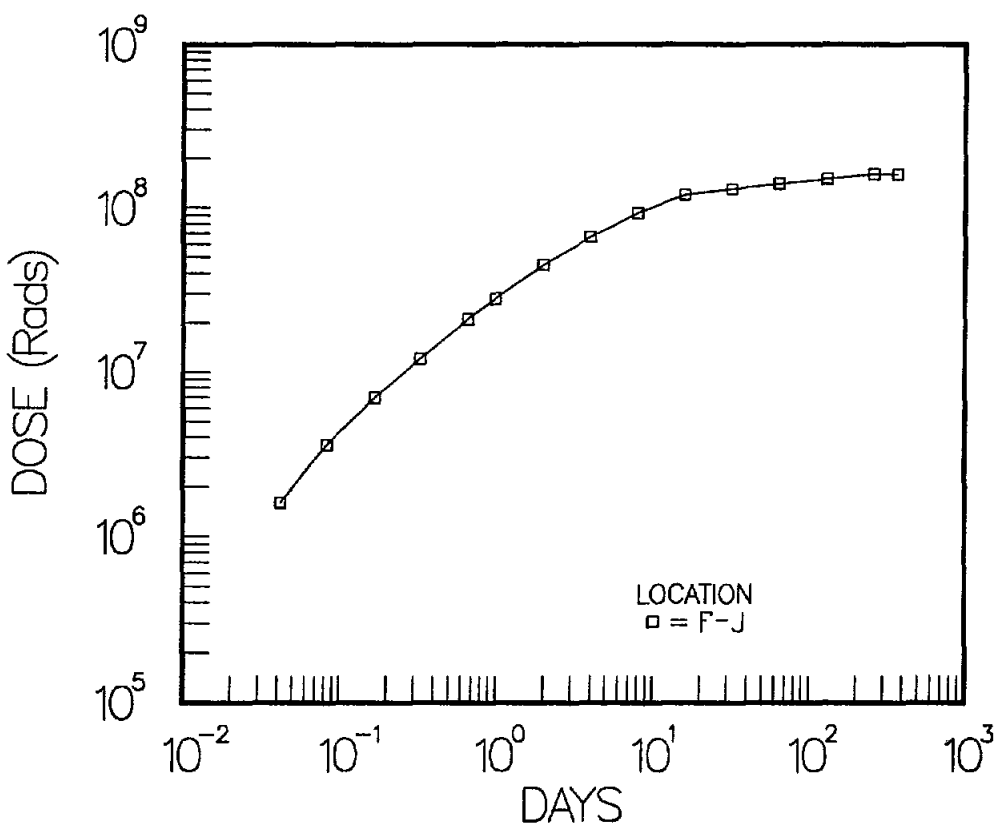


Figure B.58. Surry Case 3 Operating Floor and Dome Total Beta Dose

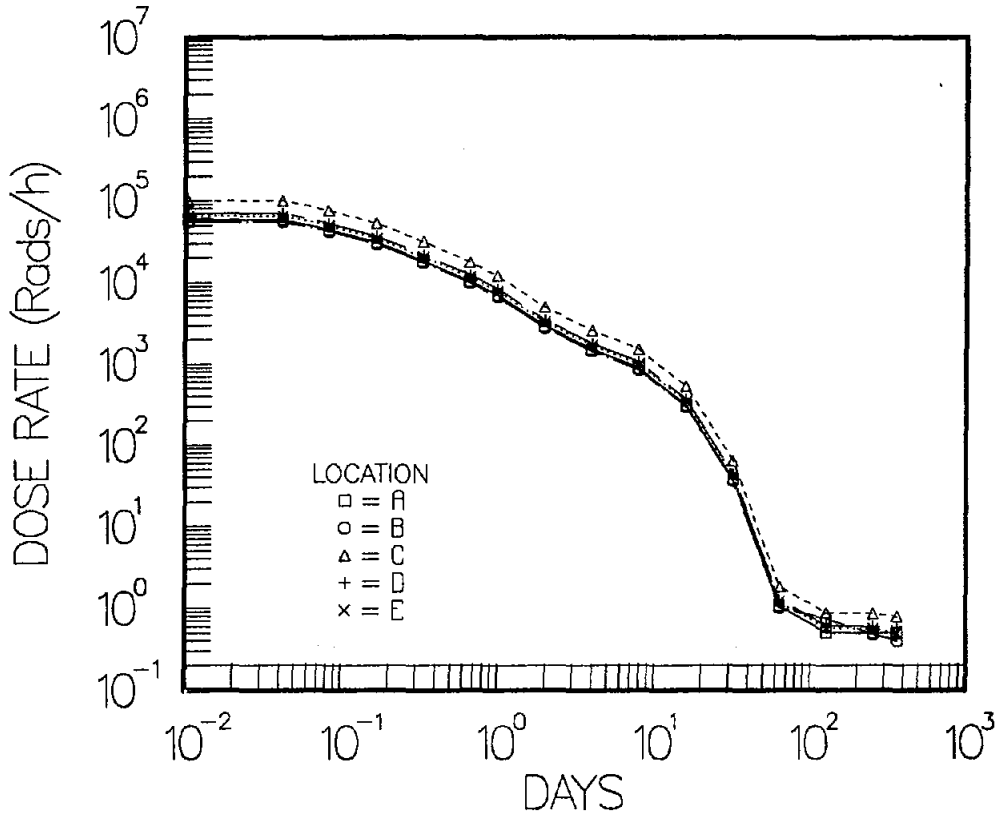


Figure B.59. Surry Case 3 Steam Generator A Gamma Dose Rate

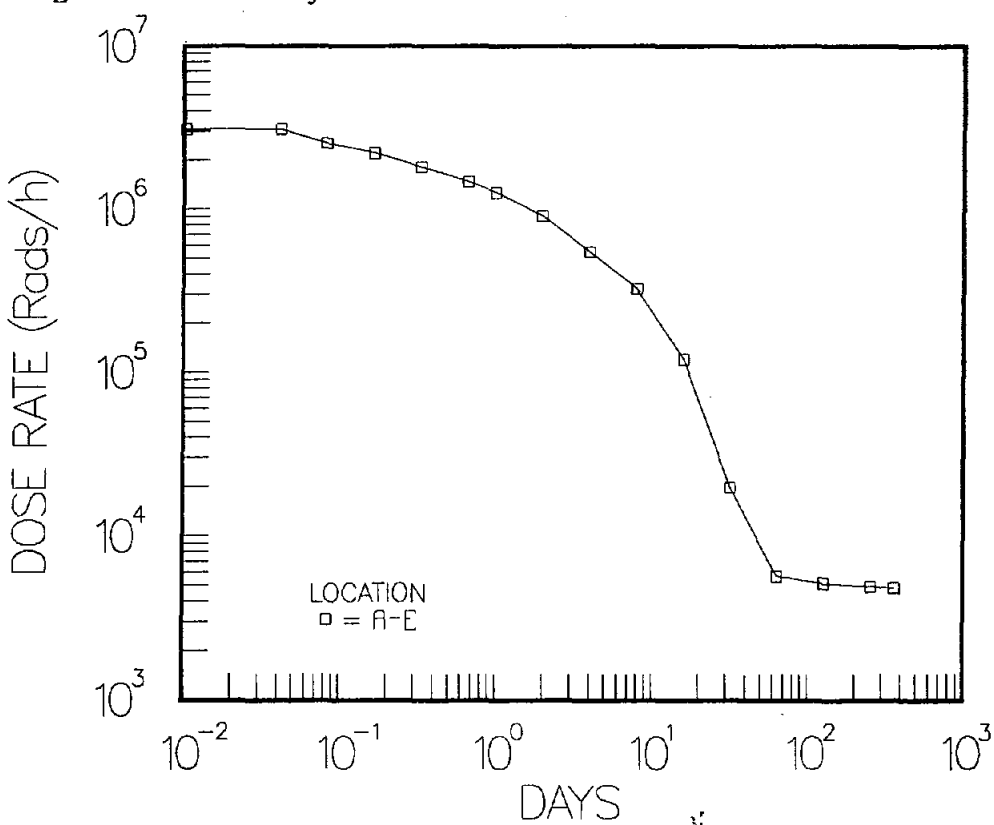


Figure B.60. Surry Case 3 Steam Generator A Beta Dose Rate

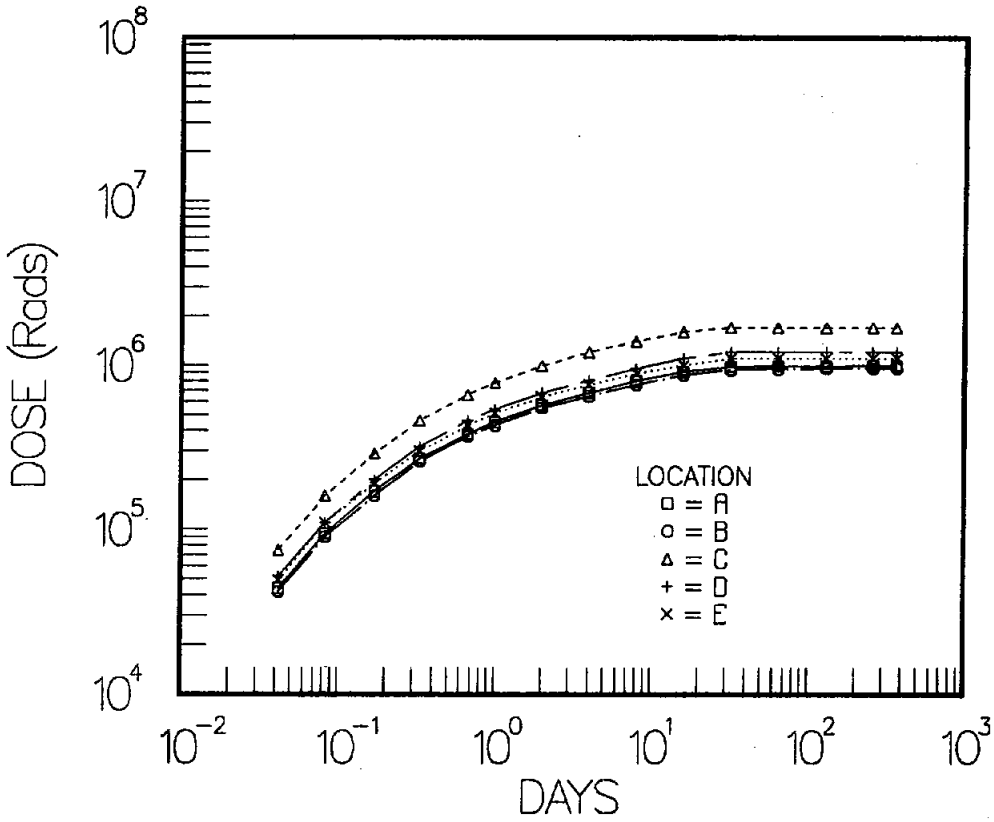


Figure B.61. Surry Case 3 Steam Generator A Total Gamma Dose

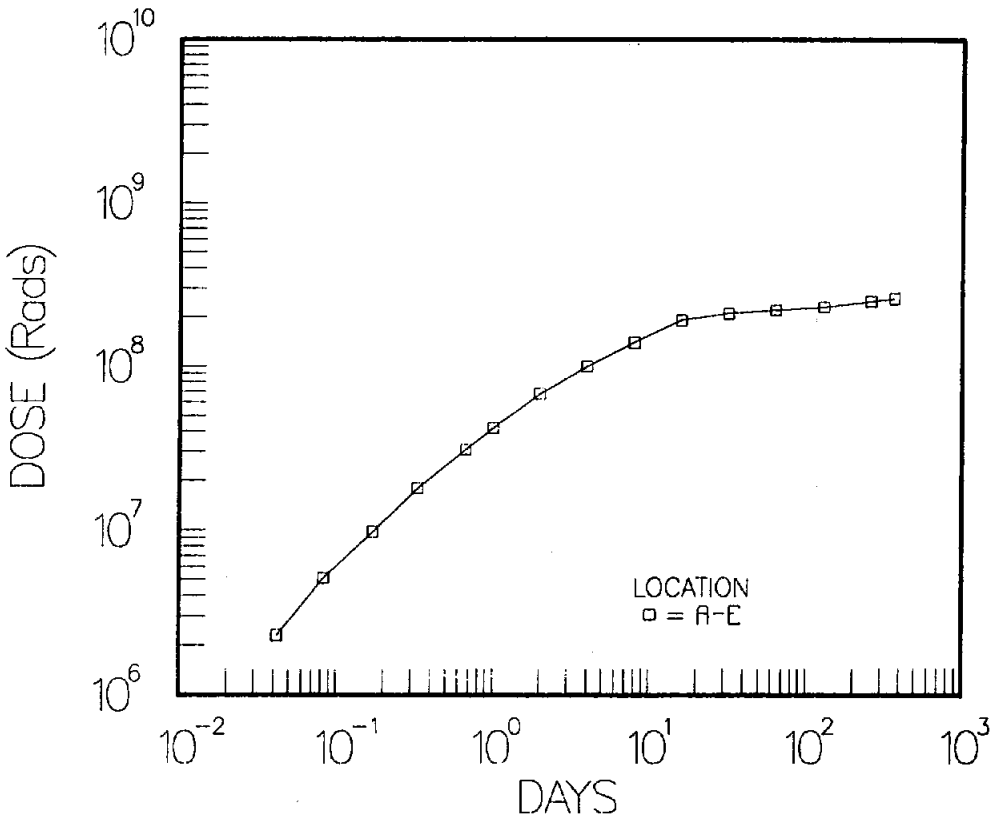


Figure B.62. Surry Case 3 Steam Generator A Total Beta Dose

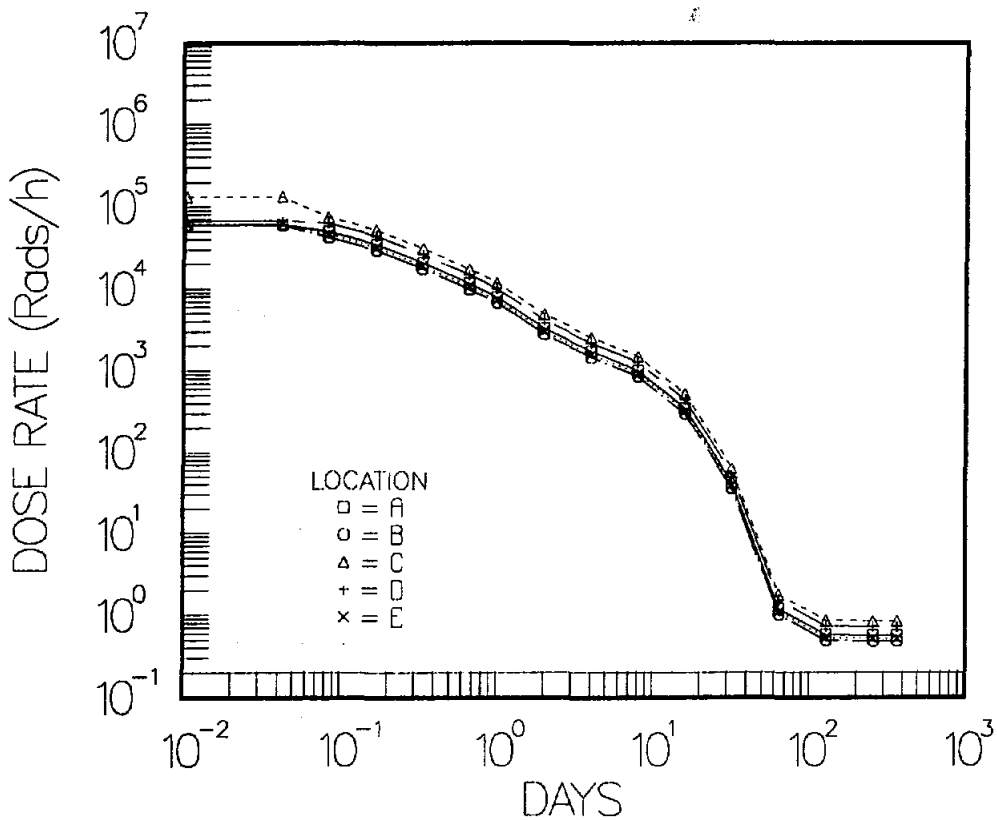


Figure B.63. Surry Case 3 Steam Generator B Gamma Dose Rate

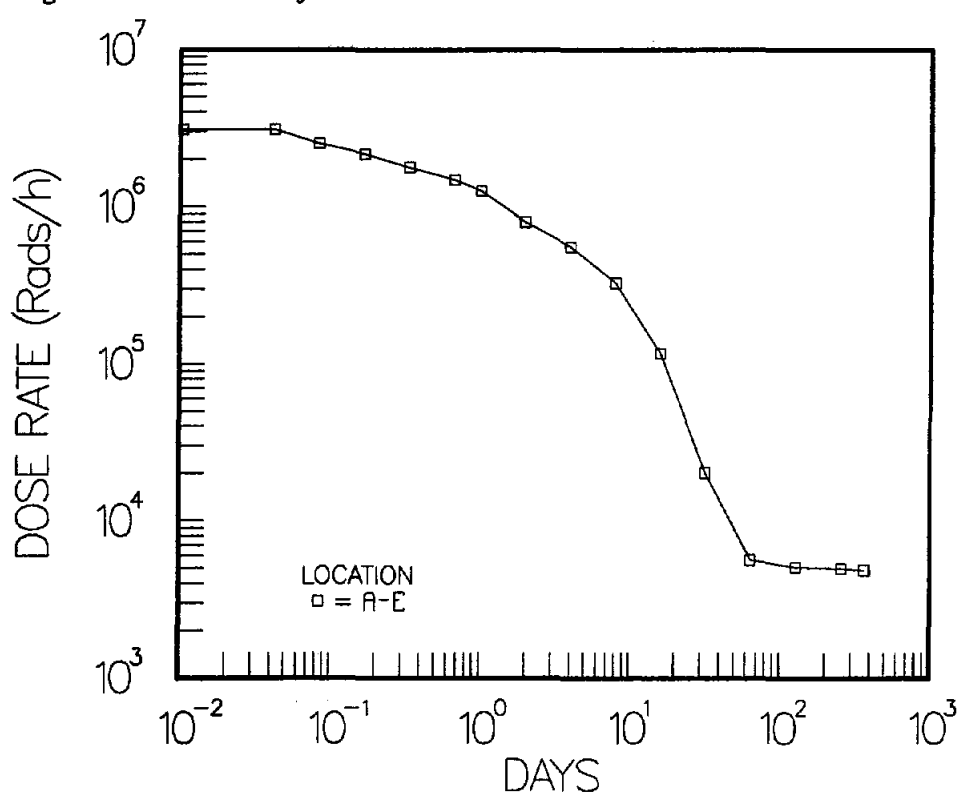


Figure B.64. Surry Case 3 Steam Generator B Beta Dose Rate

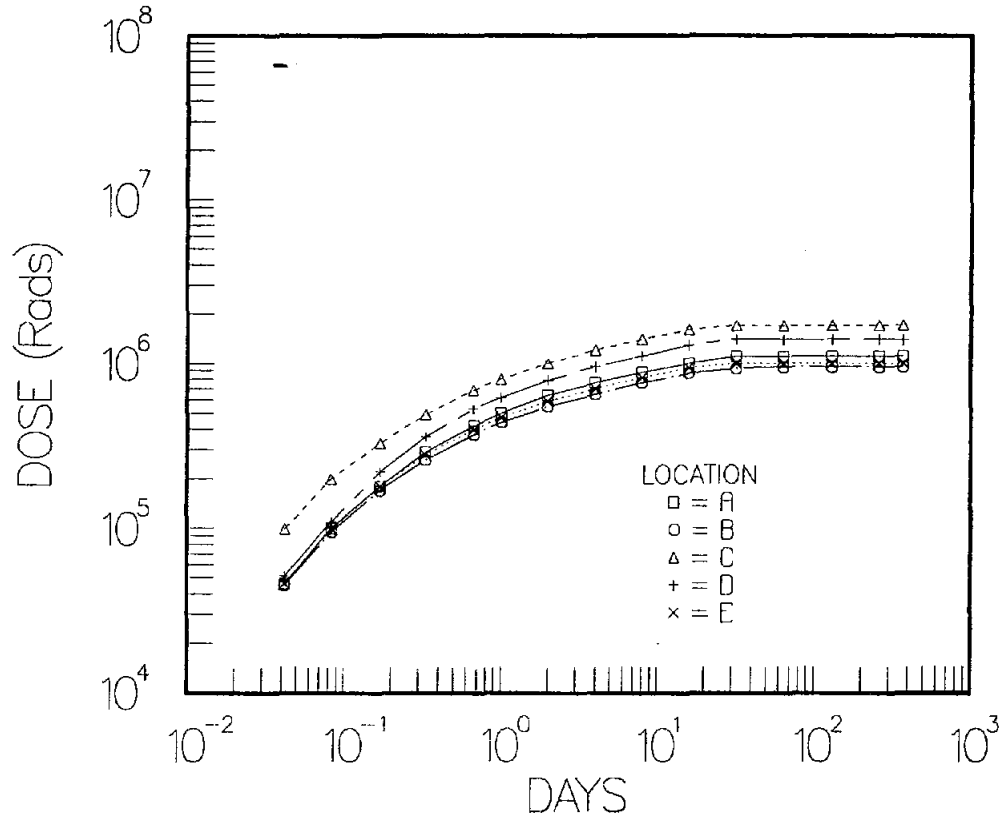


Figure B.65. Surry Case 3 Steam Generator B Total Gamma Dose

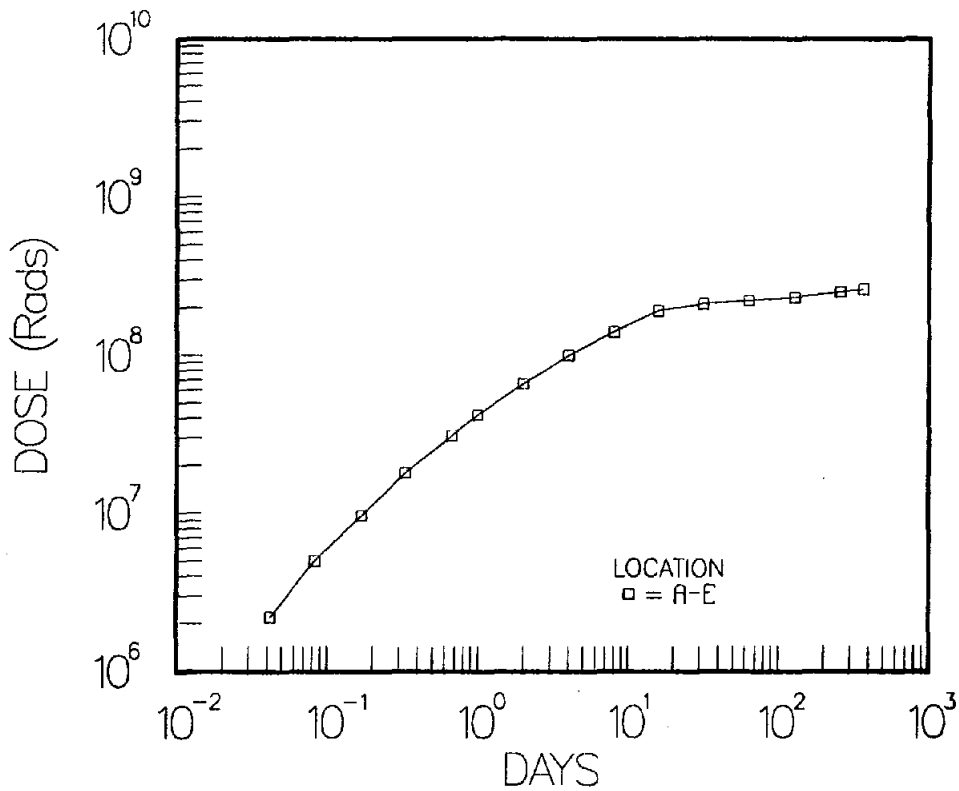


Figure B.66. Surry Case 3 Steam Generator B Total Beta Dose

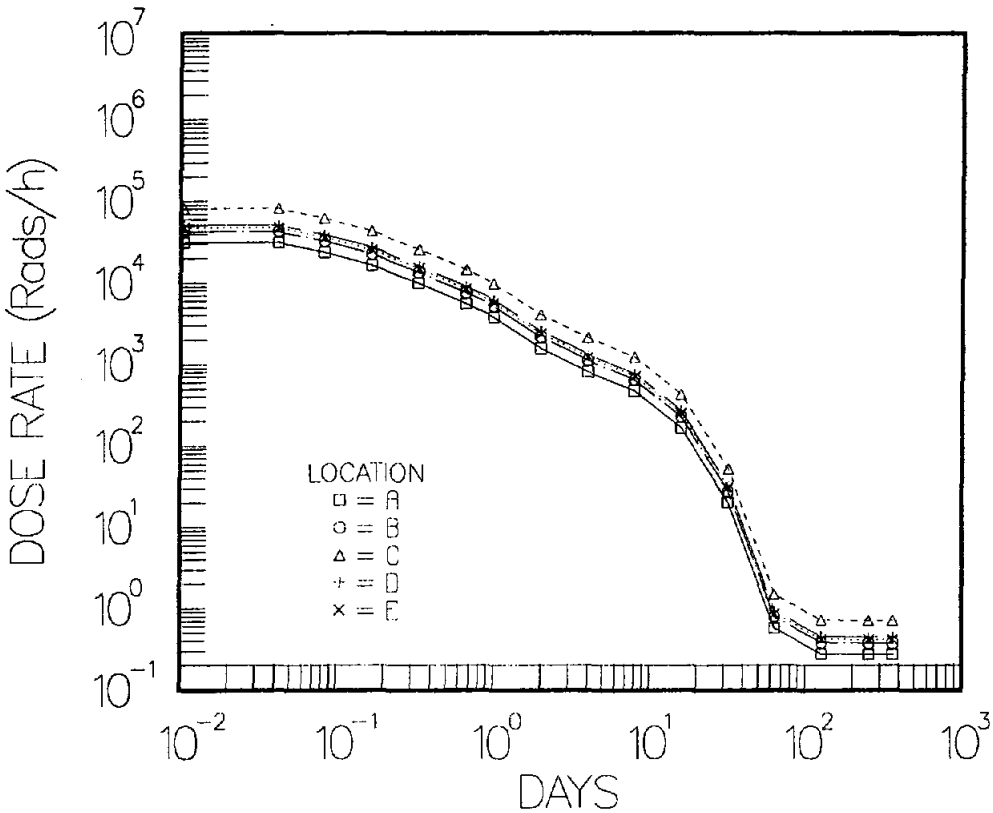


Figure B.67. Surry Case 3 RHR Cubicle Gamma Dose Rate

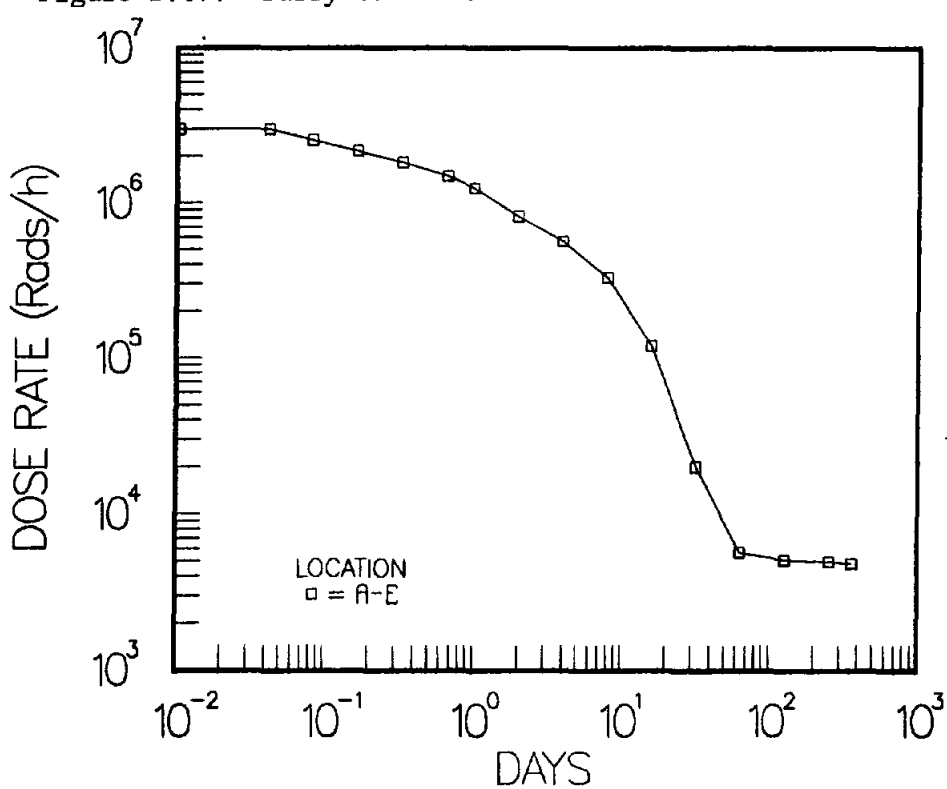


Figure B.68. Surry Case 3 RHR Cubicle Beta Dose Rate

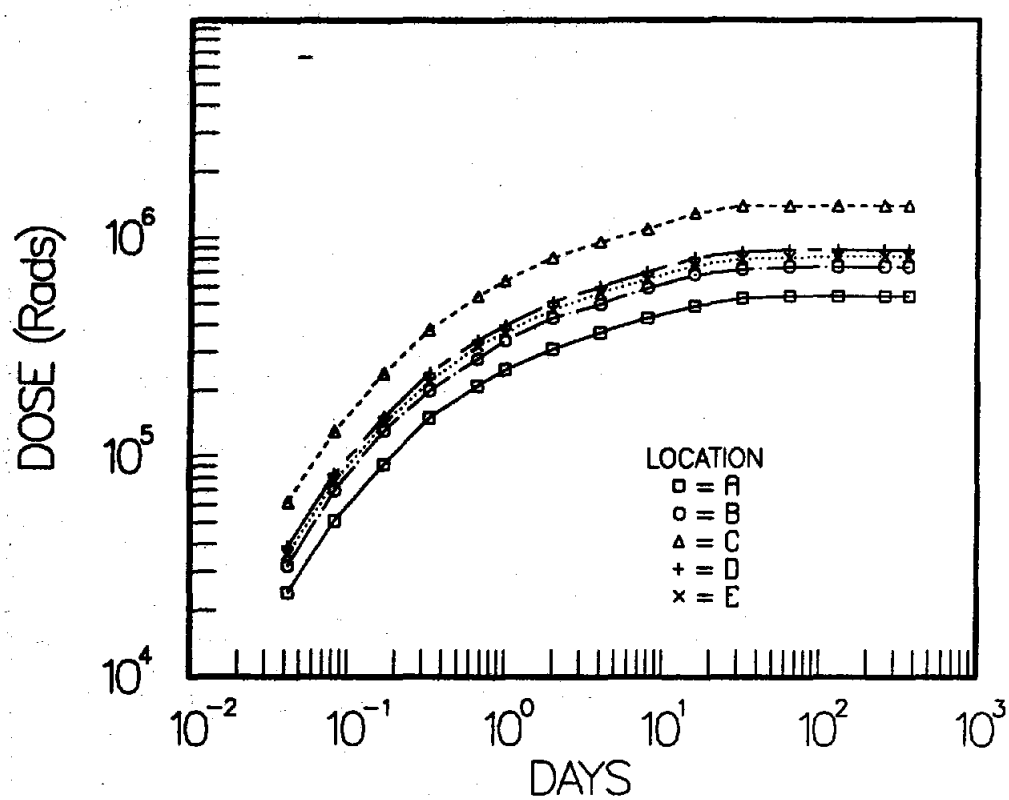


Figure B.69. Surry Case 3 RHR Cubicle Total Gamma Dose

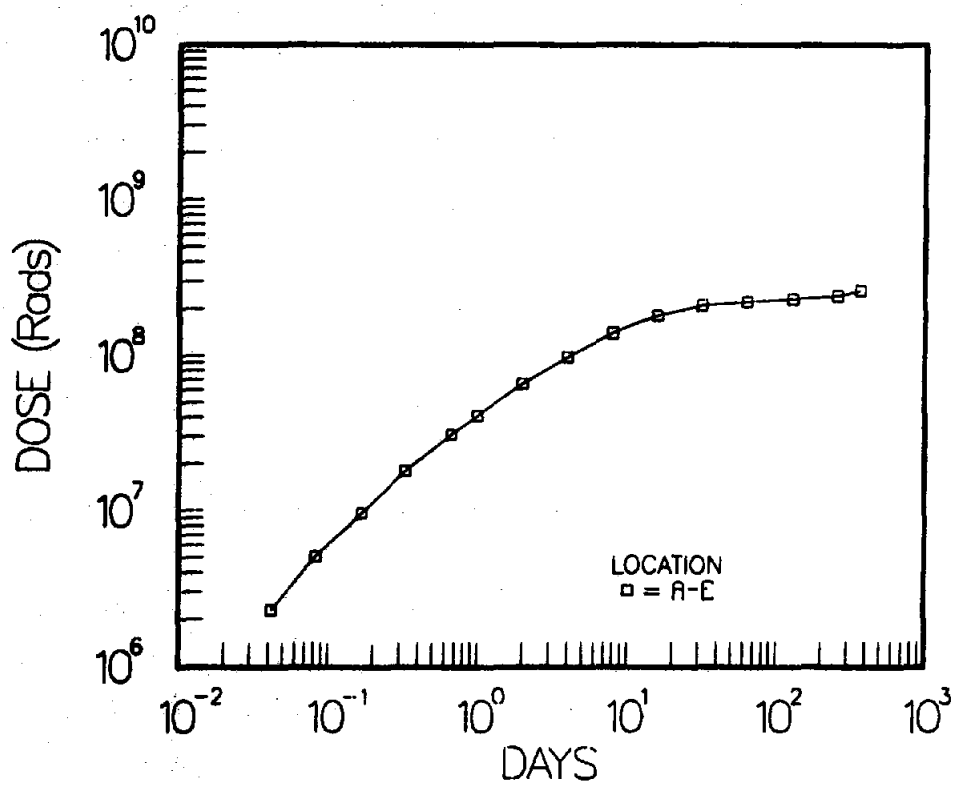


Figure B.70. Surry Case 3 RHR Cubicle Total Beta Dose

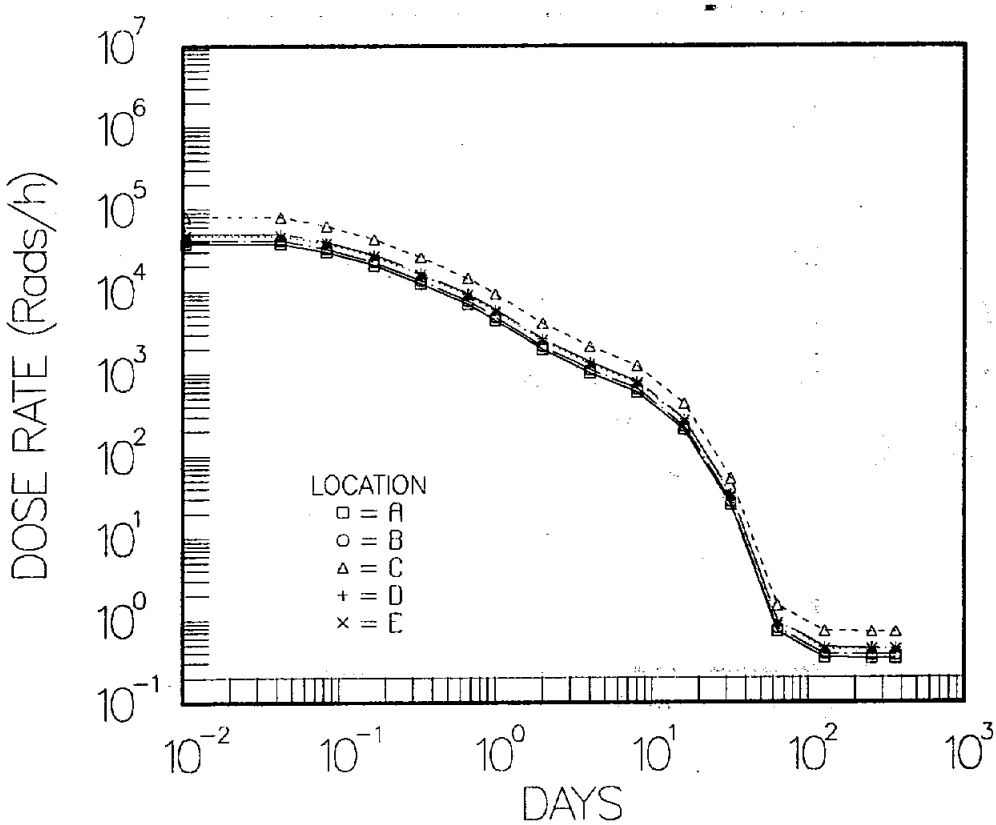


Figure B.71. Surry Case 3 Incore Instrumentation Room Gamma Dose Rate

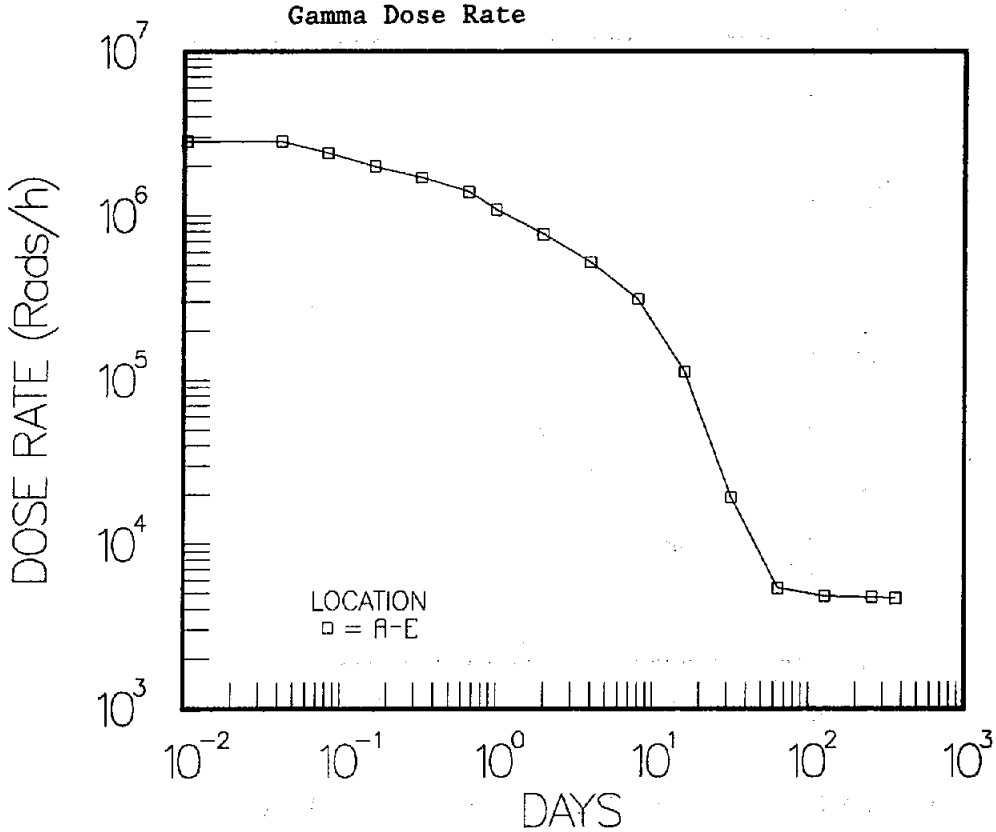


Figure B.72. Surry Case 3 Incore Instrumentation Room Beta Dose Rate

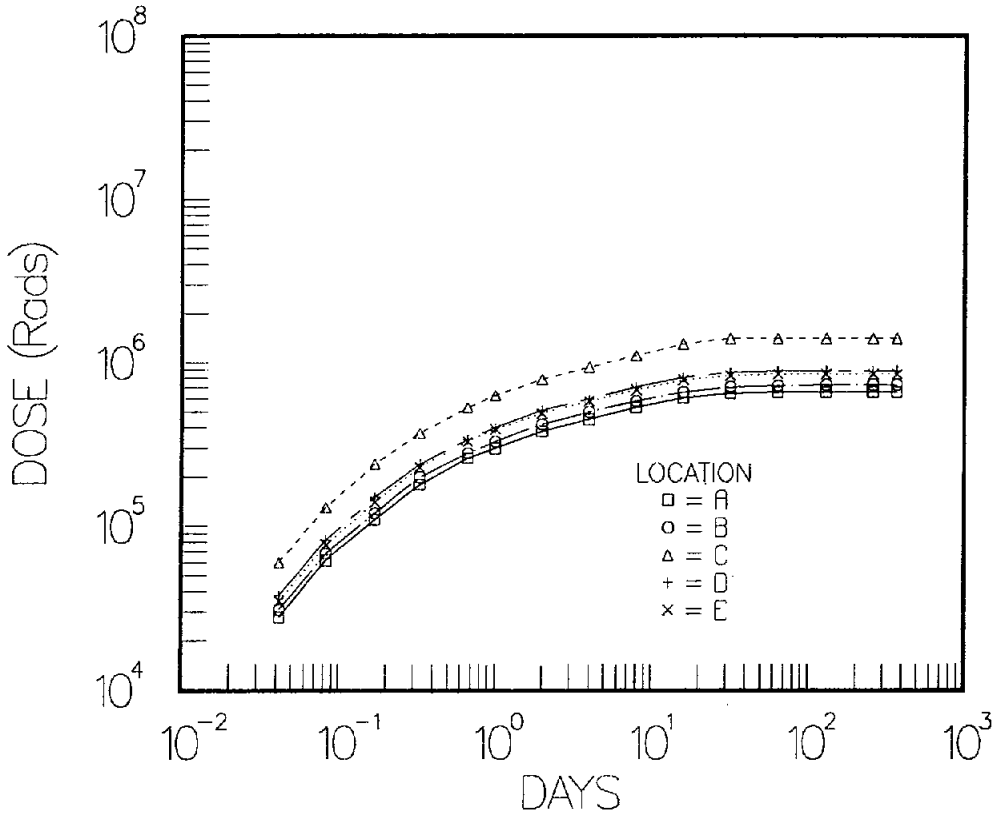


Figure B.73. Surry Case 3 Incore Instrumentation Room Total Gamma Dose

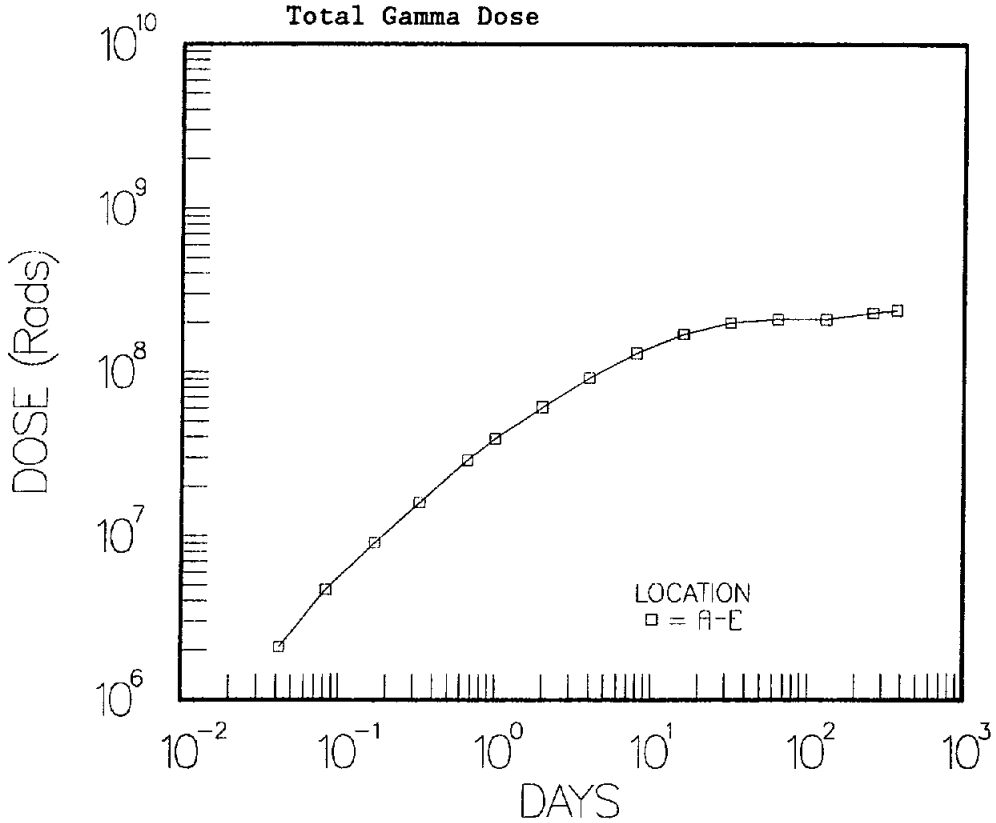


Figure B.74. Surry Case 3 Incore Instrumentation Room Total Beta Dose

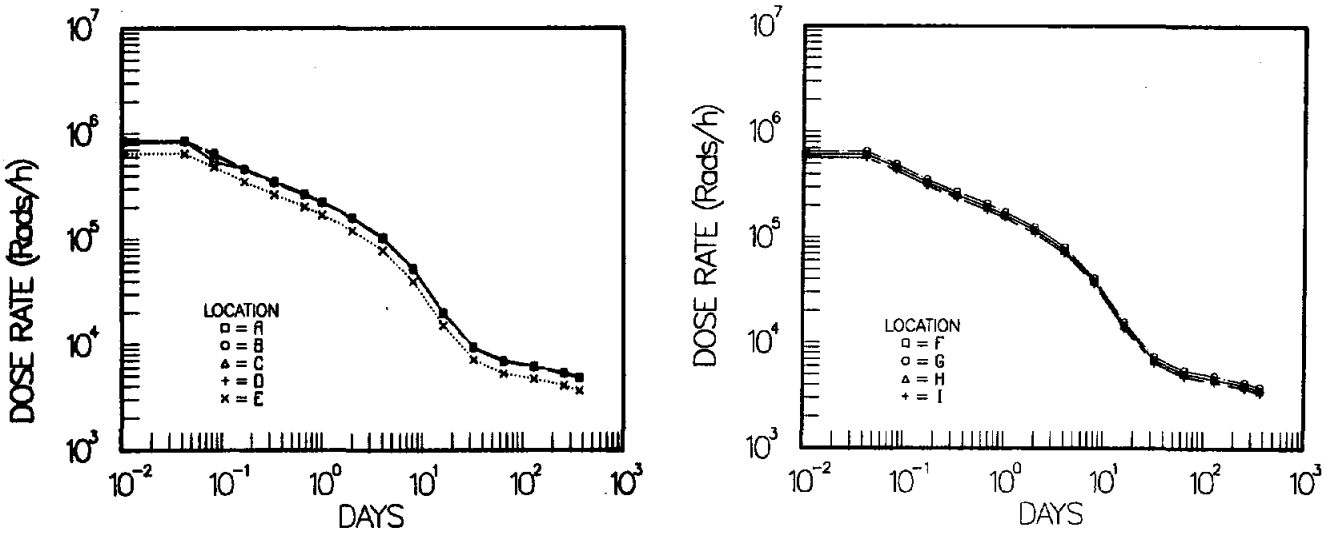


Figure B.75. Surry Case 4 Basement Gamma Dose Rate

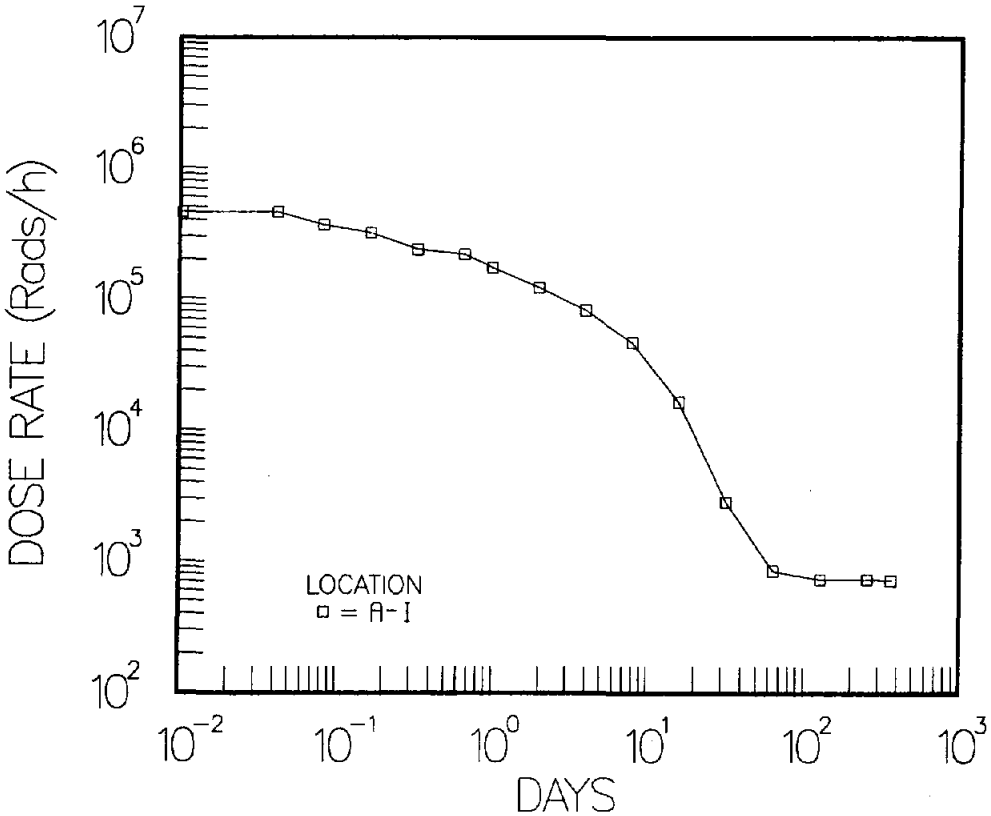


Figure B.76. Surry Case 4 Basement Beta Dose Rate

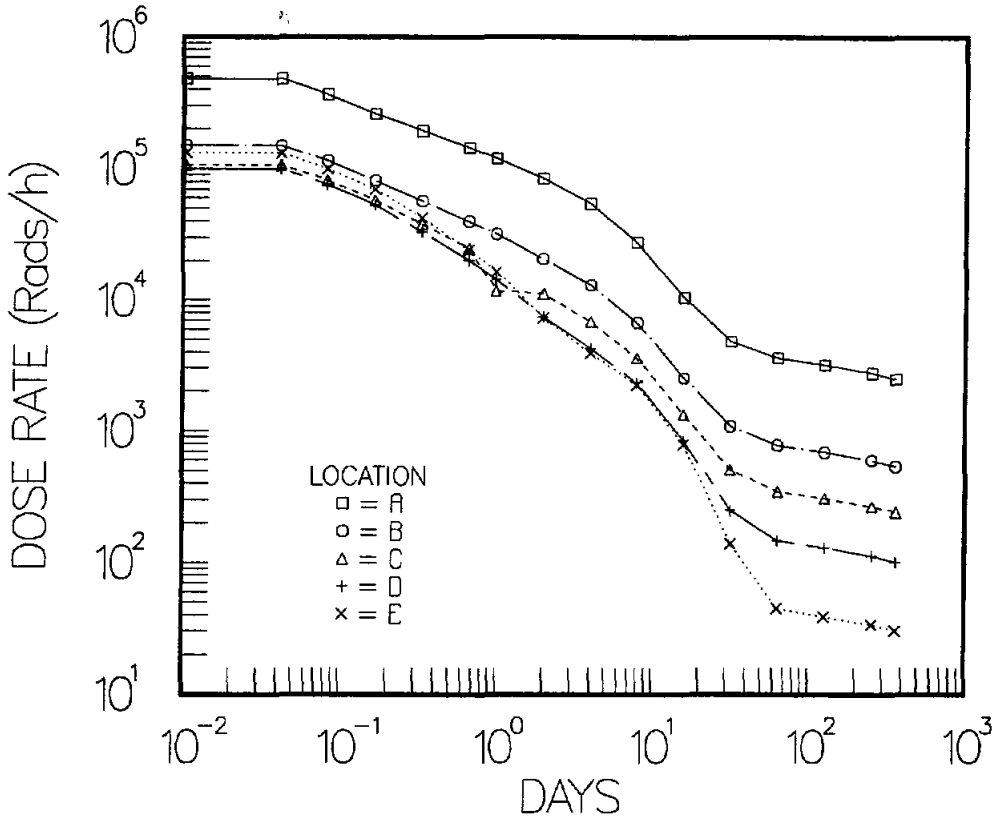


Figure B.77. Surry Case 4 Annulus Gamma Dose Rate

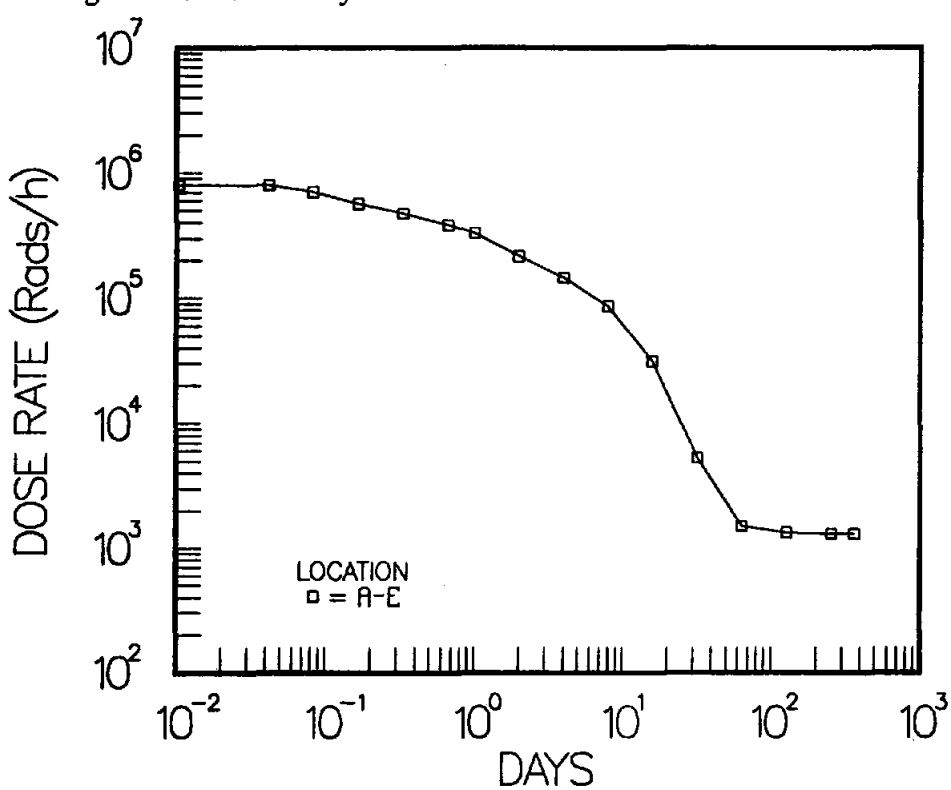


Figure B.78. Surry Case 4 Annulus Beta Dose Rate

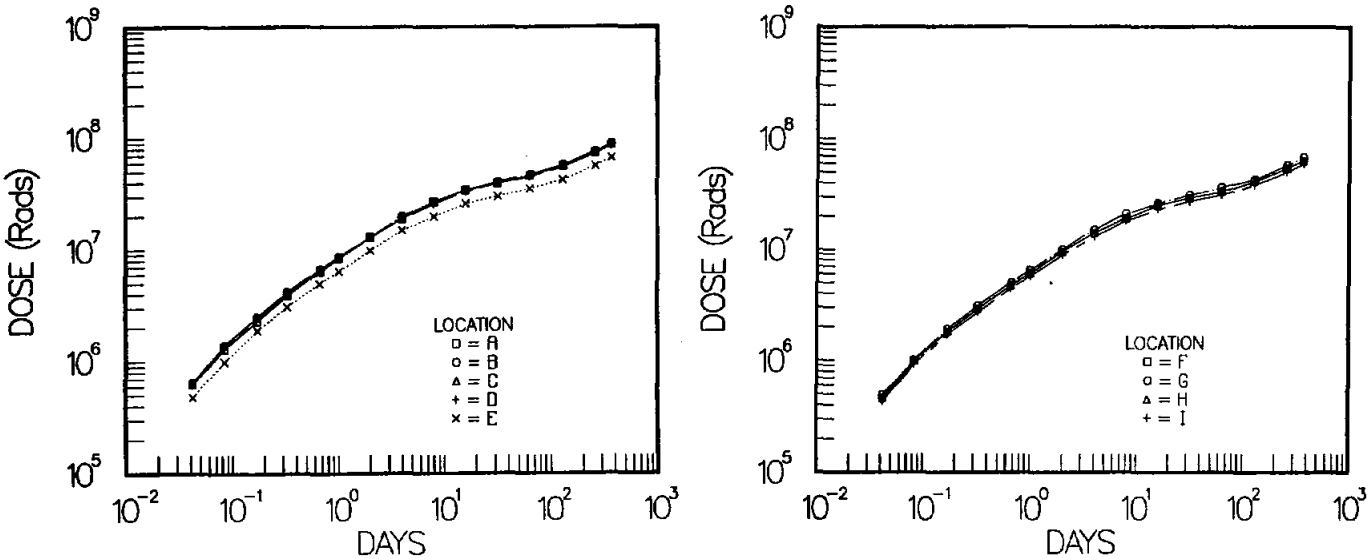


Figure B.79. Surry Case 4 Basement Gamma Total Dose

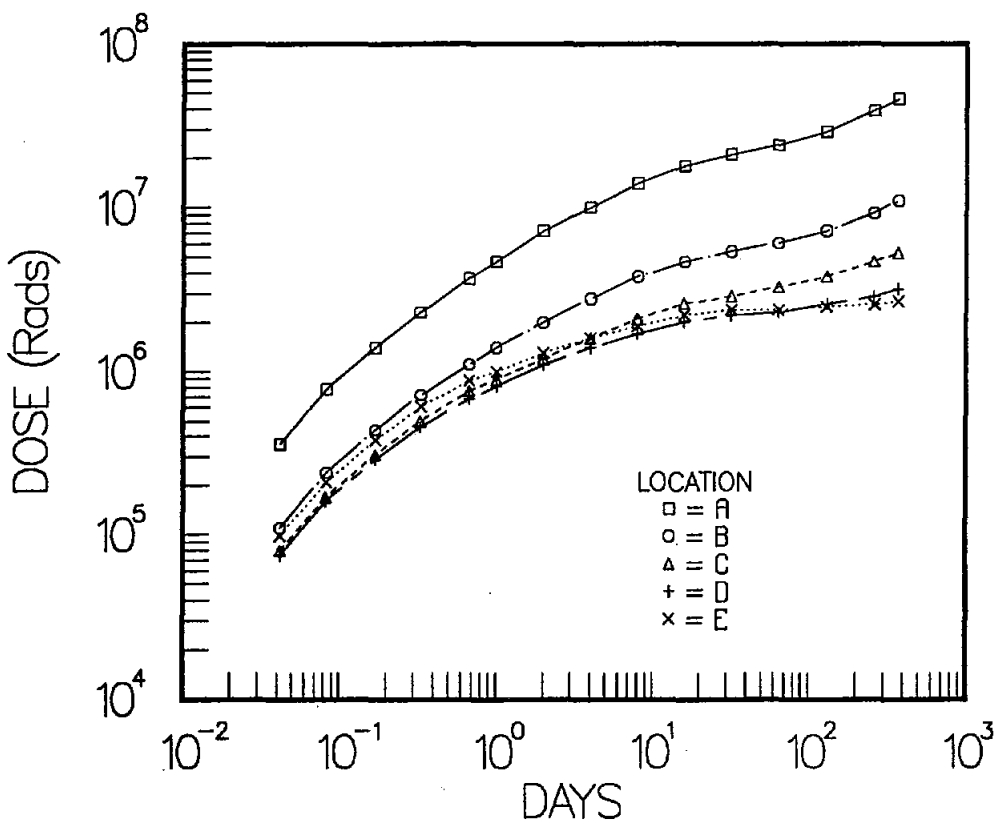


Figure B.80. Surry Case 4 Annulus Total Gamma Dose

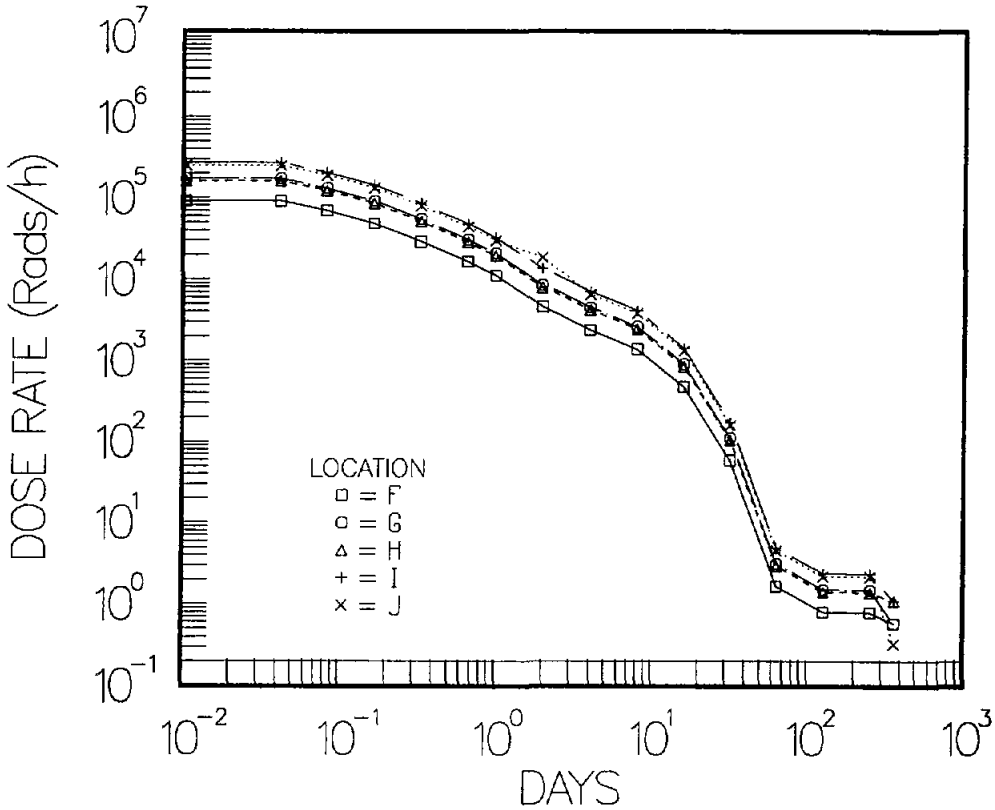


Figure B.81. Surry Case 4 Operating and Dome Gamma Dose Rate

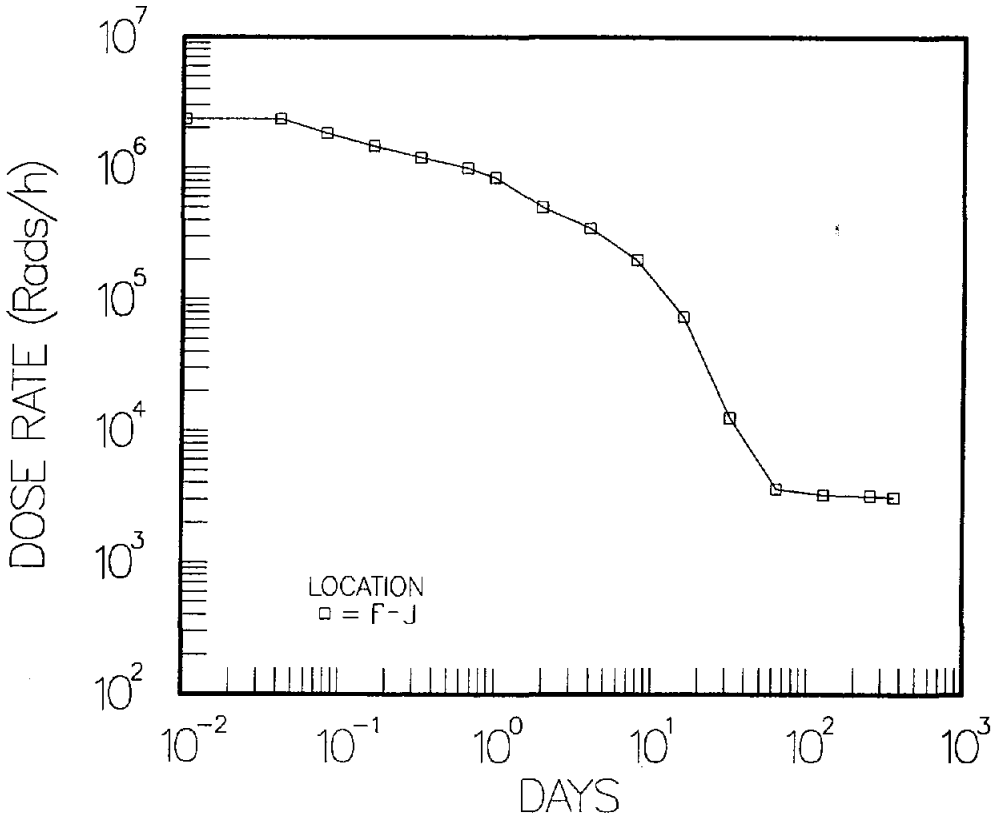


Figure B.82. Surry Case 4 Operating Floor and Dome Beta Dose Rate

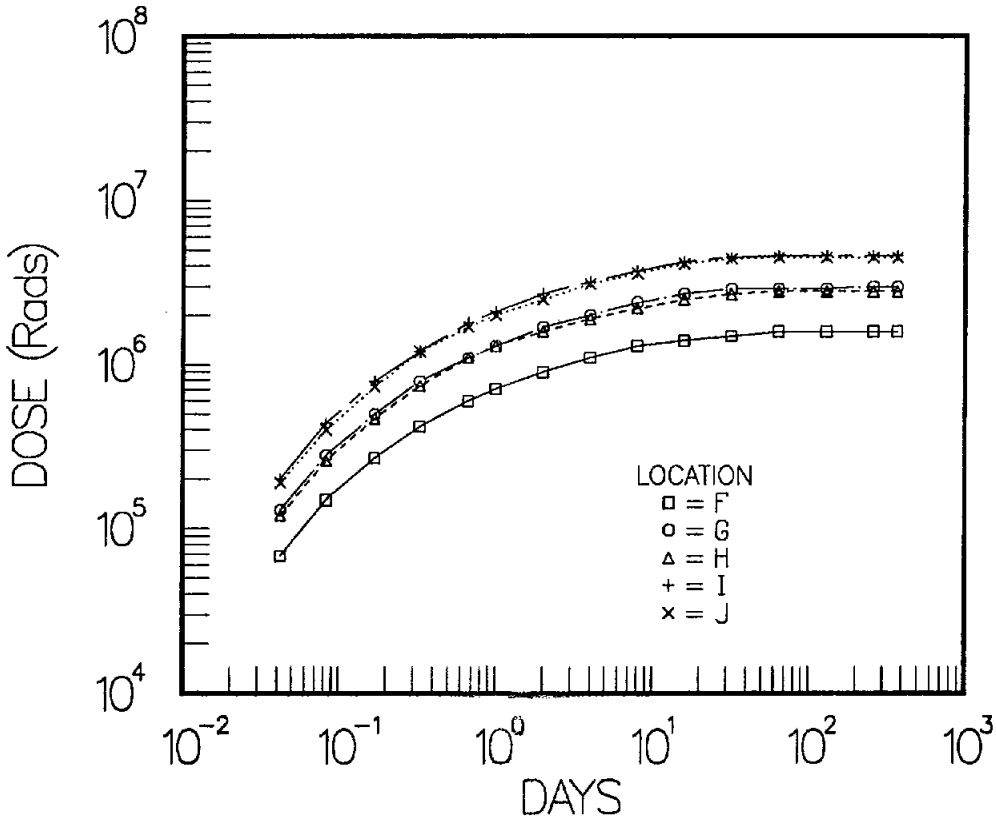


Figure B.83. Surry Case 4 Operating Floor and Dome Gamma Total Dose

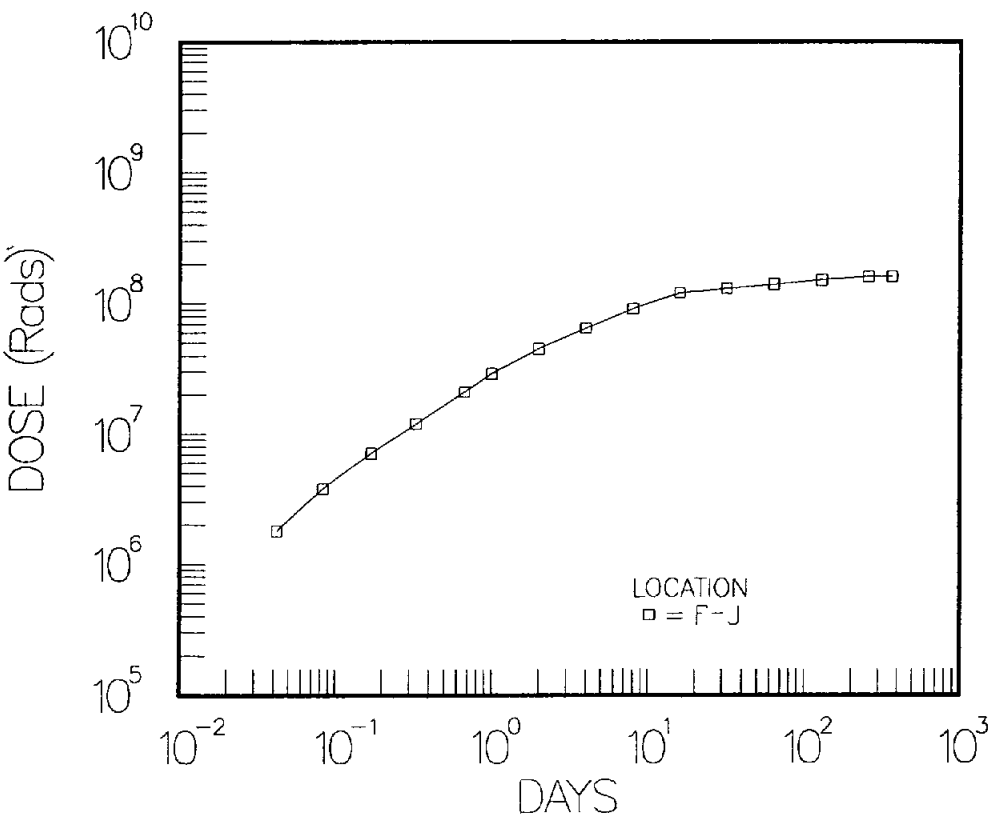


Figure B.84. Surry Case 4 Operating Floor and Dome Beta Total Dose

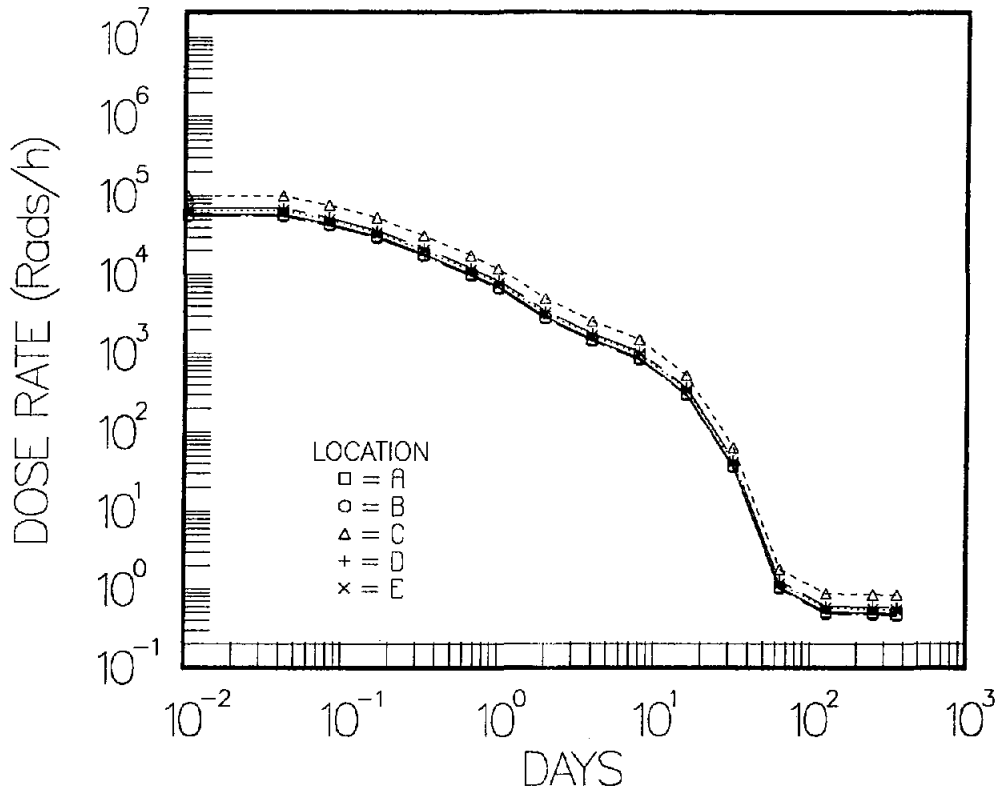


Figure B.85. Surry Case 4 Steam Generator A Gamma Dose Rate

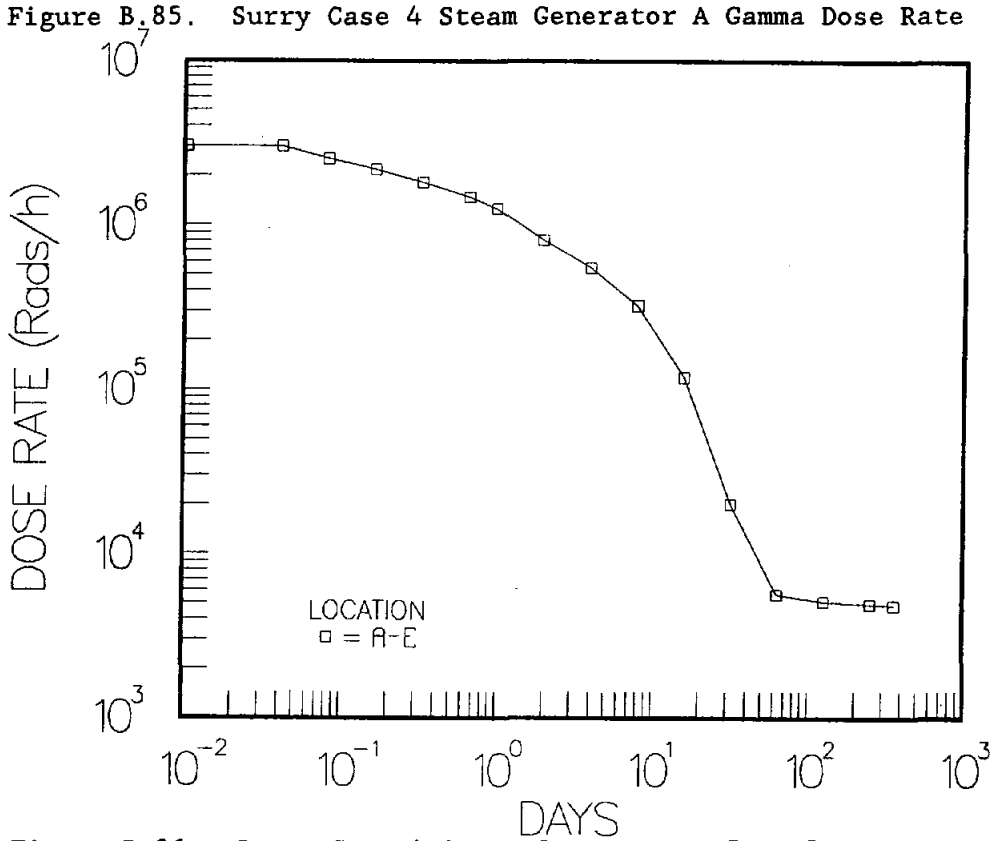


Figure B.86. Surry Case 4 Steam Generator A Beta Dose Rate

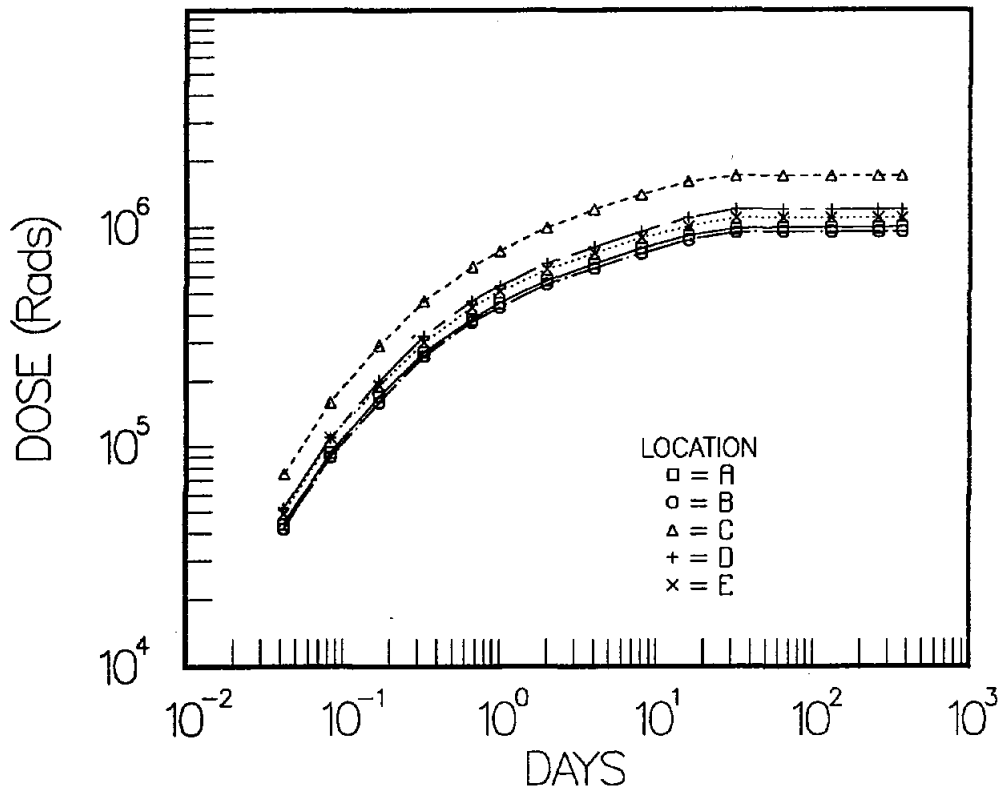


Figure B.87. Surry Case 4 Steam Generator A Gamma Total Dose

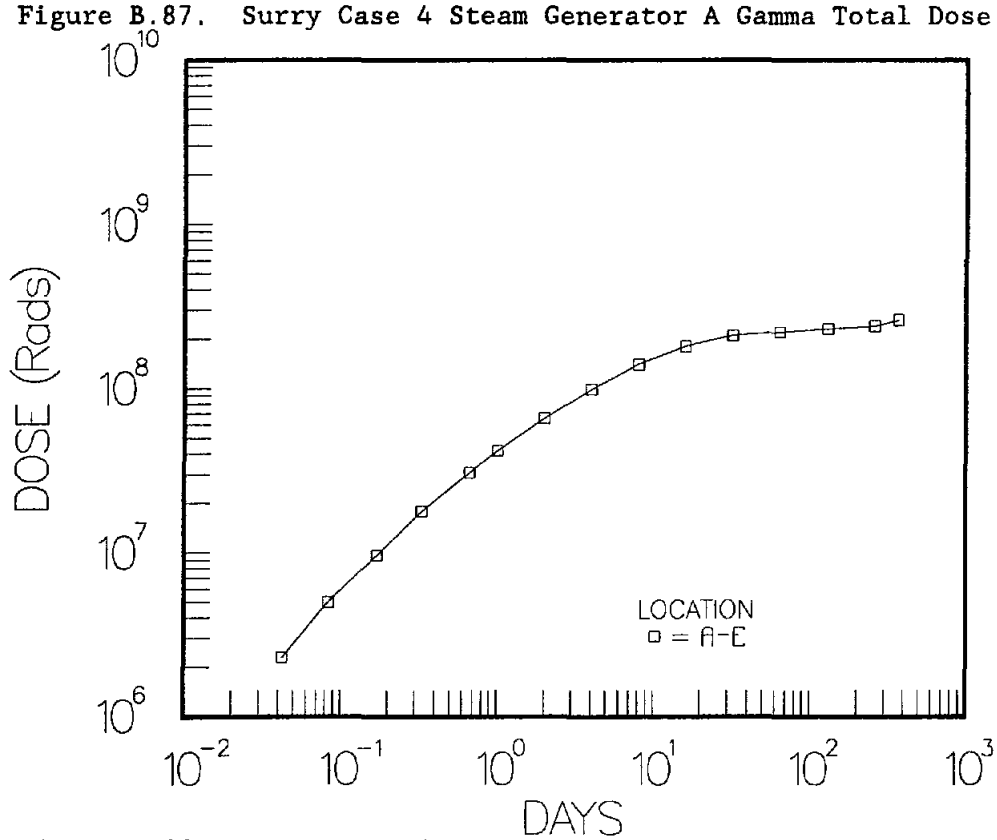


Figure B.88. Surry Case 4 Steam Generator A Beta Total Dose

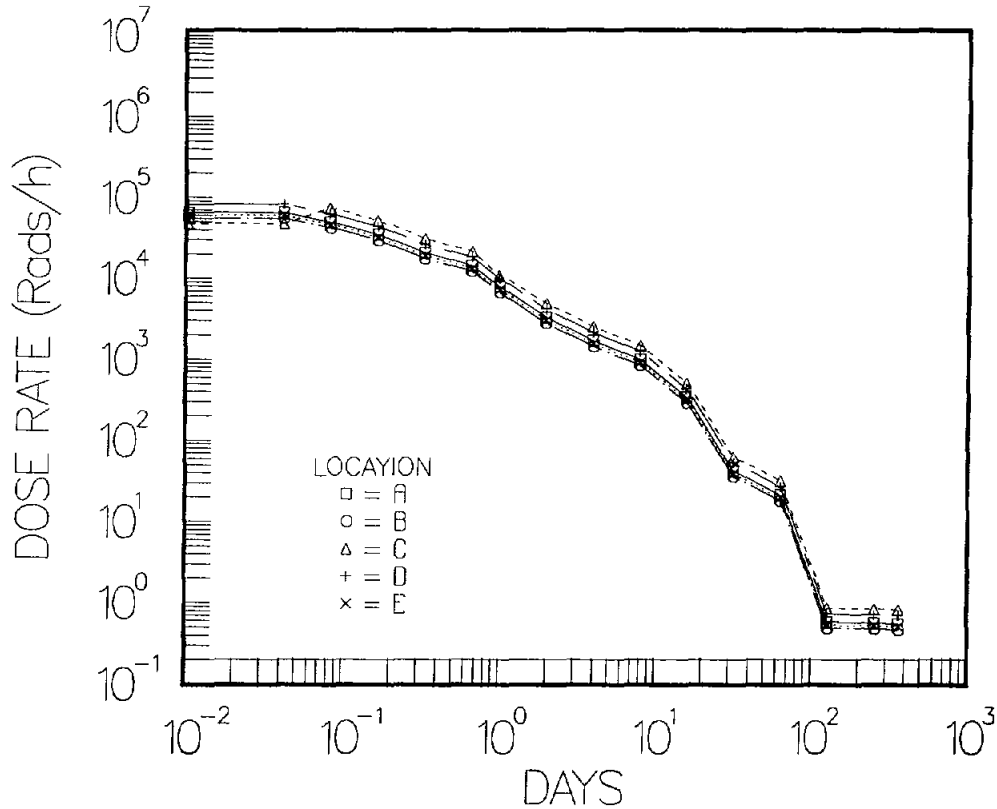


Figure B.89. Surry Case 4 Steam Generator B Gamma Dose Rate

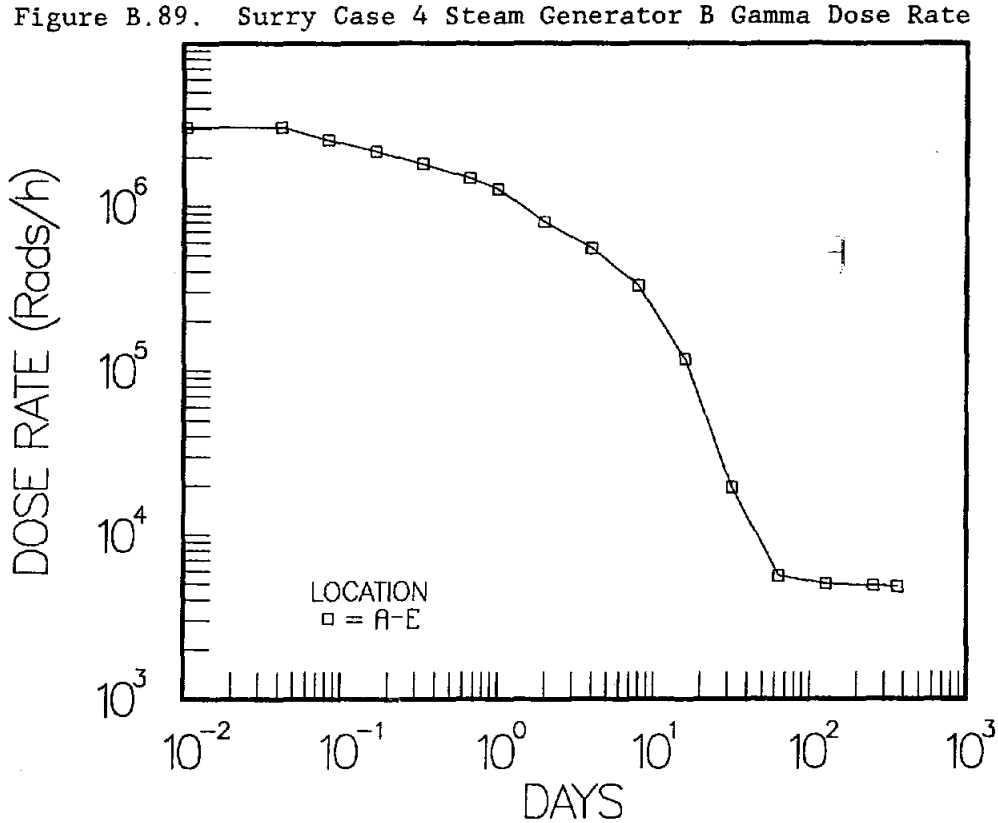


Figure B.90. Surry Case 4 Steam Generator B Beta Dose Rate

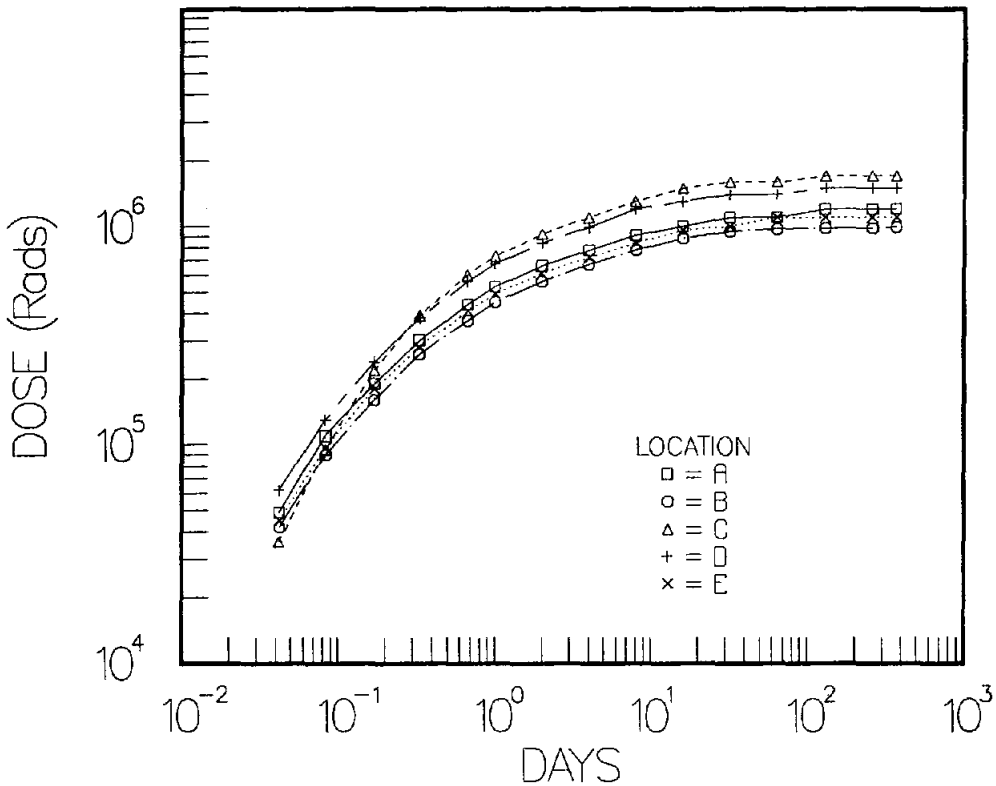


Figure B.91. Surry Case 4 Steam Generator B Total Gamma Dose

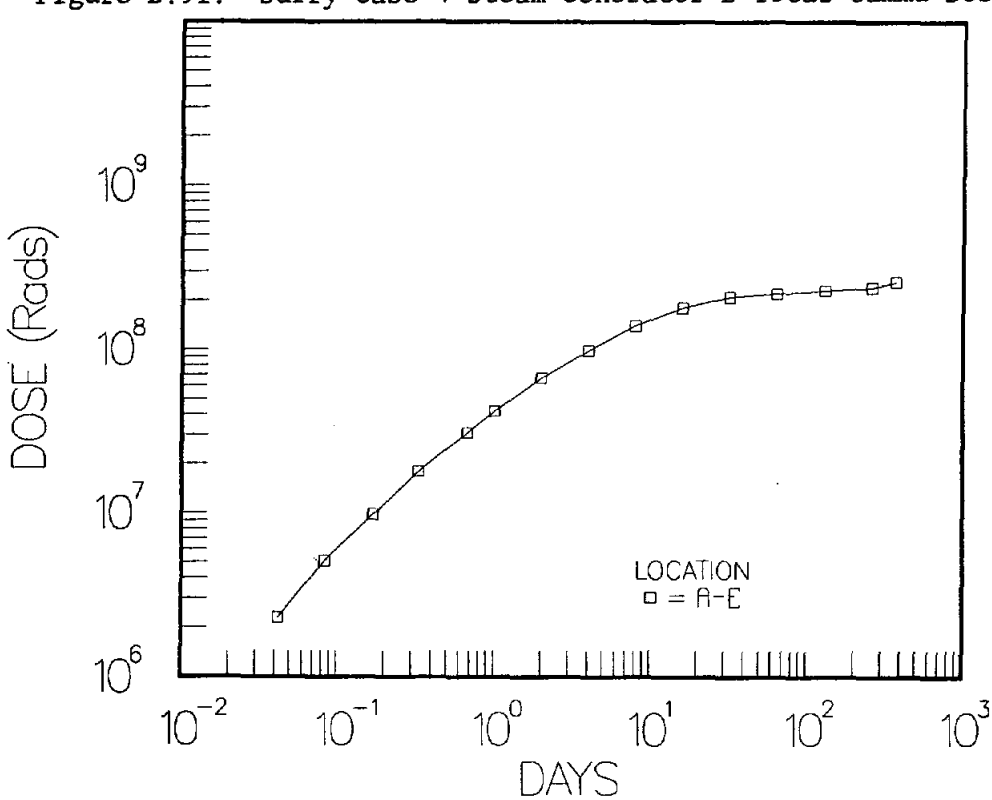


Figure B.92. Surry Case 4 Steam Generator B Total Beta Dose

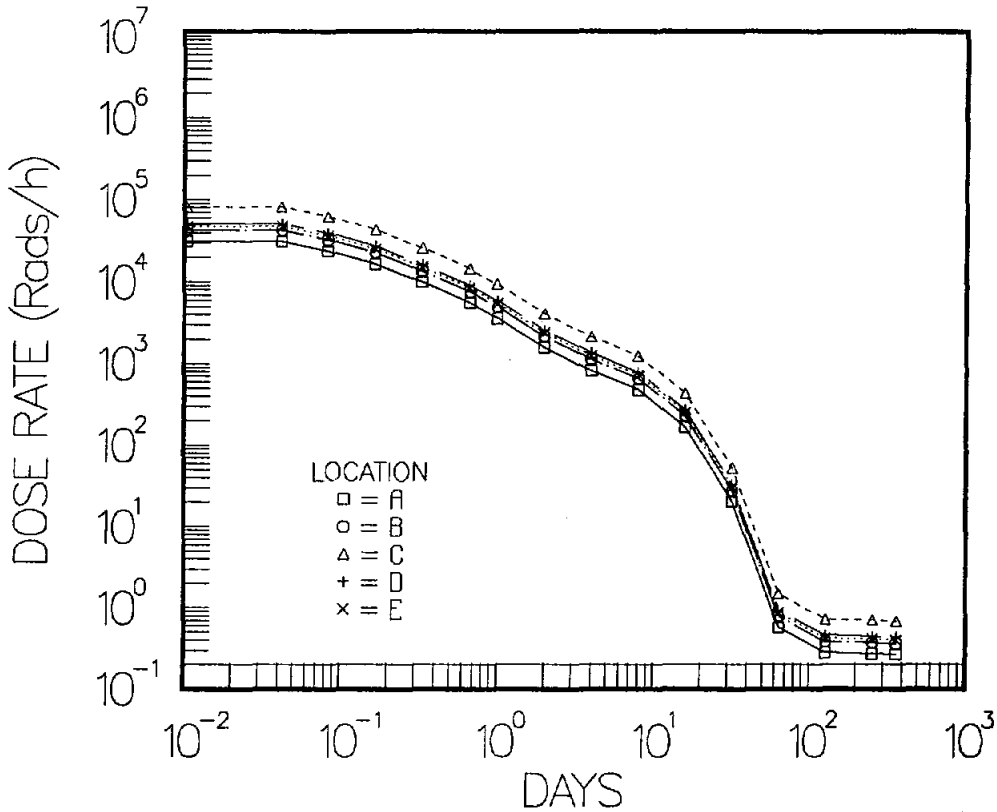


Figure B.93. Surry Case 4 RHR Cubicle Gamma Dose Rate

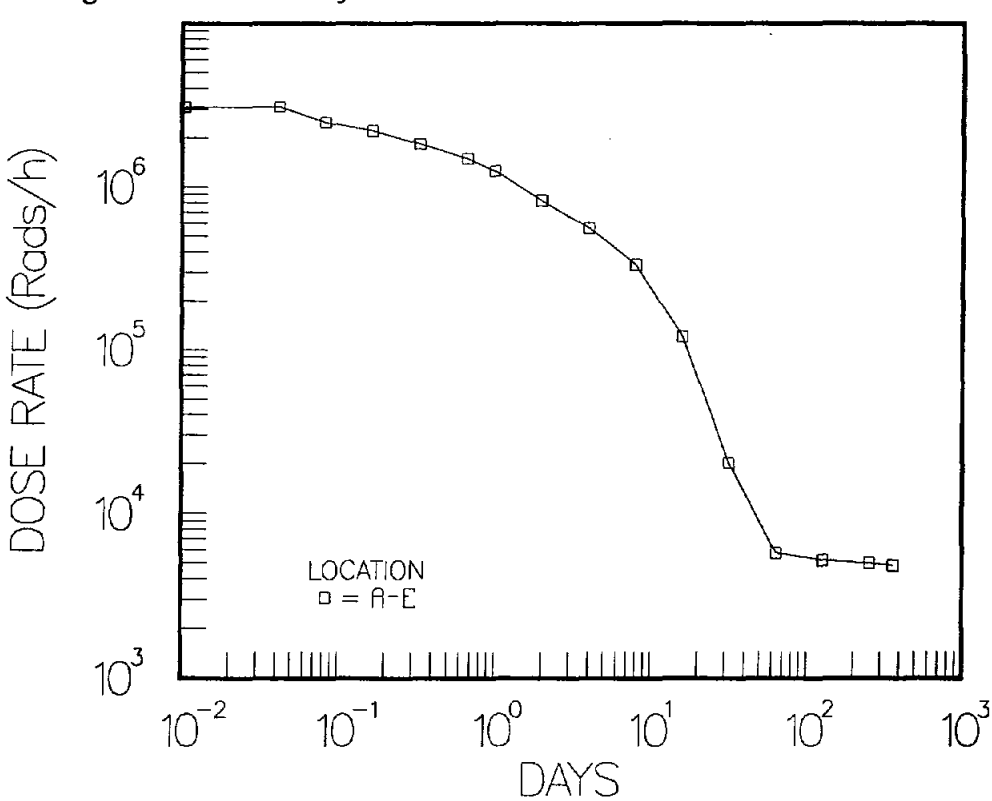


Figure B.94. Surry Case 4 RHR Cubicle Beta Dose Rate

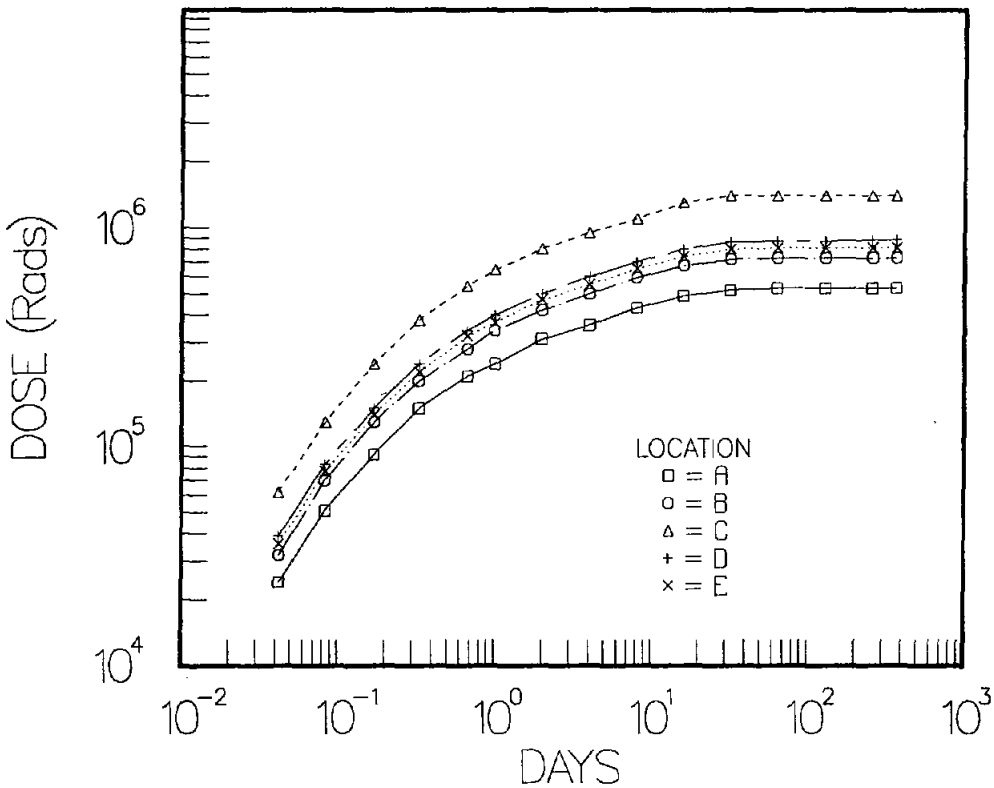


Figure B.95. Surry Case 4 RHR Cubicle Total Gamma Dose

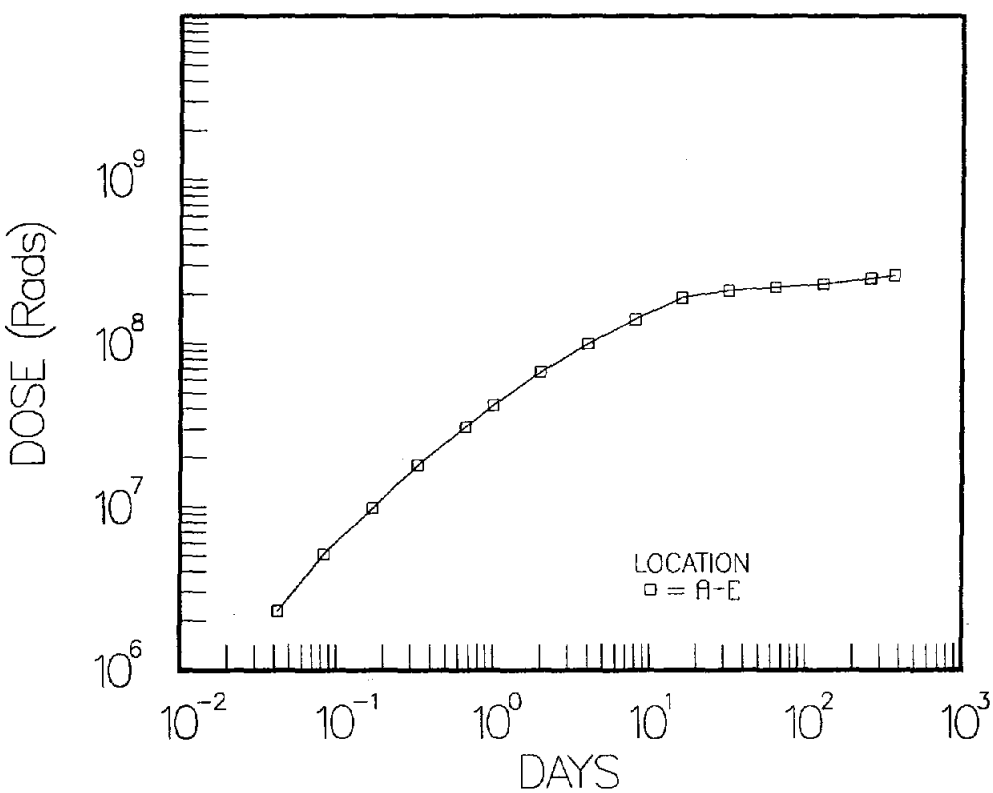


Figure B.96. Surry Case 4 RHR Cubicle Total Beta Dose

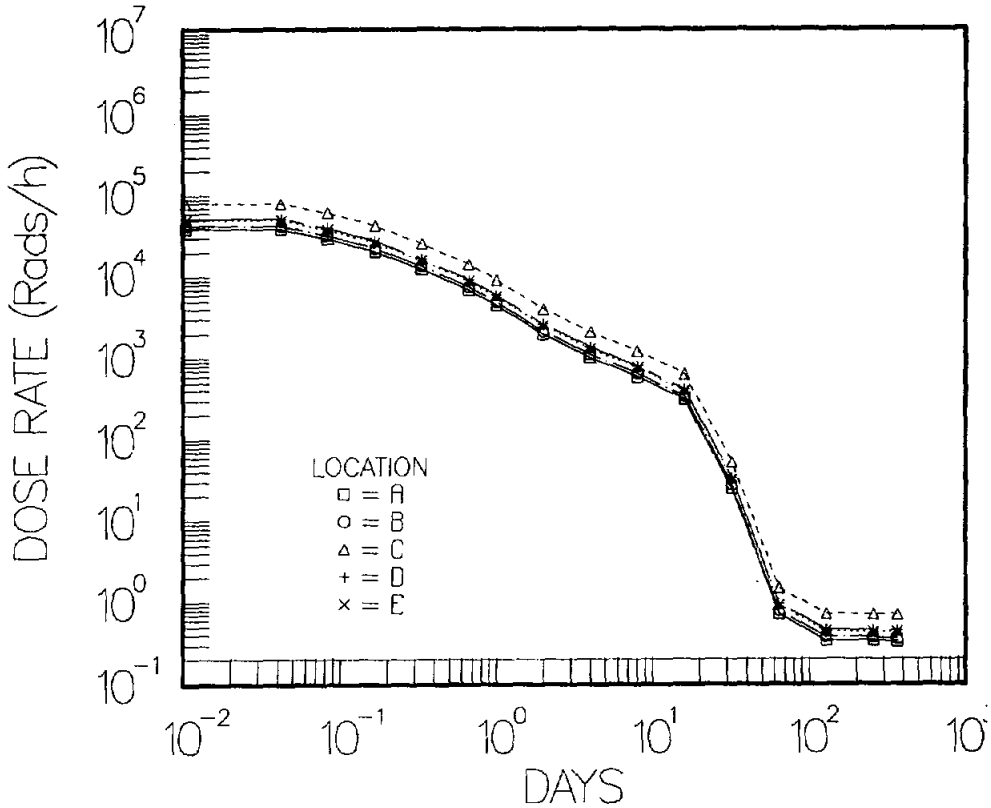


Figure B.97. Surry Case 4 Incore Instrumentation Room Gamma Dose Rate

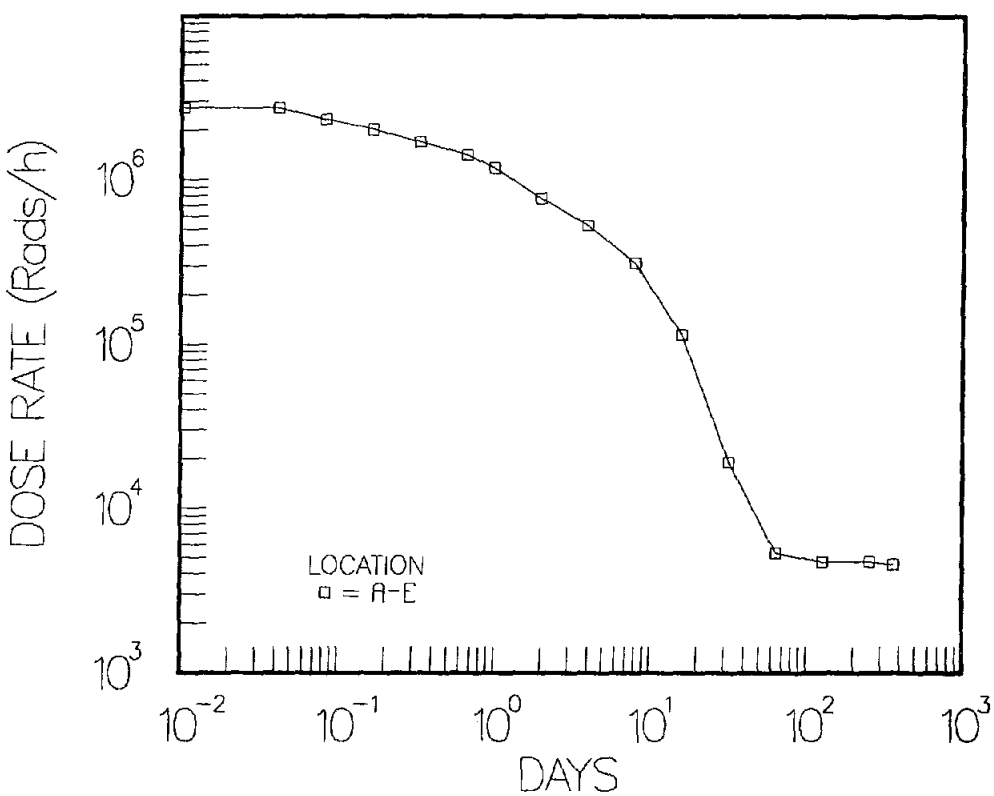


Figure B.98. Surry Case 4 Incore Instrumentation Room Beta Dose Rate

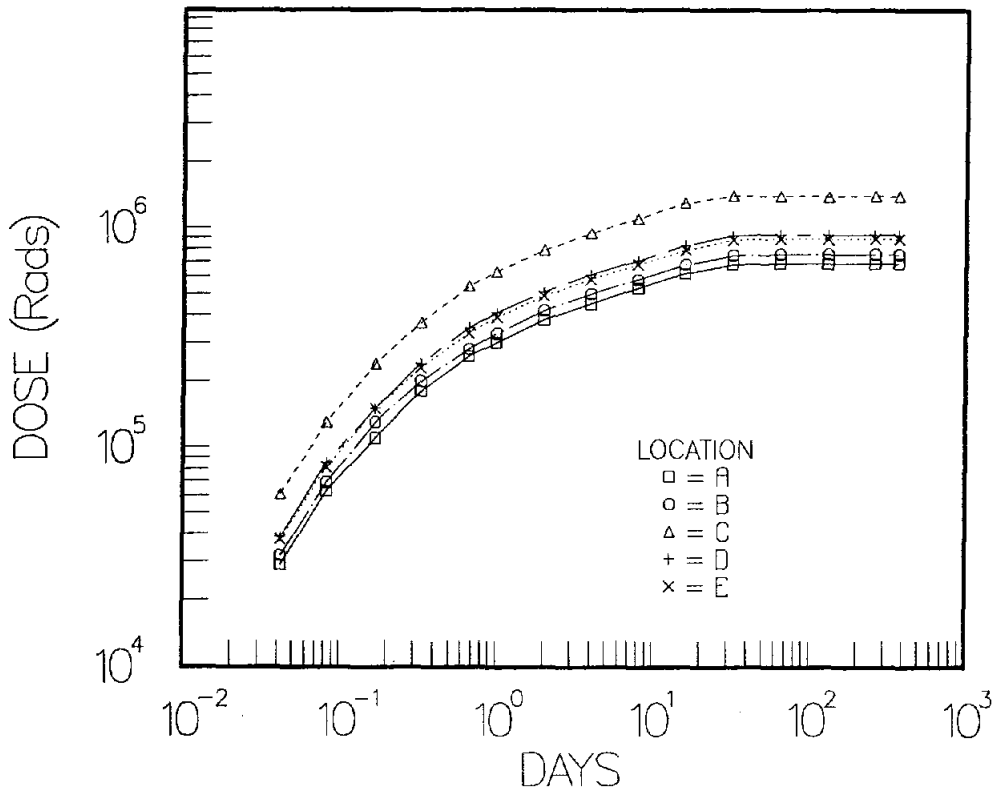


Figure B.99. Surry Case 4 Incore Instrumentation Room Total Gamma Dose

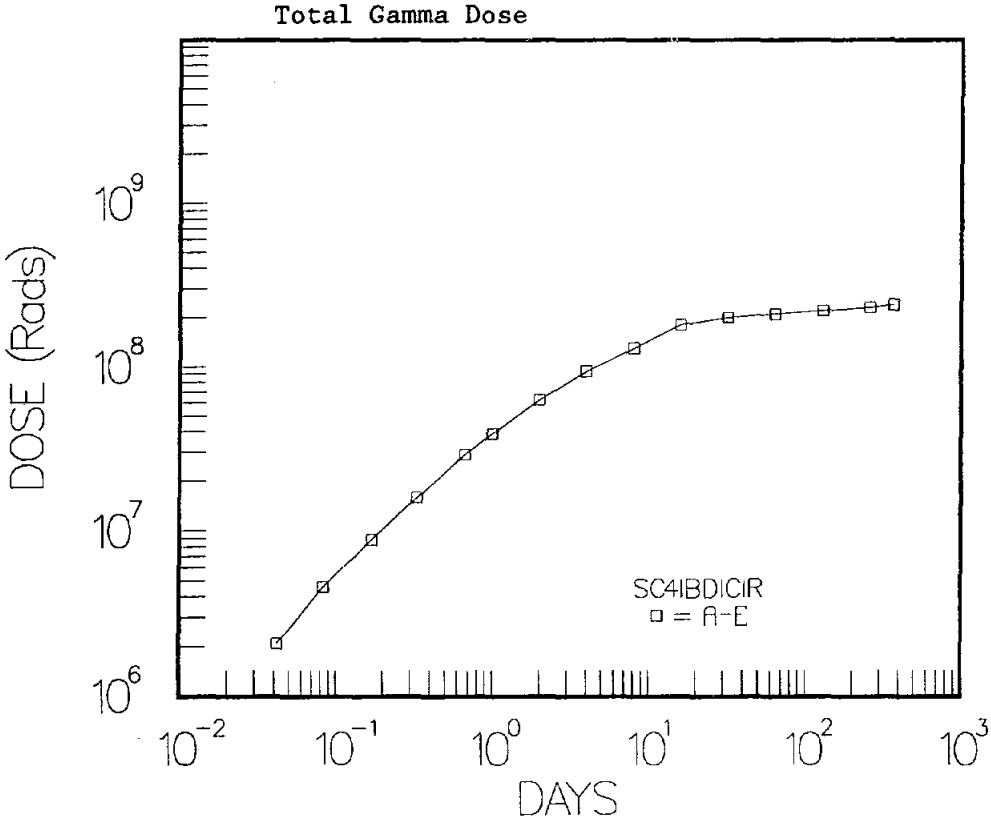
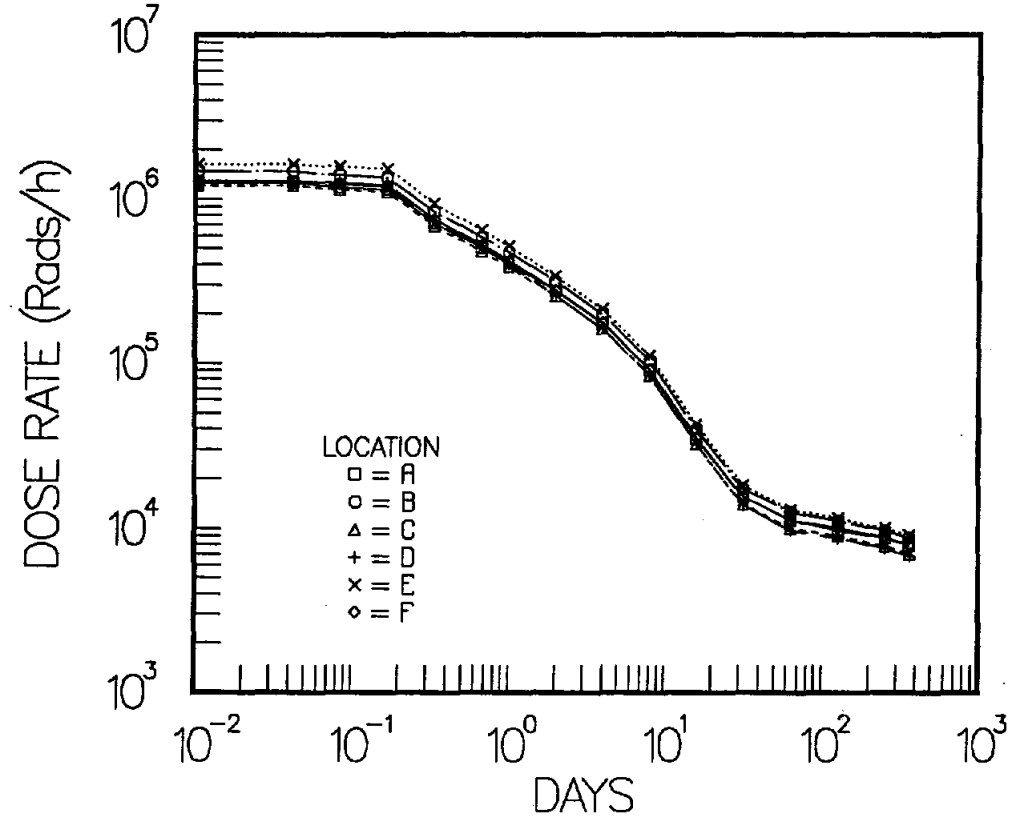


Figure B.100. Surry Case 4 Incore Instrumentation Room Total Beta Dose



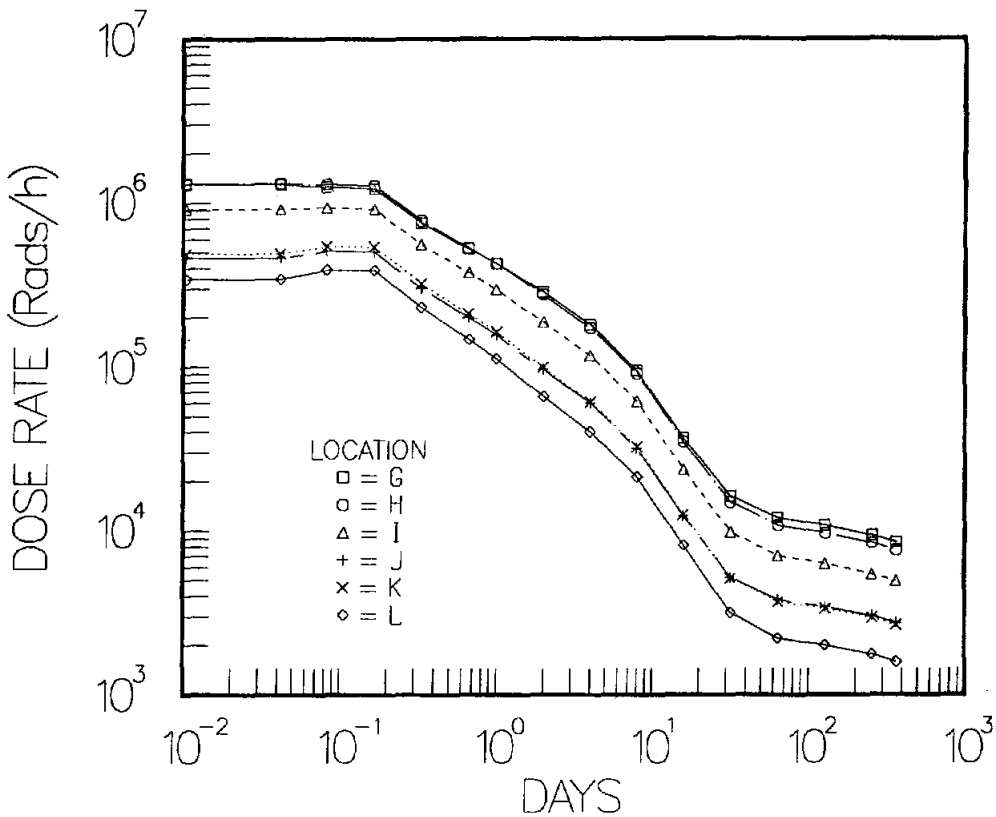
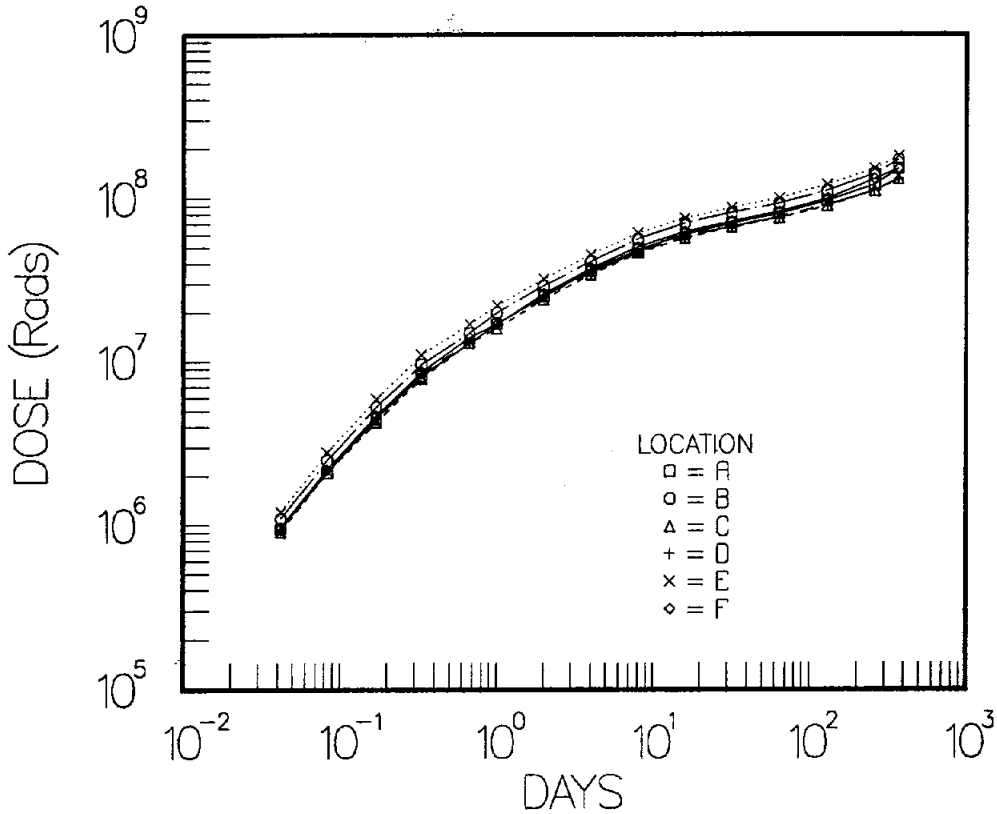


Figure B.101. Peach Bottom Case 1 Drywell Gamma Dose Rates



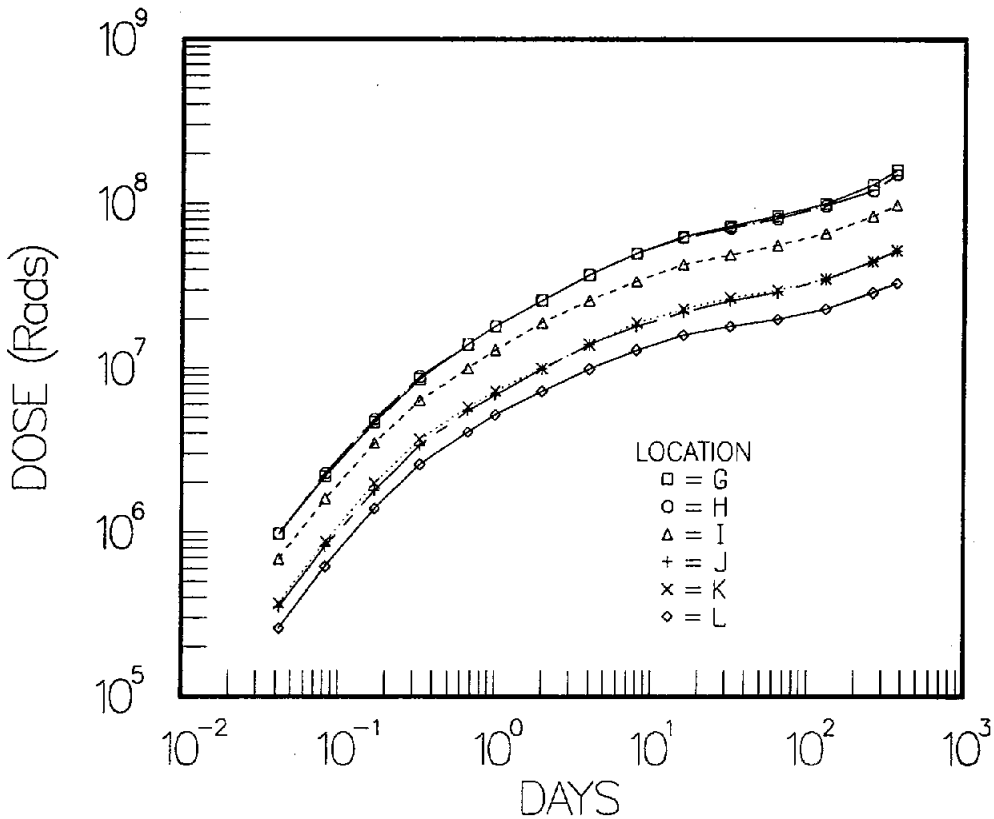
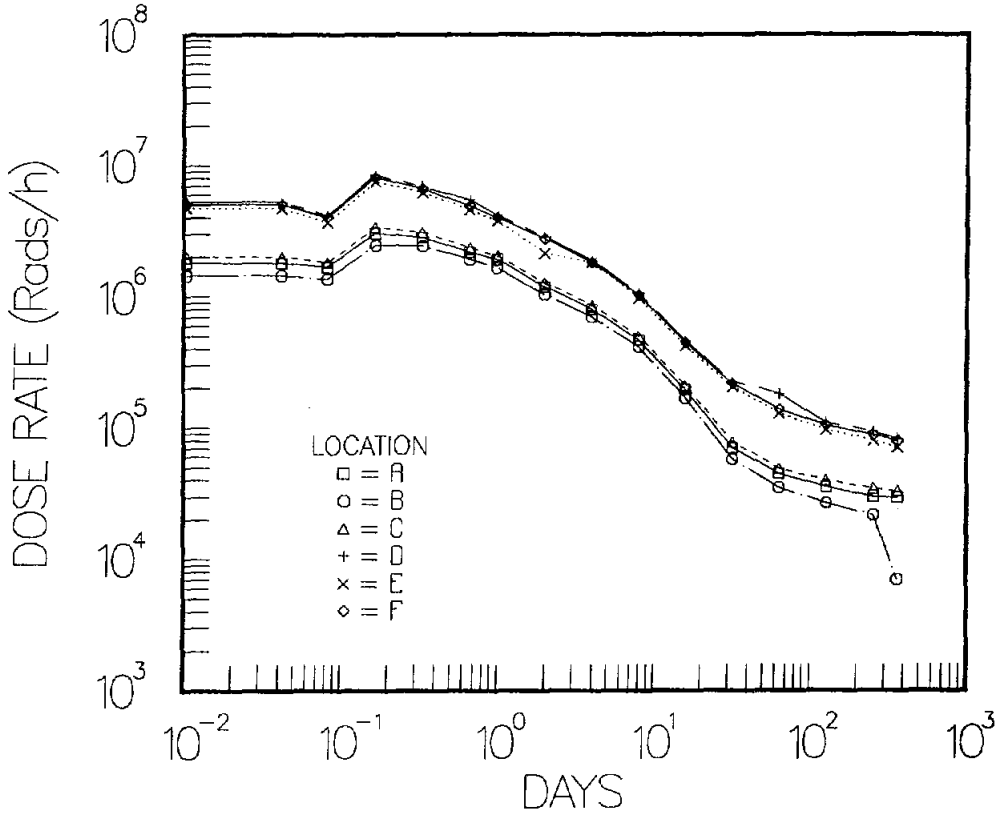


Figure B.102. Peach Bottom Case 1 Drywell Total Gamma Dose



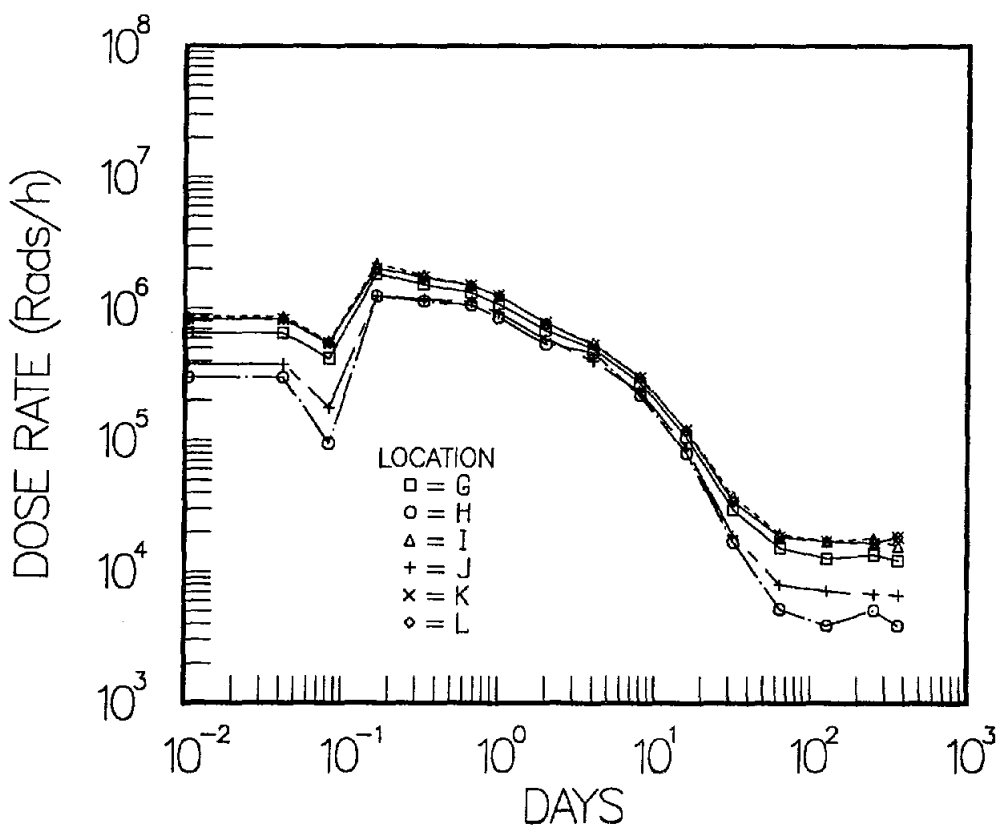
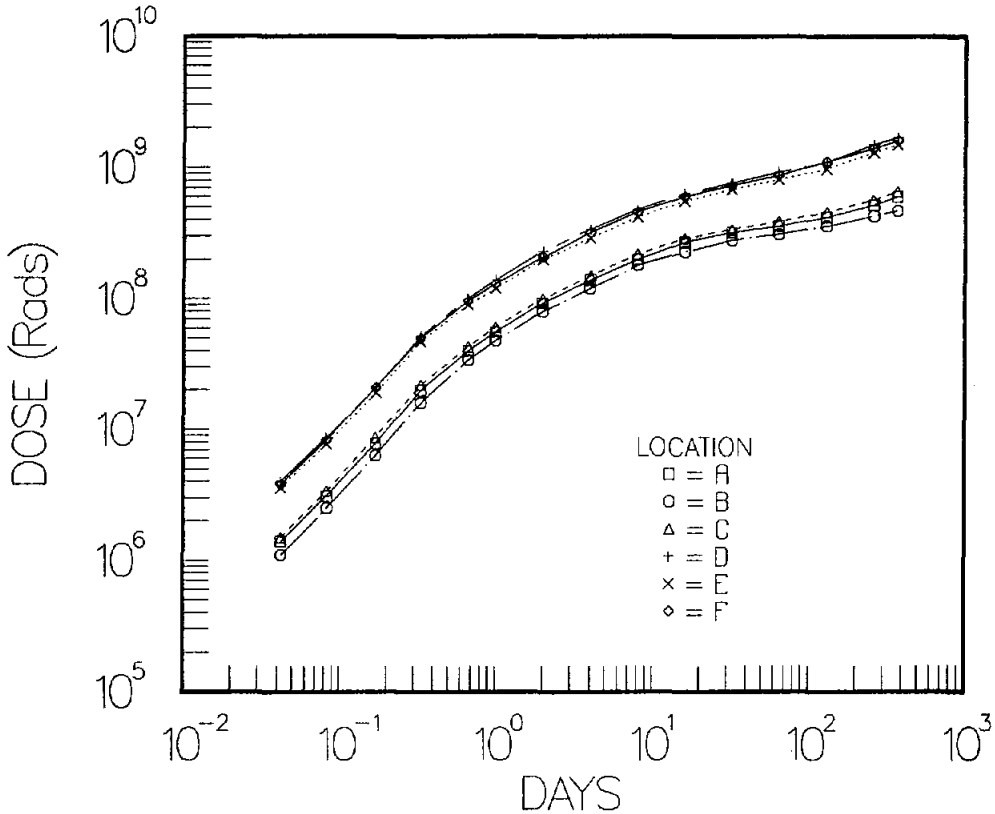


Figure B.103. Peach Bottom Case 1 Drywell Beta Dose Rates



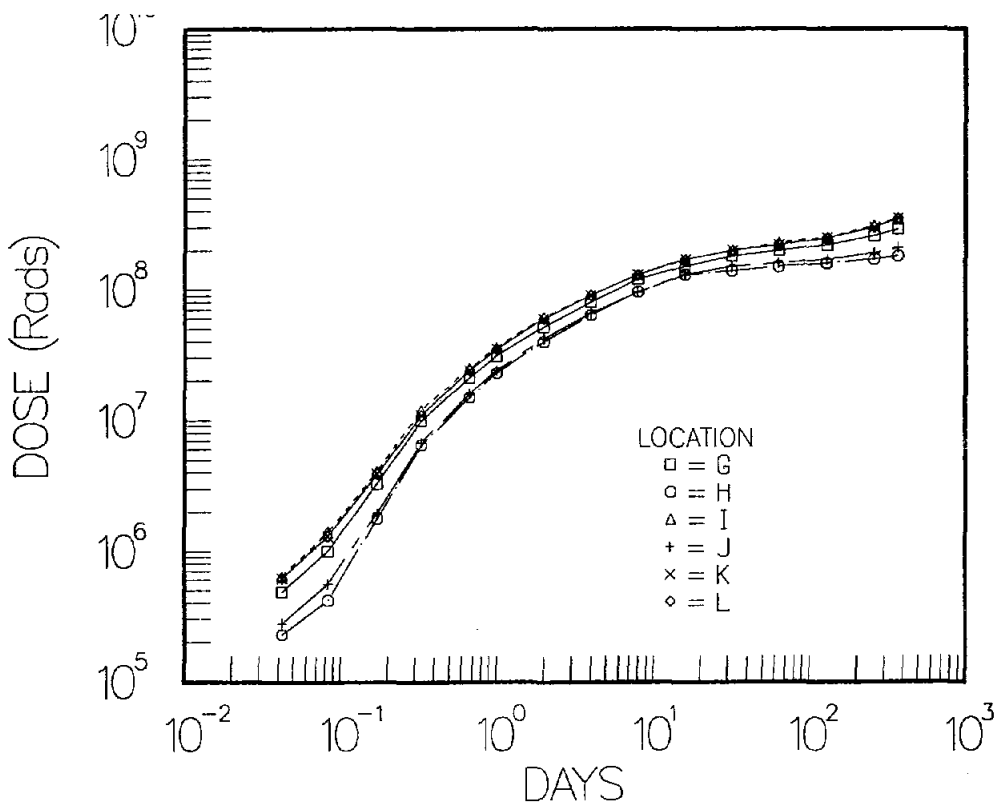


Figure B.104. Peach Bottom Case 1 Drywell Total Beta Dose

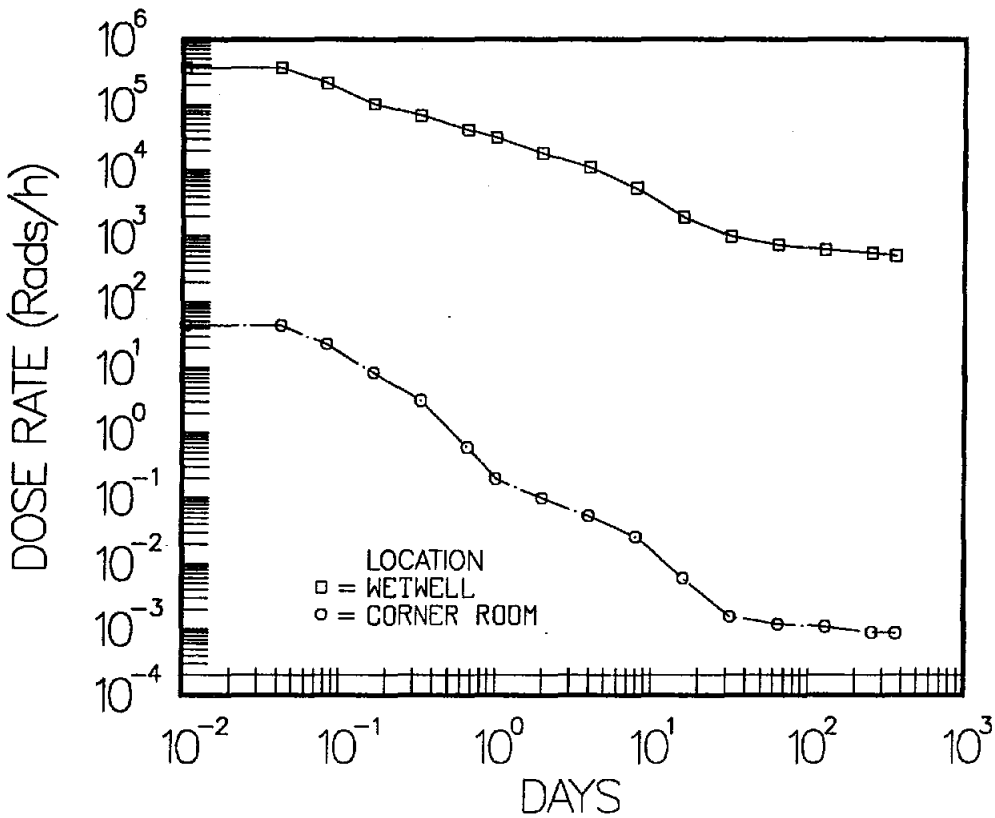


Figure B.105. Peach Bottom Case 1 Wetwell Gamma Dose Rate

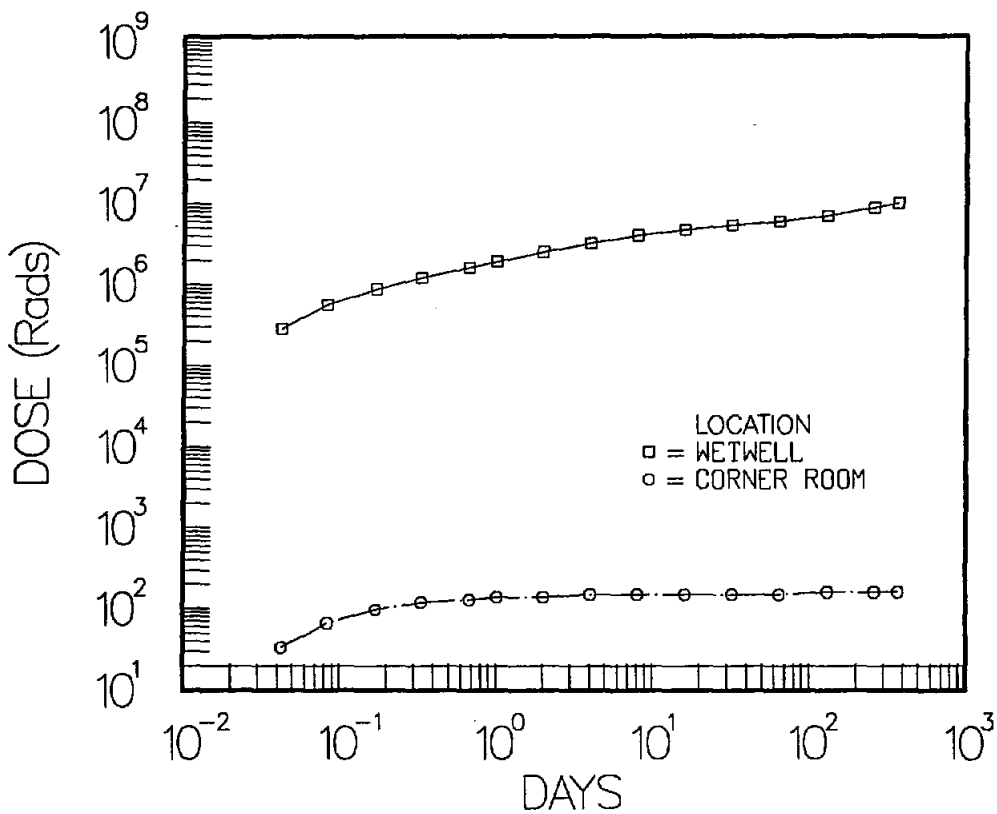
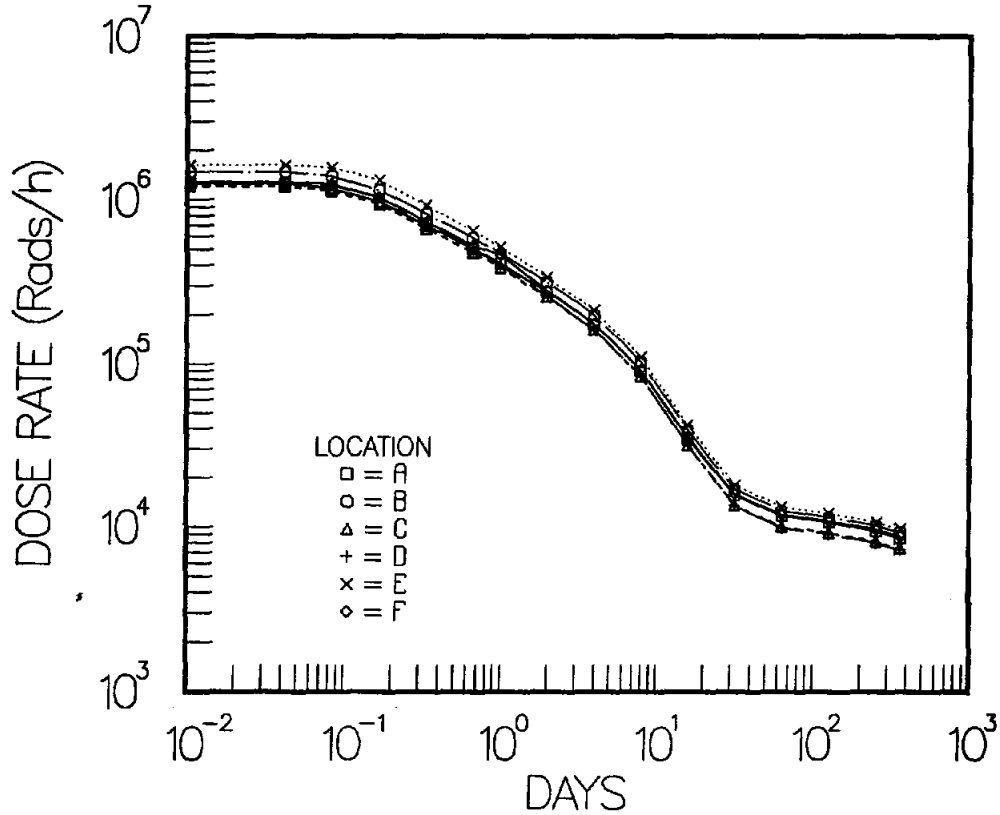


Figure B.106. Peach Bottom Case 1 Wetwell Total Gamma Dose



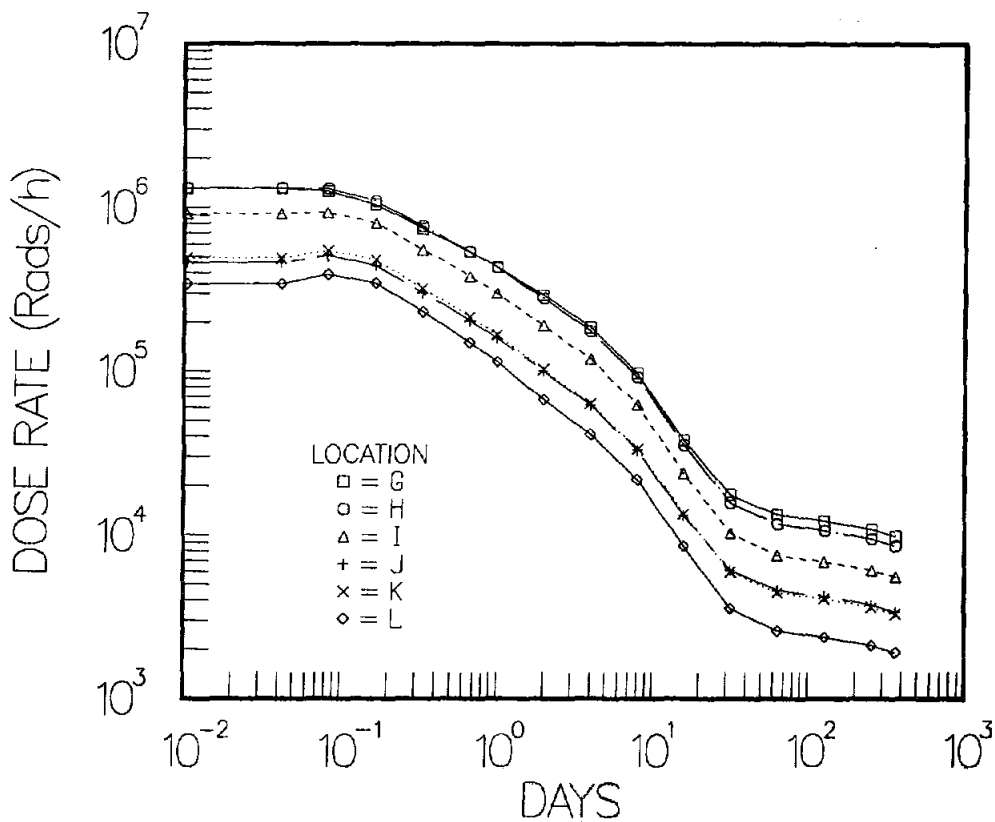
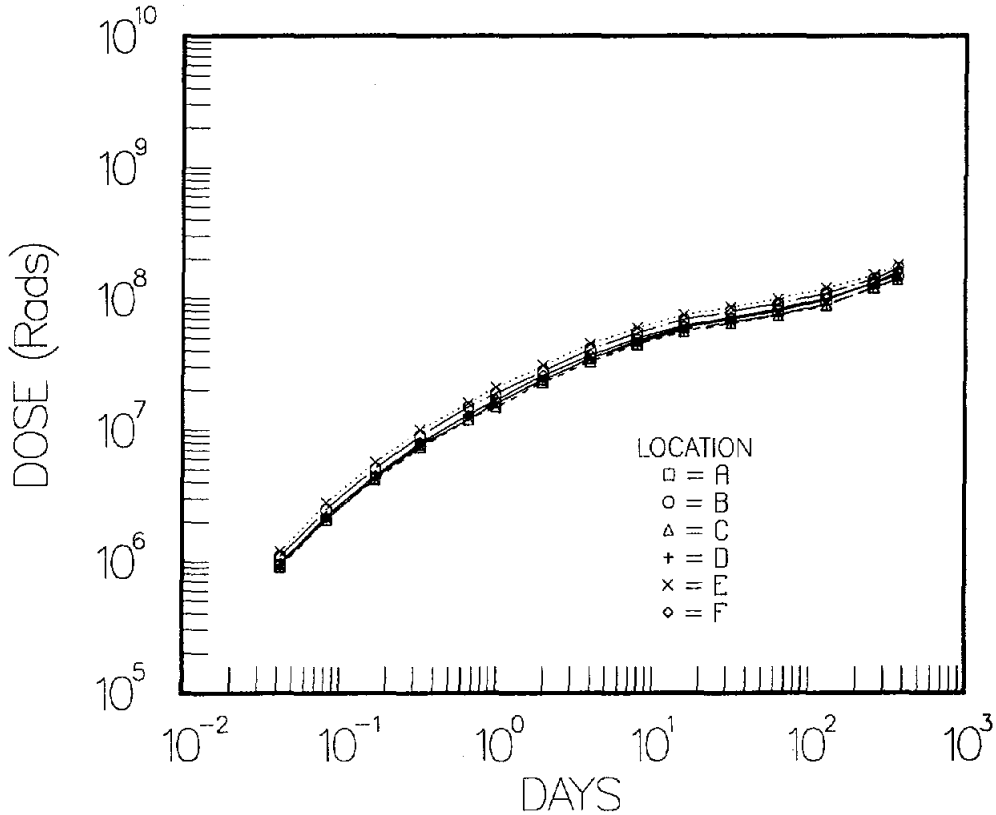


Figure B.107. Peach Bottom Case 2 Drywell Gamma Dose Rate



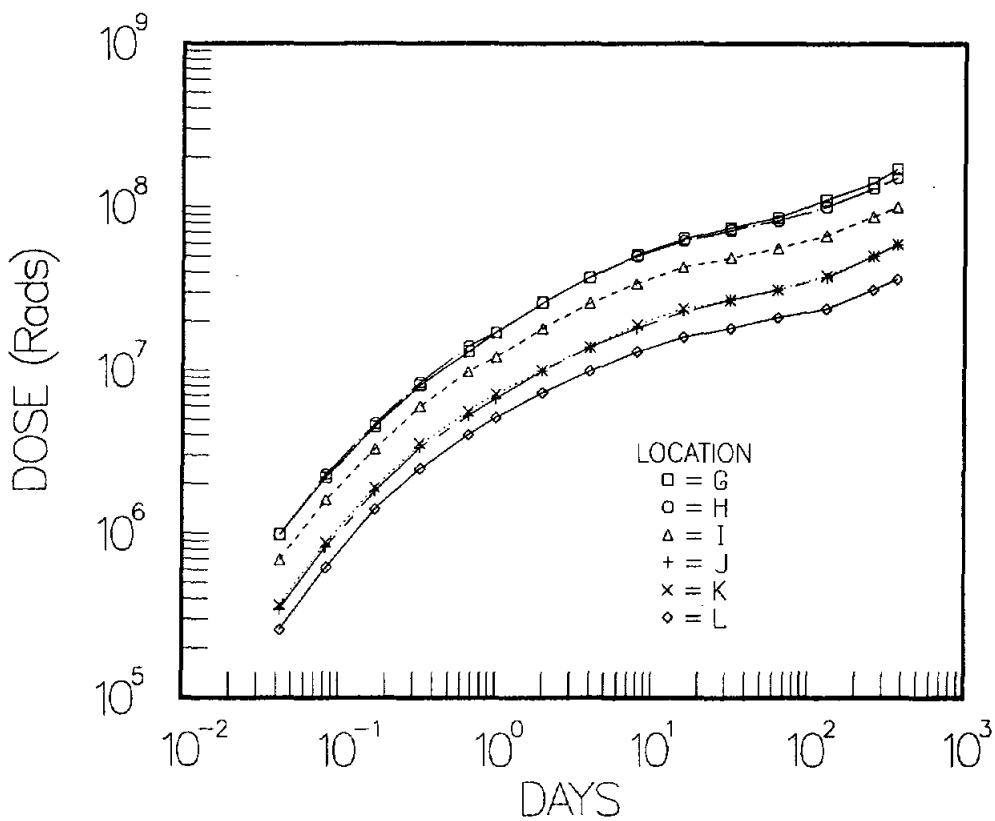
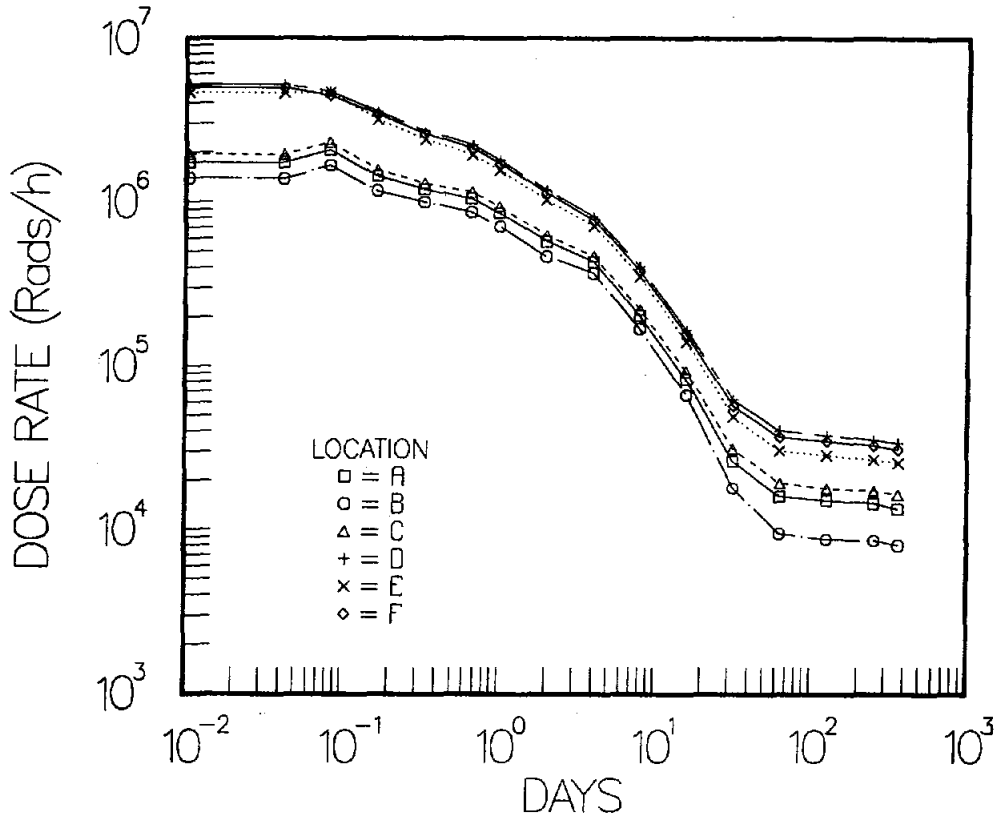


Figure B.108. Peach Bottom Case 2 Drywell Total Gamma Dose



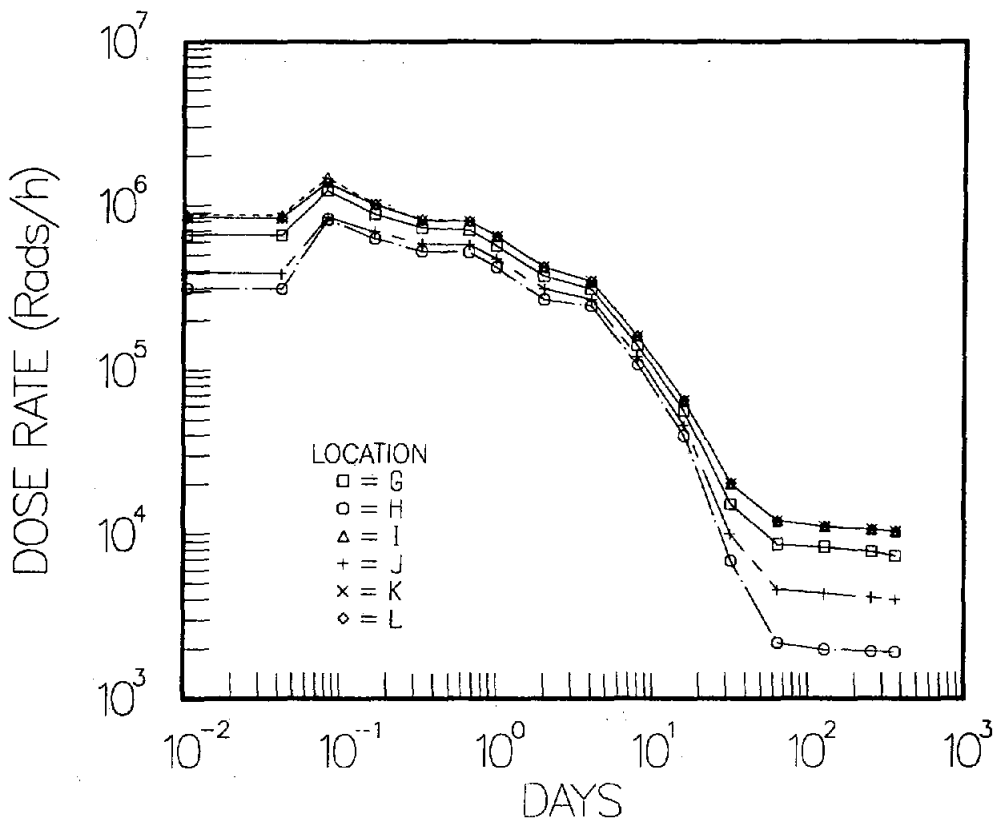
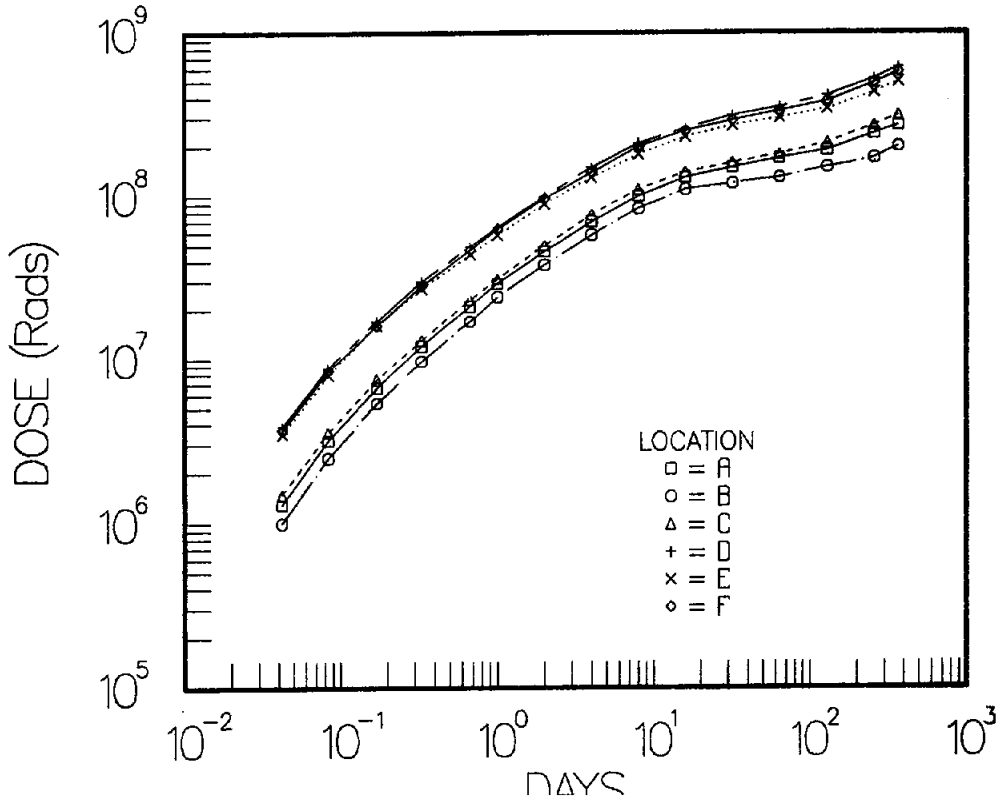


Figure B.109. Peach Bottom Case 2 Drywell Beta Dose Rate



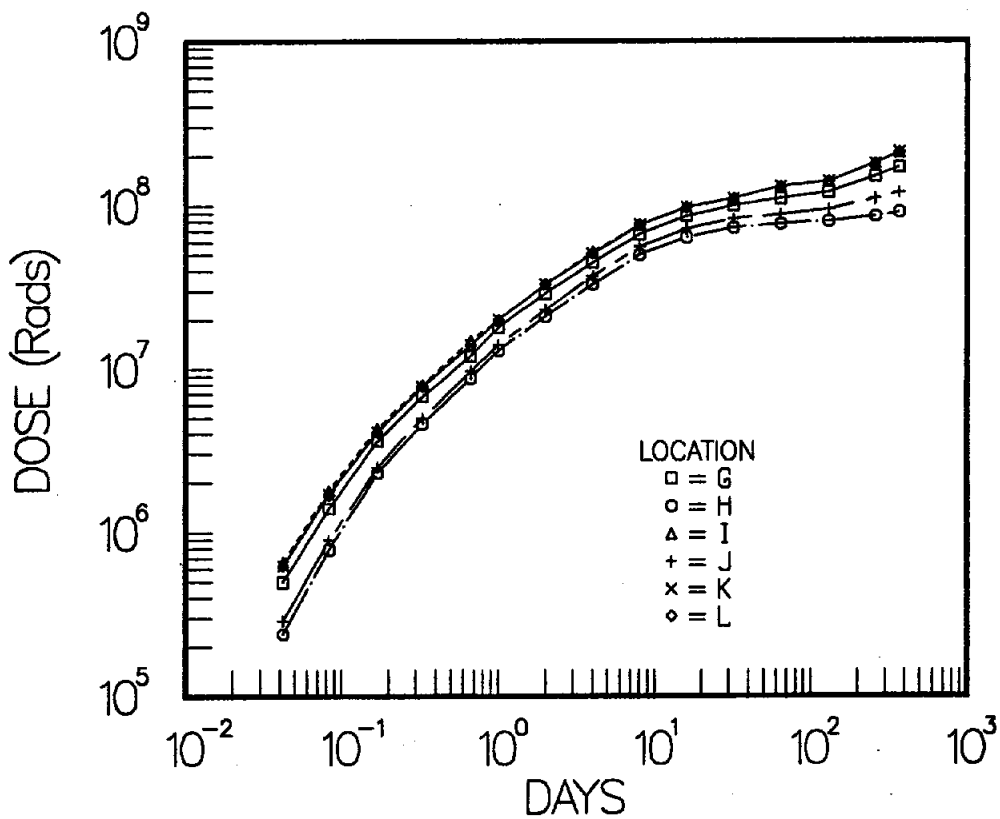


Figure B.110. Peach Bottom Case 2 Drywell Total Beta Dose

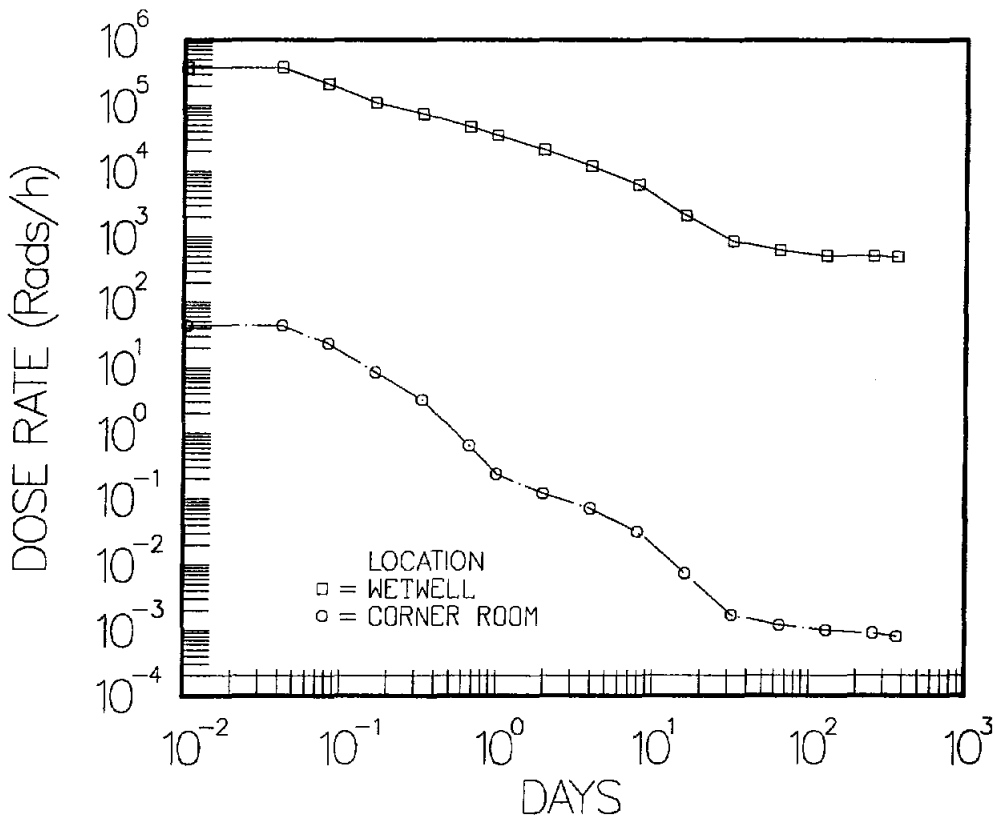


Figure B.111. Peach Bottom Case 2 Wetwell Gamma Dose Rates

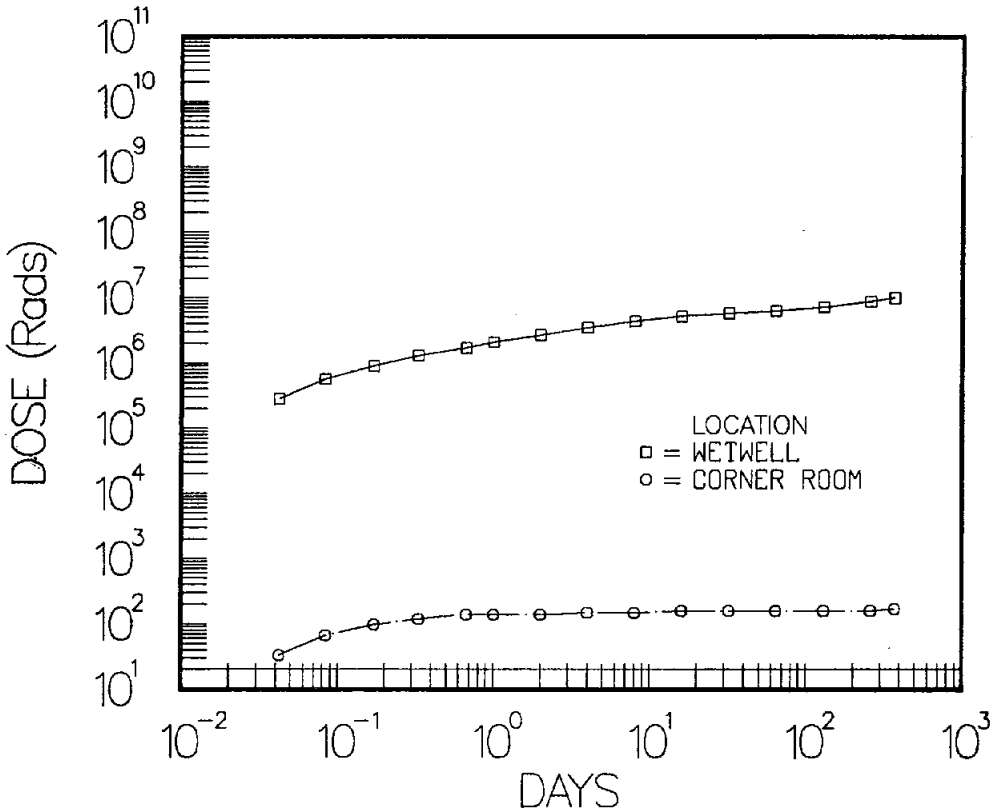
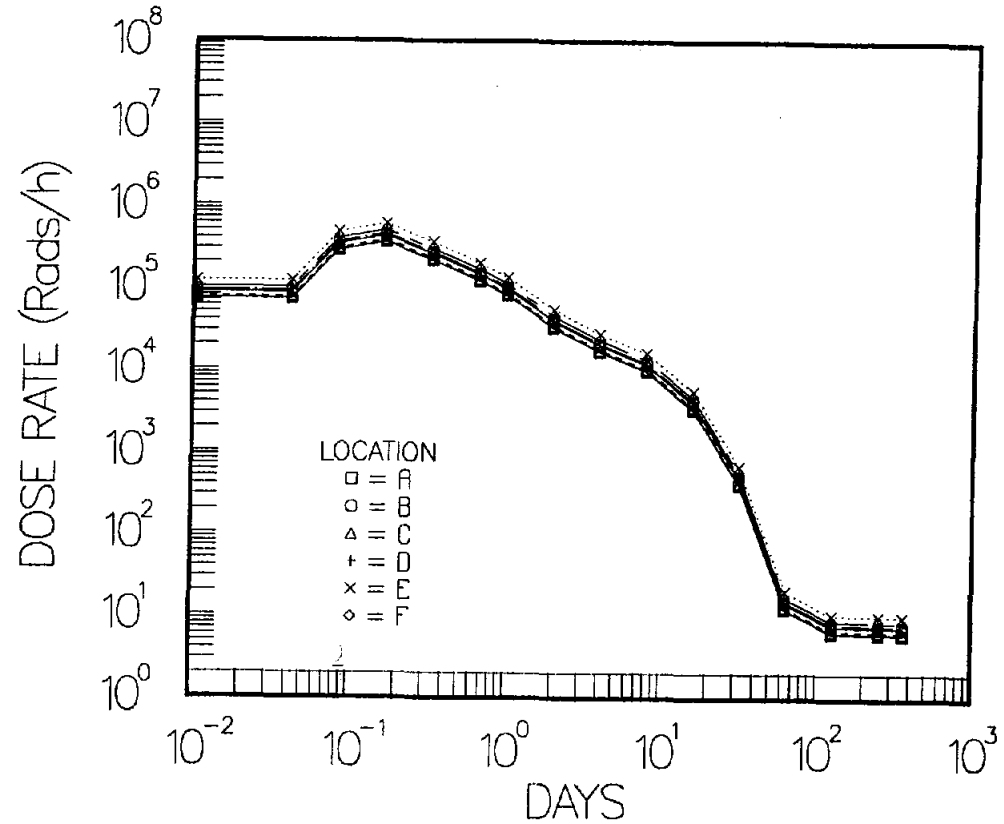


Figure B.112. Peach Bottom Case 2 Wetwell Total Gamma Doses



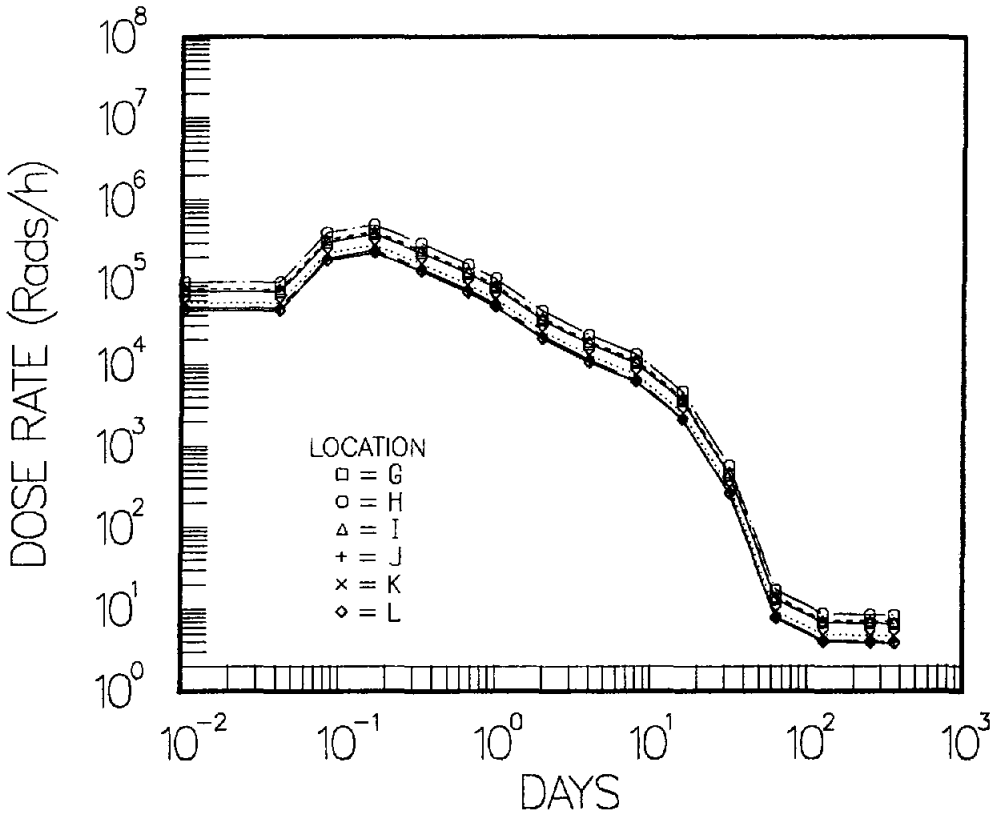
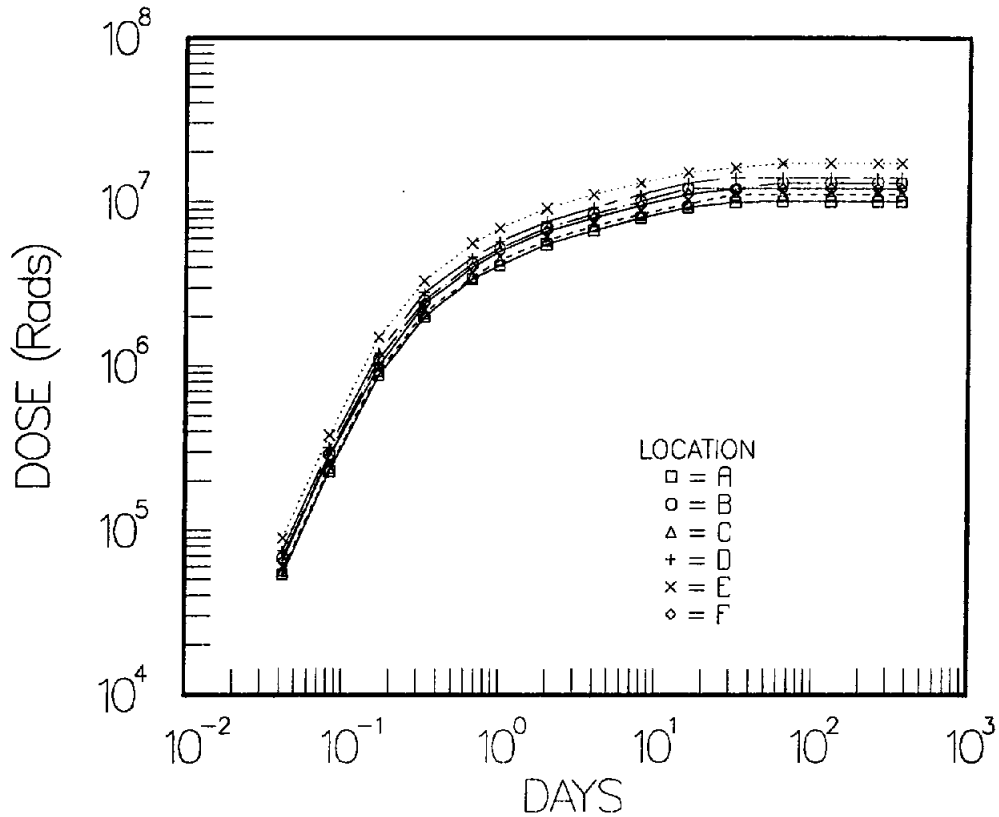


Figure B.113. Peach Bottom Case 3 Drywell Gamma Dose Rates



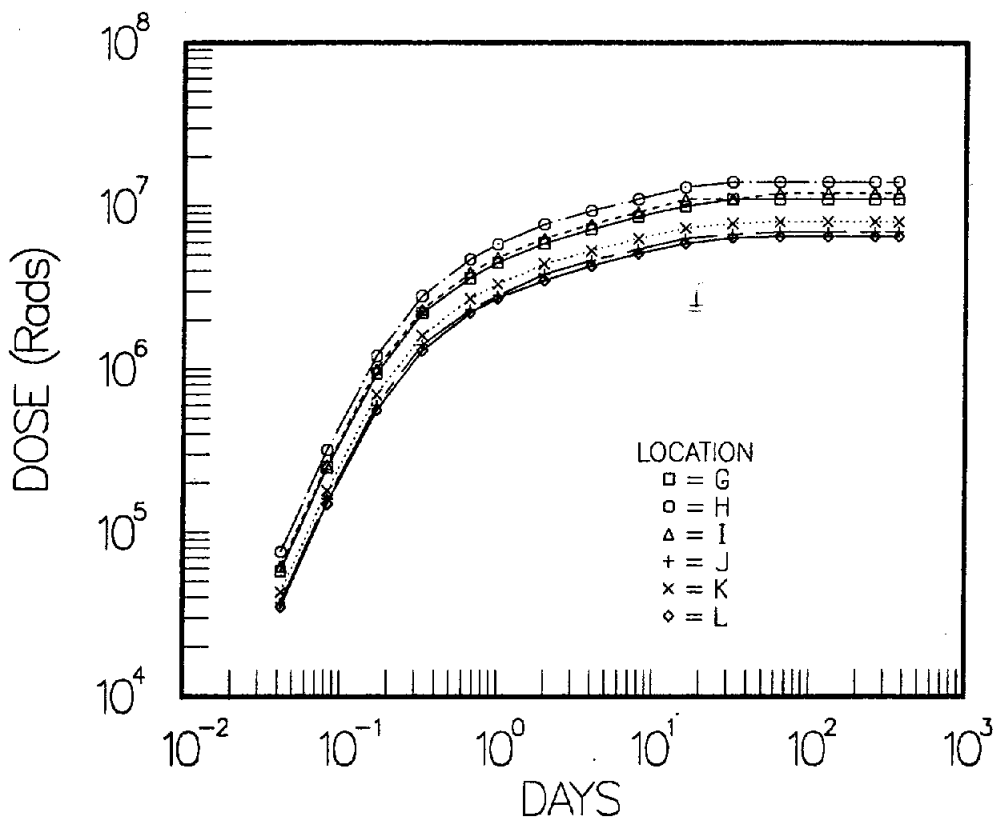


Figure B.114. Peach Bottom Case 3 Drywell Total Gamma Dose

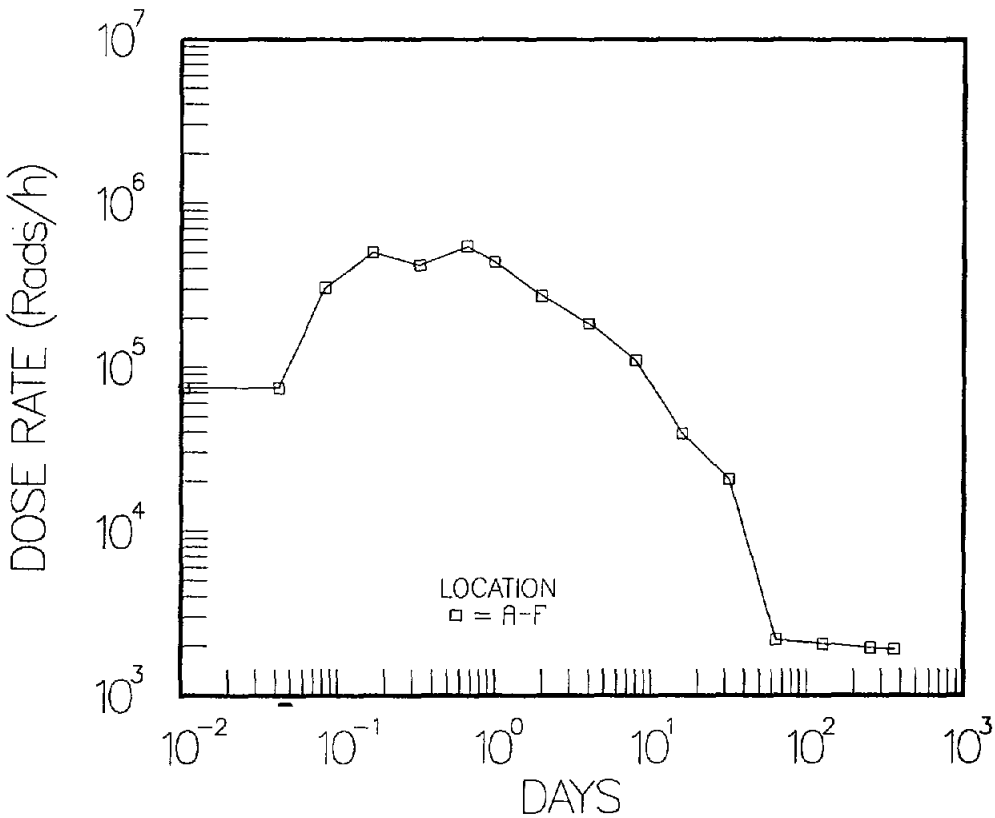


Figure B.115. Peach Bottom Case 3 Drywell Beta Dose Rates

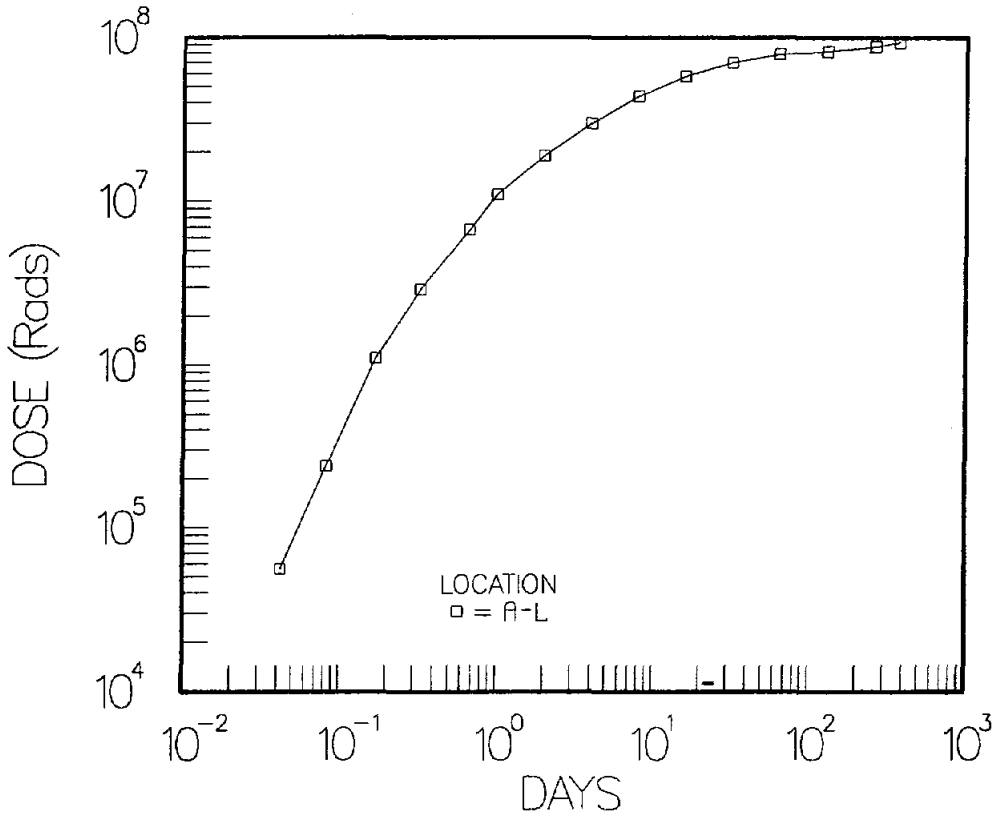


Figure B.116. Peach Bottom Case 3 Drywell Total Beta Dose

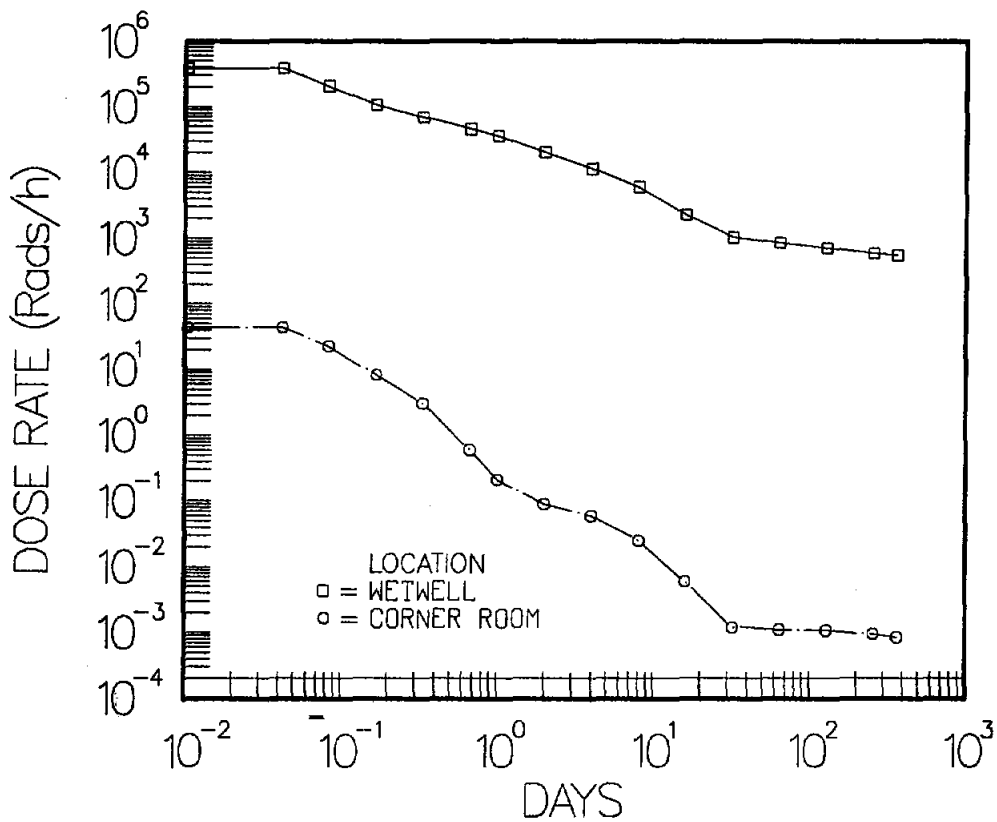


Figure B.117. Peach Bottom Case 3 Wetwell Gamma Dose Rate

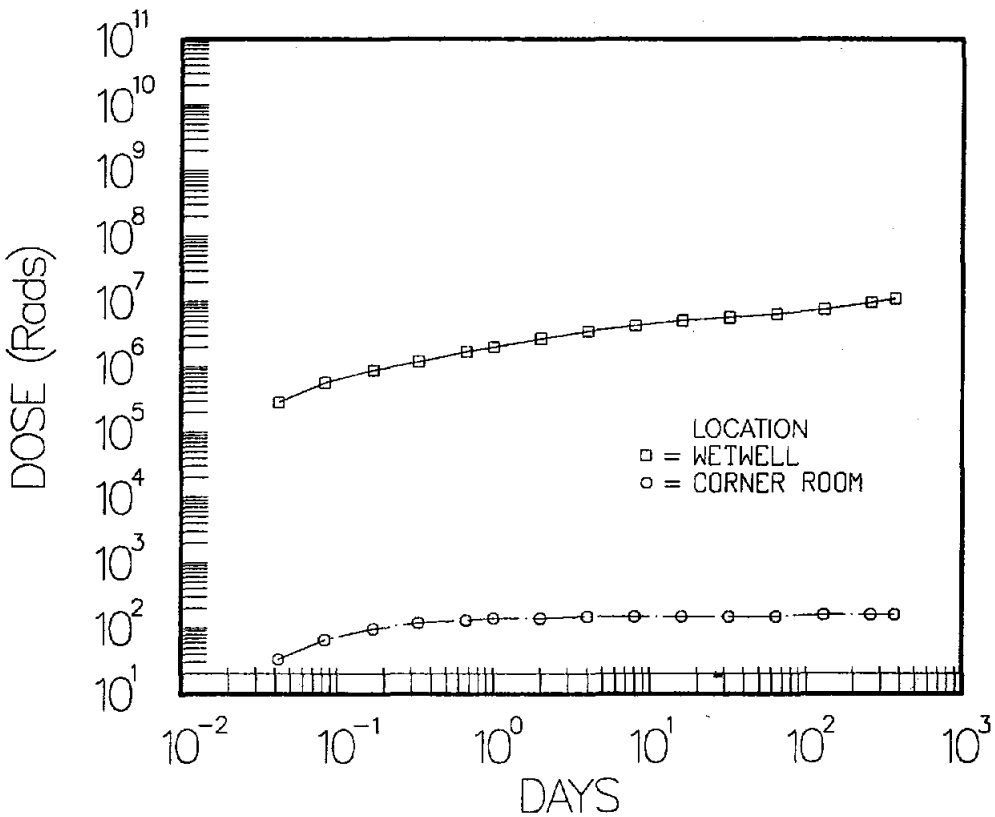


Figure B.118. Peach Bottom Case 3 Wetwell Total Gamma Dose

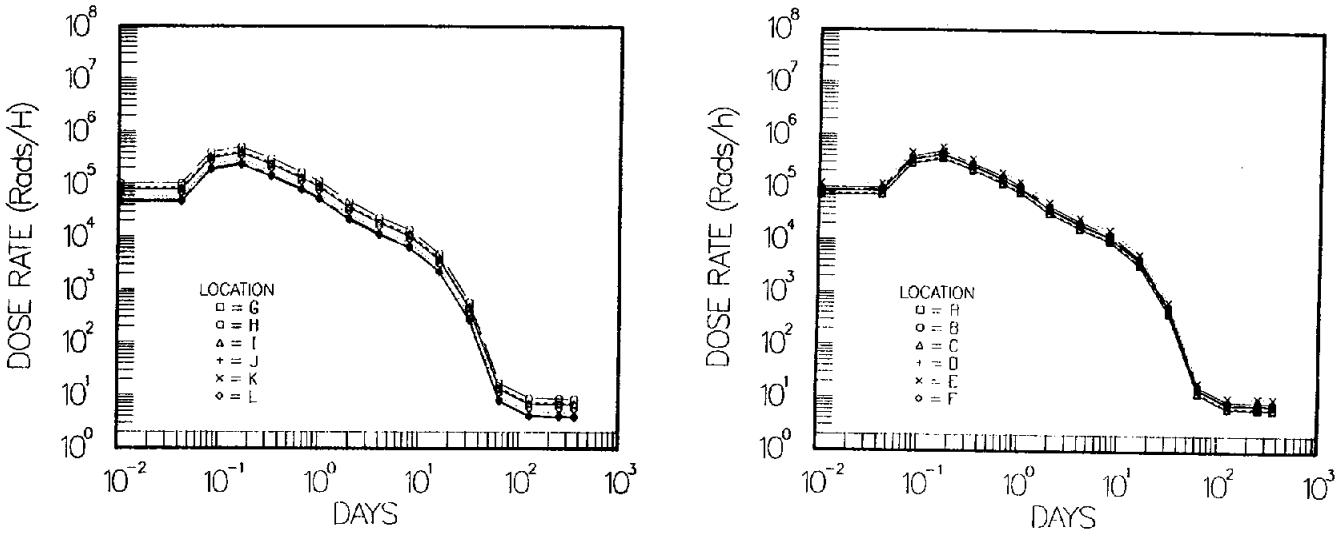


Figure B.119. Peach Bottom Case 4 Drywell Gamma Dose Rate

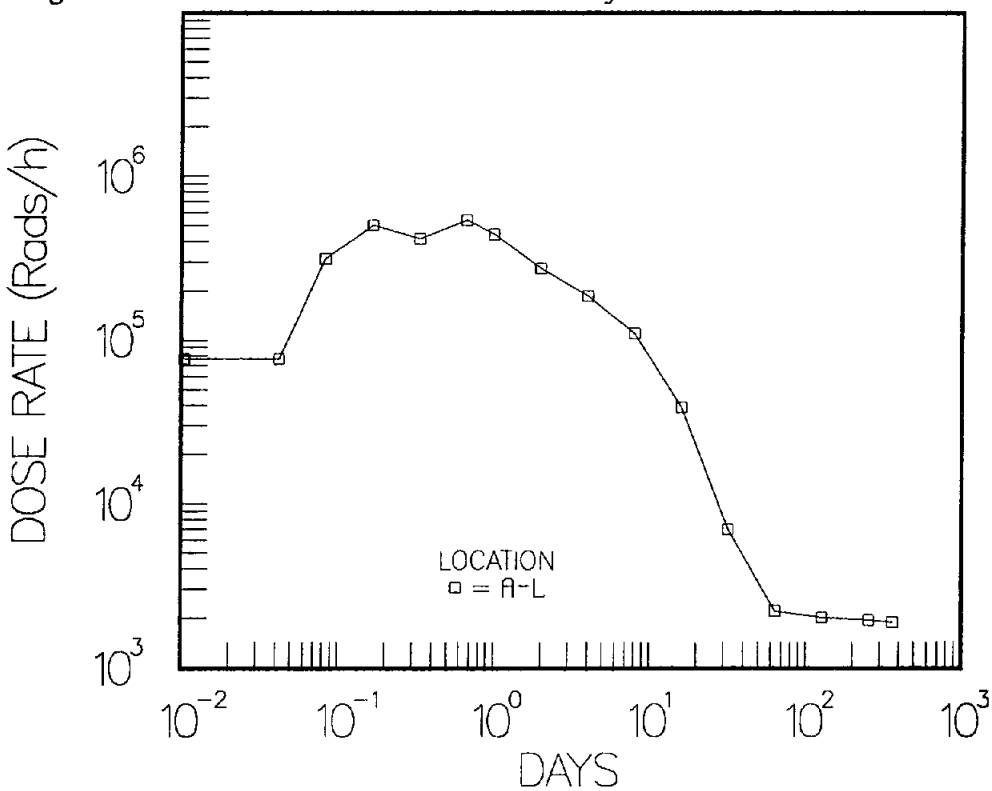


Figure B.120. Peach Bottom Case 4 Drywell Beta Dose Rate

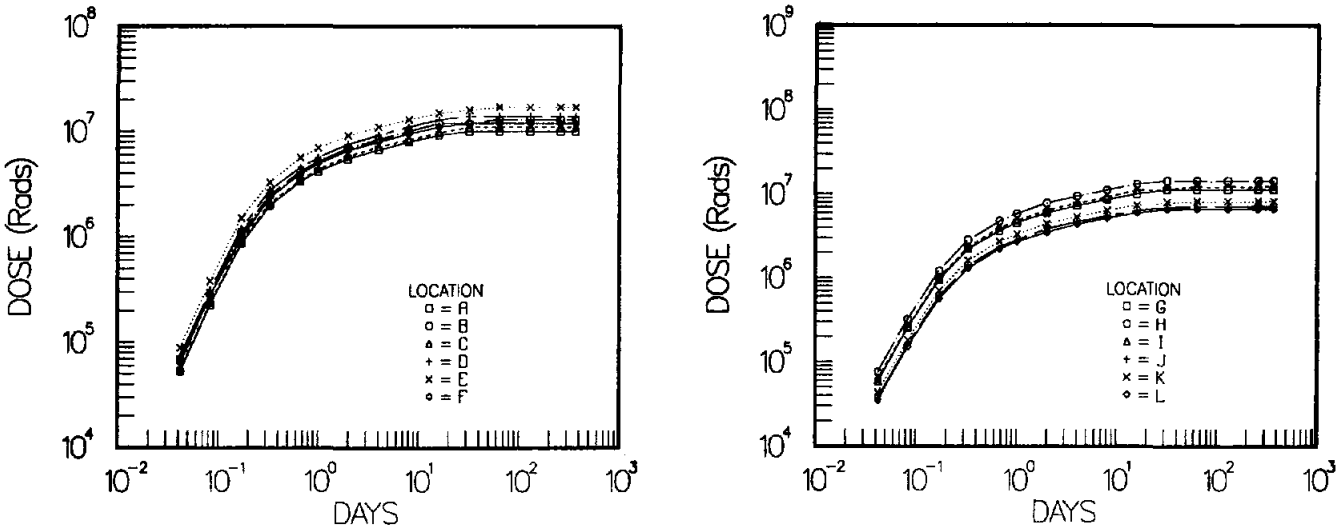


Figure B.121. Peach Bottom Case 4 Drywell Total Gamma Dose

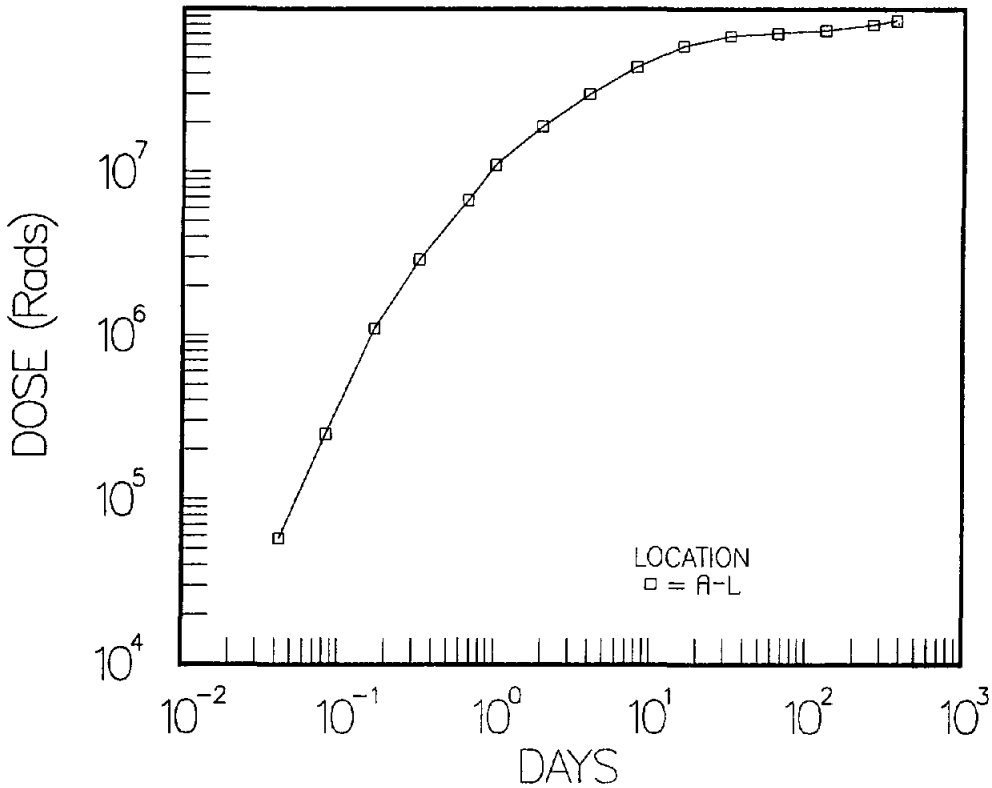


Figure B.122. Peach Bottom Case 4 Drywell Total Beta Dose

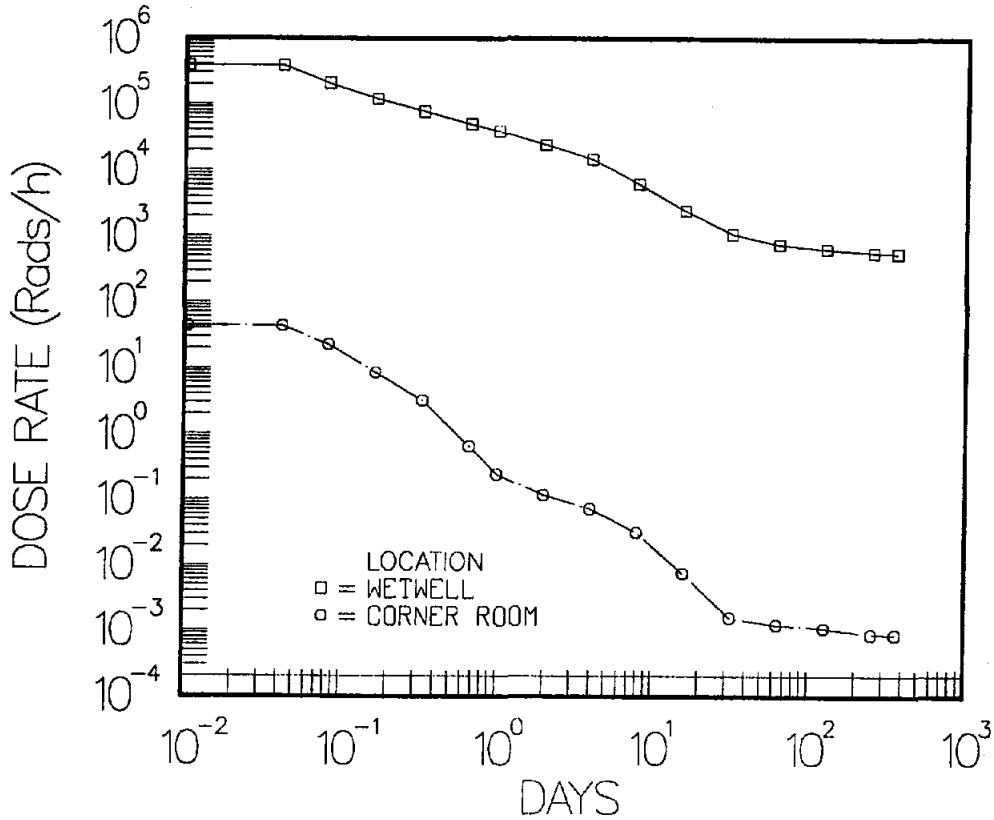


Figure B.123. Peach Bottom Case 4 Wetwell Gamma Dose Rate

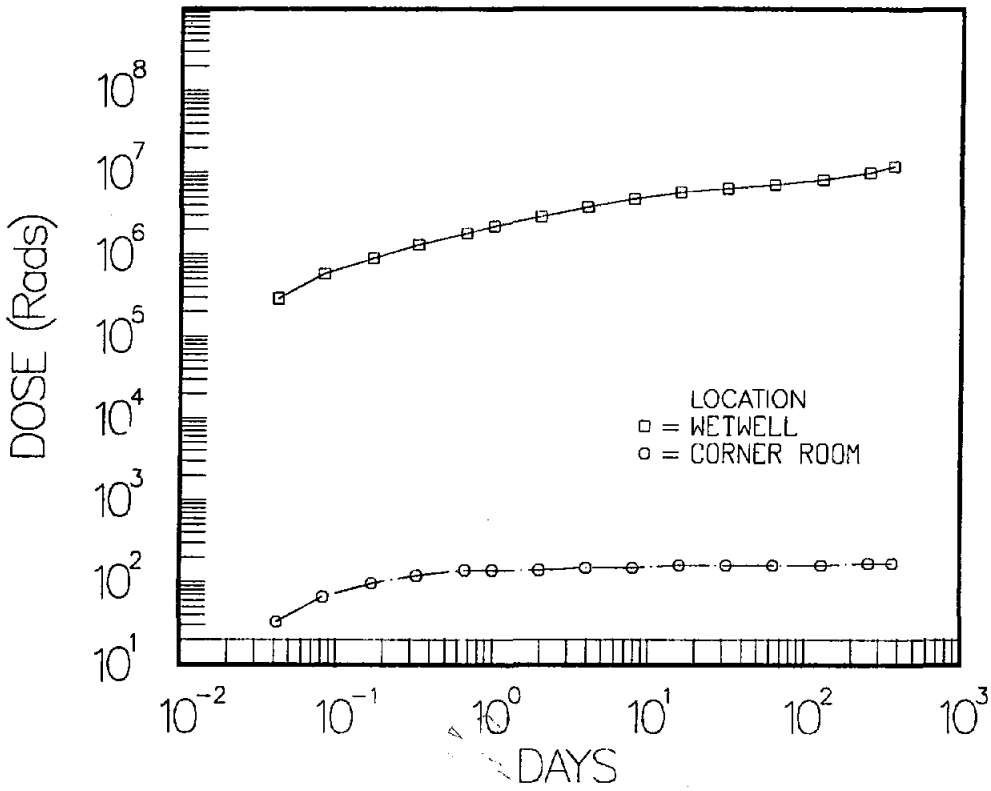


Figure B.124. Peach Bottom Case 4 Wetwell Total Gamma Dose

APPENDIX C

AIRBORNE, WALL, FLOOR, AND SUMP CONTRIBUTIONS TO DOSE RATES FOR SELECTED CONTAINMENT LOCATIONS

Table C.1

Surry Case 1 Basement Gamma Dose Rates

	A			F		
	a	f	w	a	f	w
1h	7.77e5	3.09e5	2.21e4	5.97e5	2.12e5	5.98e4
2h	3.09e5	7.17e5	2.93e4	2.12e5	4.87e5	1.10e5
4h	1.91e5	7.11e5	2.78e4	1.31e5	4.82e5	2.23e5
8h	5.27e4	7.07e5	2.23e4	3.63e4	4.8e5	7.87e4
16h	2.25e4	5.74e5	1.75e4	1.55e4	3.89e5	6.45e4
1d	1.42e4	4.94e5	1.58e4	9.81e3	3.35e5	5.52e4
2d	5.91e3	3.71e5	1.11e4	4.07e3	2.52e5	3.99e4
4d	3.06e3	2.58e5	6.94e3	2.10e3	1.75e5	2.69e4
8d	1.79e3	1.53e5	5.22e3	1.23e3	1.04e5	1.58e4
16d	6.22e2	8.01e4	1.88e3	4.28e2	5.43e4	6.77e3
32d	7.60e1	4.51e4	9.24e2	5.24e1	3.06e4	3.55e3
64d	2.14e0	2.92e4	7.98e2	1.48e0	1.98e4	2.40e3
128d	1.04e0	2.06e4	5.99e2	7.15e-1	1.40e4	1.90e3
256d	1.01e0	1.39e4	4.99e2	6.99e-1	9.48e3	1.42e3
1y	9.95e-1	1.16e4	2.99e2	6.86e-1	7.9e3	1.26e3

Capital letters refer to dose locations.

a - airborne contribution
f - floor contribution
w - wall contribution
h - hour(s)
d - day(s)
y - year
These abbreviations apply to all Appendix C tables.

Table C.2

Surry Case 1 Basement Beta Dose Rates

	A			F			F
	a	f	w	a	f	w	w'
1h	1.25e6	5.35e5	1.19e5	1.25e6	5.35e5	2.71e6	4.68e5
2h	6.74e5	1.03e6	1.51e5	6.74e5	1.03e6	4.20e6	5.36e5
4h	5.58e5	1.28e6	8.98e4	5.58e5	1.28e6	3.37e6	2.96e5
8h	1.84e5	1.36e6	1.0e5	1.84e5	1.36e6	3.78e6	4.28e5
16h	1.2e5	1.07e6	8.36e4	1.20e5	1.07e6	3.15e6	3.28e5
1d	9.99e4	8.11e5	6.54e4	9.99e4	8.11e5	2.72e6	2.81e5
2d	6.06e4	5.80e5	4.68e4	6.06e4	5.80e5	1.97e6	2.23e5
4d	4.24e4	5.07e5	3.17e4	4.24e4	5.07e5	1.45e6	1.42e5
8d	2.52e4	3.77e5	2.31e4	2.52e4	3.77e5	9.94e5	9.22e4
16d	9.54e3	2.66e5	1.39e4	9.54e3	2.66e5	6.13e5	6.02e4
32d	1.57e3	2.14e5	1.04e4	1.57e3	2.14e5	3.87e5	4.38e4
64d							
128d	4.09e2	8.65e4	4.42e3	4.09e2	8.65e4	1.57e5	1.68e4
256d	4.03e2	4.76e4	2.71e3	4.03e2	4.76e4	1.04e5	8.26e3
1y	3.99e2	3.37e4	2.21e3	3.99e2	3.37e4	8.89e4	6.95e3

Table C.3

Surry Case 1 Annulus Gamma Dose Rates

	A			C			E		
	a	f	w	a	f	w	a	f	w
1h	5.94e5	7.46e4	1.31e5	4.90e5	9.27e3	1.64e5	8.85e5	1.18e3	3.24e5
2h	2.25e5	1.74e5	1.78e5	1.87e5	2.16e4	1.80e5	3.39e5	9.11e3	4.38e5
4h	1.42e5	1.72e5	1.81e5	1.17e5	2.14e4	1.97e5	2.12e5	2.74e3	3.74e5
8h	3.91e4	1.71e5	1.27e5	3.23e4	2.13e4	1.64e5	5.84e4	2.73e3	3.23e5
16h	1.67e4	1.39e5	1.02e5	1.32e4	1.73e4	1.32e5	2.50e4	2.22e3	2.60e5
1d	1.06e4	1.19e5	8.87e4	8.72e3	1.49e4	1.13e5	1.58e4	1.91e3	2.23e5
2d	4.38e3	8.98e4	6.53e4	3.62e3	1.12e4	8.37e4	6.55e3	1.44e3	1.67e5
4d	2.28e3	6.24e4	4.39e4	1.88e3	7.80e3	5.64e4	3.39e3	9.90e2	1.11e5
8d	1.56e3	3.72e4	2.40e4	1.09e3	4.65e3	3.11e4	1.98e3	5.96e2	6.10e4
16d	4.61e2	1.93e4	1.09e4	3.81e2	2.42e3	1.32e4	6.89e2	3.10e2	2.77e4
32d	5.71e1	1.09e4	5.7e3	4.66e1	1.36e3	7.27e3	8.42e1	1.74e2	1.43e4
64d	1.6e0	7.08e3	3.81e3	1.30e0	8.84e2	4.99e3	2.4e0	1.13e2	9.81e3
128d	7.7e-1	4.99e3	3.03e3	6.4e-1	6.25e2	3.90e3	1.15e0	8.01e1	7.32e3
256d	7.5e-1	3.38e3	2.33e3	6.2e-1	4.23e2	3.02e3	1.12e0	5.42e1	5.95e3
1y	7.4e-1	2.81e3	2.07e3	6.1e-1	3.52e2	2.63e3	1.1e0	4.52e1	5.25e3

Table C.4

Surry Case 1 Annulus Beta Dose Rates

	A			C			E		
	a	f	w	a	f	w	a	f	w
1h	2.14e6	5.36e5	5.64e5	2.14e6	-	5.64e5	2.14e6	-	5.64e5
2h	1.11e6	1.03e6	7.38e5	1.11e6	-	7.38e5	1.11e6	-	7.38e5
4h	9.41e5	1.29e6	3.39e5	9.41e5	-	3.39e5	9.41e5	-	3.39e5
8h	3.65e5	1.36e6	5.23e5	3.65e5	-	5.23e5	3.65e5	-	5.23e5
16h	2.33e5	1.07e6	3.68e5	2.33e5	-	3.68e5	2.33e5	-	3.68e5
1d	1.87e5	8.13e5	2.91e5	1.87e5	-	2.91e5	1.87e5	-	2.91e5
2d	1.14e5	5.80e5	2.08e5	1.14e5	-	2.08e5	1.14e5	-	2.08e5
4d	7.75e4	5.07e5	1.35e5	7.75e5	-	1.35e5	7.75e4	-	1.35e5
8d	4.72e4	3.75e5	1.01e5	4.72e4	-	1.01e5	4.72e4	-	1.01e5
16d	1.62e4	2.66e5	6.21e4	1.62e4	-	6.21e4	1.62e4	-	6.21e4
32d	2.92e3	2.14e5	4.43e4	2.92e3	-	4.43e4	2.92e3	-	4.43e4
64d									
128d	7.82e2	8.65e4	1.84e4	7.82e2	-	1.84e4	7.82e2	-	1.84e4
256d	7.45e2	4.76e4	1.92e3	7.45e2	-	1.92e3	7.45e2	-	1.92e3
1y	7.22e2	3.37e4	7.05e2	7.22e2	-	7.05e2	7.22e2	-	7.05e2

Table C.5

Surry Case 1 Dome Gamma Dose Rates

	H			I			J		
	a	f	w	a	f	w	a	f	w
1h	1.20e6	6.47e4	4.08e5	1.84e6	9.72e4	2.34e5	1.72e6	4.42e4	3.48e5
2h	4.58e5	1.51e5	4.29e5	7.03e5	2.26e5	3.24e5	6.62e5	1.03e5	4.82e5
4h	2.86e5	1.50e5	4.76e5	4.4e5	2.25e5	2.68e5	4.13e5	1.02e5	4.00e5
8h	7.89e4	1.49e5	4.06e5	1.21e5	2.23e5	2.33e5	1.14e5	1.01e5	3.47e5
16h	3.38e4	1.21e5	3.27e5	5.19e4	1.81e5	1.88e5	4.88e4	8.28e4	2.79e5
1d	2.13e4	1.04e5	2.82e5	3.27e4	1.56e5	1.62e5	3.08e4	7.14e4	2.40e5
2d	8.86e3	7.84e4	2.09e5	1.36e4	1.17e5	1.20e5	1.28e4	5.35e4	1.78e5
4d	4.58e3	5.45e4	1.40e5	7.05e3	8.17e4	8.03e4	6.63e3	3.72e4	1.20e5
8d	1.42e3	3.25e4	7.7e4	2.67e3	4.87e4	4.41e4	3.87e3	2.22e4	6.57e4
16d	9.31e2	1.69e4	3.47e4	1.43e3	2.53e4	2.0e4	1.35e3	1.15e4	2.98e4
32d	1.14e2	9.52e3	1.81e4	1.76e2	1.42e4	1.05e4	1.65e2	6.50e3	1.54e4
64d	3.2e0	6.17e3	1.24e4	4.9e0	9.26e3	7.1e3	4.6e0	4.22e3	1.05e4
128d	9.3e-1	4.36e3	9.73e3	1.26e0	6.54e3	5.6e3	1.9e0	2.98e3	8.28e3
256d	1.52e0	2.95e3	7.45e3	2.34e0	4.42e3	4.27e3	2.2e0	2.02e3	6.43e3
1y	1.49e0	2.46e3	6.5e3	2.29e0	3.69e3	3.70e3	2.15e0	1.68e3	5.57e3

Table C.6

Surry Case 1 Dome Beta Dose Rates

	H			I			J		
	a	f	w	a	f	w	a	f	w
1h	5.56e6	8.27e3	4.04e5	5.56e6	8.27e3	6.3e2	5.56e5	-	3.26e5
2h	3.01e6	5.24e4	5.76e5	3.01e6	5.24e4	4.3e0	3.01e6	-	4.37e5
4h	2.37e6	1.69e4	4.95e5	2.37e6	1.69e4	7.07e2	2.37e6	-	2.94E5
8h	8.77e5	1.99e4	5.50e5	8.77e5	1.99e4	9.52e2	8.77e5	-	3.65e5
16h	5.63e5	2.31e3	4.51e5	5.63e5	2.31e3	9.6e1	5.63e5	-	2.81e5
1d	4.51e5	5.18e2	3.61e5	4.51e5	5.18e2	8.4e-1	4.51e5	-	2.39e5
2d	2.71e5	7.24e1	2.82e5	2.71e5	7.24e1	1.16e1	2.71e5	-	1.71e5
4d	1.86e5	7.44e1	2.14e5	1.86e5	7.44e1	-	1.86e5	-	1.22e5
8d	1.12e5	8.97e2	1.46e5	1.12e5	8.97e2	-	1.12e5	-	8.72e4
16d	4.06e4	3.68e2	8.92e4	4.06e4	3.68e2	-	4.06e4	-	5.55e4
32d	7.09e3	3.41e1	5.45e4	7.09e3	3.41e1	-	7.09e3	-	3.58e4
64d									
128d	1.85e3	7.94e1	2.26e4	1.85e3	7.94e1	-	1.85e3	-	1.39e4
256d	1.79e3	1.52e2	1.49e4	1.79e3	1.52e1	-	1.79e3	-	8.91e3
1y	1.73e3	9.7e0	1.24e4	1.73e3	9.70e0	-	1.73e3	-	7.02e3

Table C.7

Surry Case 1 Steam Generator A Cubicle Gamma Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	8.73e5	4.94e4	7.26e4	4.77e5	3.98e4	1.57e5	4.59e5	3.99e4	1.57e5
2h	3.34e5	1.15e5	1.01e5	1.82e5	9.28e4	2.18e5	1.76e5	9.31e4	2.16e5
4h	2.08e5	1.14e5	8.40e4	1.14e5	9.2e4	1.79e5	1.09e5	9.23e4	1.80e5
8h	5.75e4	1.13e5	7.25e4	3.14e4	9.15e4	1.56e5	3.02e4	9.18e4	1.56e5
16h	2.45e4	9.22e4	5.83e4	1.34e4	7.43e4	1.25e5	1.29e4	7.45e4	1.25e5
1d	1.55e4	7.94e4	5.01e4	8.49e3	6.4e4	1.08e5	8.17e3	6.42e4	1.08e5
2d	6.44e3	5.96e4	3.7e4	3.52e3	4.80e4	8.05e4	3.39e3	4.82e4	7.94e4
4d	3.34e3	4.14e4	2.48e4	1.82e3	3.34e4	5.38e4	1.76e3	3.35e4	5.34e4
8d	1.94e3	2.47e4	1.37e4	1.06e3	1.99e4	2.95e4	1.02e3	1.99e4	1.95e4
16d	6.78e2	1.28e4	6.22e3	3.71e2	1.03e4	1.34e4	3.57e2	1.04e4	1.33e4
32d	8.29e1	7.24e3	3.18e3	4.53e1	5.84e3	7.01e3	4.36e1	5.85e3	6.91e3
64d	2.33e0	4.69e3	2.20e3	1.27e0	3.78e3	4.76e3	1.23e0	3.79e3	4.75e3
128d	1.13e0	3.31e3	1.72e3	6.18e-1	2.67e3	3.73e3	5.95-1	2.68e3	3.71e3
256d	1.10e0	2.24e3	1.36e3	6.04e-1	1.80e3	2.88e3	5.82e-1	1.81e3	2.86e3
1y	1.08e0	1.87e3	1.15e3	5.93e-1	1.51e3	2.5e3	5.71e-1	1.51e3	2.49e3

Table C.8

Surry Case 1 Steam Generator A Cubicle Beta Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	8.03e6	2.62e2	4.34e2	8.03e6	7.02e5	7.71e5	8.03e6	5.53e5	7.32e5
2h	4.33e6	6.04e2	5.05e2	4.33e6	1.71e6	1.11e6	4.33e6	1.18e6	1.09e6
4h	3.58e6	7.30e2	4.11e2	3.58e6	2.13e6	1.06e6	3.58e6	1.65e6	1.07e6
8h	1.33e6	8.36e2	3.28e2	1.33e6	2.39e6	9.80e5	1.33e6	1.75e6	8.73e5
16h	8.99e5	7.87e2		8.99e5	2.43e6		8.99e5	1.69e6	
1d	7.09e5	5.87e2	2.24e2	7.09e5	1.77e6	7.14e5	7.09e5	1.24e6	6.33e5
2d	4.20e5	4.60e2	1.39e2	4.20e5	1.28e6	5.31e5	4.20e5	1.00e6	4.81e5
4d	3.01e5	3.50e2		3.01e5	1.00e6		3.01e5	7.98e5	
8d	1.82e5	2.60e2	7.20e1	1.82e5	8.28e5	2.67e5	1.82e5	5.21e5	2.44e5
16d	6.61e4	1.84e2		6.61e4	4.92e5		6.61e4	4.07e5	
32d	1.12e4	1.30e2	3.30e1	1.12e4	3.60e5	1.05e5	1.12e4	2.70e5	9.39e4
64d									
128d	2.90e3	4.70e1	1.40e1	2.90e3	1.31e5	4.11e4	2.90e3	1.15e5	3.49e4
256d									
1y	2.78e3	2.11e1	5.40e0	2.78e3	6.33e4	2.06e4	2.78e3	4.77e4	2.00e4

Table C.9

Surry Case 1 RHR Cubicle Gamma Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	5.49e5	1.08e5	7.30e4	3.40e5	8.25e4	2.08e5	3.73e5	7.86e4	1.51e5
2h	2.40e5	2.53e5	8.70e4	1.75e5	1.93e5	2.02e5	1.92e5	1.83e5	2.15e5
4h	1.50e5	2.51e5	7.40e4	1.09e5	1.91e5	1.68e5	1.20e5	1.82e5	1.74e5
8h	4.13e4	2.49e5	6.97e4	3.02e4	1.90e5	1.45e5	3.31e4	1.81e5	1.51e5
16h	1.76e4	2.02e5	5.24e4	1.29e4	1.54e5	1.17e5	1.41e4	1.47e5	1.21e5
1d	1.11e4	1.74e5	4.49e4	8.16e3	1.33e5	9.98e4	3.93e3	1.26e5	1.05e5
2d	4.62e3	1.30e5	3.44e4	3.39e3	9.98e4	7.38e4	3.71e3	9.50e4	7.83e4
4d	2.40e3	9.10e4	2.26e4	1.75e3	6.93e4	5.0e4	1.92e3	6.6e4	5.21e4
8d	1.39e3	5.42e4	1.23e4	1.02e3	4.13e4	2.77e4	1.12e3	3.93e4	2.86e4
16d	4.87e2	2.82e4	5.51e3	3.56e2	2.15e4	1.24e4	3.90e2	2.05e4	1.29e4
32d	5.95e1	1.59e4	3.04e3	4.36e1	1.21e4	6.56e3	4.77e1	1.15e4	6.75e3
64d	1.67e0	1.03e4	2.00e3	1.22e0	7.86e3	4.44e3	1.34e0	7.49e3	4.61e3
128d	8.12e-1	7.28e3	1.54e3	5.94e-1	5.55e3	3.45e3	6.51e-1	5.27e3	3.60e3
256d	7.94e-1	4.92e3	1.19e3	5.81e-1	3.75e3	2.66e3	6.36e-1	3.57e3	2.77e3
1y	7.78e-1	4.10e3	1.04e3	5.70e-1	3.13e3	2.31e3	6.24e-1	2.98e3	2.42e3

Table C.10

Surry Case 1 RHR Cubicle Beta Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	7.92e6	1.29e3	2.29e2	7.92e6	5.24e5	7.54e5	7.92e6	5.91e5	4.30e5
2h	4.21e6	2.86e3	2.95e2	4.21e6	1.06e6	9.77e5	4.21e6	6.03e5	1.03e6
4h	3.56e6	3.29e3	2.43e2	3.56e6	1.30e6	9.52e5	3.56e6	1.23e6	5.98e5
8h	1.34e6	3.48e3	2.07e2	1.34e6	1.62e6	9.55e5	1.34e6	1.32e6	5.42e5
16h	8.85e5	2.61e3	1.39e2	8.85e5	9.66e5	7.85e5	8.85e5	8.95e5	4.34e5
1d	7.28e5	2.24e3	1.27e2	7.28e5	7.9e5	6.87e5	7.28e5	7.32e5	3.73e5
2d	4.34e5	1.55e3	8.39e1	4.34e5	6.04e5	4.75e5	4.34e5	5.64e5	2.62e5
4d	3.06e5	1.13e3	5.64e1	3.06e5	4.59e5	3.50e5	3.06e5	4.62e5	1.83e5
8d	1.84e5	9.39e2	4.19e1	1.84e5	4.74e5	2.49e5	1.84e5	3.70e5	1.30e5
16d	6.88e4	6.68e2		6.88e4	2.24e5		6.88e4	2.20e5	
32d	1.14e4	5.22e2	2.11e1	1.14e4	1.92e5	9.02e4	1.14e4	2.22e5	5.23e4
64d	3.24e3	3.29e2	1.34e1	3.24e3	1.21e5	5.74e4	3.24e3	1.40e5	3.33e4
128d	2.91e3			2.91e3	3.78e4		2.91e3	1.98e4	
256d	2.86e3	1.14e2	4.08e0	2.86e3	3.77e4	2.41e4	2.86e3	4.35e4	1.32e4
1y	2.82e3	8.46e1	2.87e0	2.82e3	3.51e4	2.00e4	2.82e3	2.08e4	1.04e4

Table C.11

Surry Case 2 Basement Gamma Dose Rates

	A			F		
	a	f	w	a	f	w
1h	7.99e5	3.07e5	1.40e4	5.51e5	2.08e5	8.00e4
2h	2.71e5	7.07e5	3.20e4	1.86e5	4.80e5	1.10e5
4h	1.24e5	6.01e5	2.60e4	8.52e4	4.08e5	9.28e4
8h	3.73e4	5.31e5	2.17e4	2.57e4	3.60e5	8.23e4
16h	2.09e4	4.21e5	1.81e4	1.44e4	2.86e5	6.56e4
1d	1.42e4	3.61e5	1.48e4	9.81e3	2.44e5	5.62e4
2d	5.91e3	2.65e5	1.11e4	4.07e3	1.80e5	4.09e4
4d	3.06e3	1.73e5	7.94e3	2.10e3	1.17e5	2.69e4
8d	1.79e3	8.91e4	3.71e3	1.23e3	6.05e4	1.37e4
16d	6.22e2	3.47e4	1.48e3	4.29e2	2.35e4	5.37e3
32d	7.60e1	1.62e4	7.24e2	5.24e1	1.10e4	2.45e3
64d	2.14e0	1.18e4	5.98e2	1.47e0	8.05e3	1.81e3
128d	1.04e0	1.04e4	4.99e2	7.15e-1	7.09e3	1.61e3
256d	1.01e0	9.06e3	3.79e2	6.99e-1	6.15e3	1.40e3
1y	9.95e-1	8.14e3	3.49e2	6.85e-1	5.53e3	1.26e3

Table C.12

Surry Case 2 Basement Beta Dose Rates

	A			F		
	a	f	w	a	f	w
1h	1.22e6	5.17e5	1.06e5	1.22e6	5.17e5	2.66e6
2h	4.78e5	1.24e6	1.48e5	4.78e5	1.24e6	4.04e6
4h	2.60e5	9.50e5	1.42e5	2.60e5	9.50e5	3.71e6
8h	1.45e5	7.42e5	9.18e4	1.45e5	7.42e5	3.38e6
16h	1.27e5	6.08e5	7.95e4	1.27e5	6.08e5	2.65e6
1d	9.96e4	4.10e5	5.22e4	9.96e4	4.10e5	2.21e6
2d	6.56e4	2.37e5	4.00e4	6.56e4	2.37e5	1.62e6
4d	4.18e4	1.58e5	2.43e4	4.18e4	1.58e5	1.09e6
8d	2.54e4	8.63e4	1.22e4	2.54e4	8.63e4	6.38e5
16d	8.91e3	4.00e4	6.94e3	8.91e3	4.00e4	3.31e5
32d	1.59e3	2.00e4	3.42e3	1.59e3	2.00e4	1.69e5
64d	4.58e2	1.32e4	2.07e3	4.58e2	1.32e4	1.06e5
128d	4.19e2	9.25e3	1.83e3	4.19e2	9.25e3	8.49e4
256d	4.06e2	5.10e3	1.41e3	4.06e2	5.10e3	7.30e4
1y	4.00e2	3.52e3	1.21e3	4.00e2	3.52e3	6.75e4

Table C.13

Surry Case 2 Annulus Gamma Dose Rates

	A			C			E		
	a	f	w	a	f	w	a	f	w
1h	5.93e5	7.46e4	1.28e5	4.90e5	9.27e3	1.65e3	8.85e5	1.18e3	3.24e5
2h	2.01e5	1.71e5	1.84e5	1.66e5	2.13e4	2.28e5	3.00e5	2.46e3	4.46e5
4h	9.16e4	1.45e5	1.52e5	7.57e4	1.81e4	1.94e5	1.37e5	2.32e3	3.88e5
8h	2.77e4	1.28e5	1.34e5	2.29e4	1.60e4	1.71e5	4.14e4	2.05e3	3.37e5
16h	1.56e4	1.02e5	1.06e5	1.28e4	1.27e4	1.37e5	2.32e4	1.63e3	2.67e5
1d	8.89e3	8.73e4	8.98e4	8.72e3	1.09e4	1.16e5	1.58e4	1.40e3	2.30e5
2d	4.38e3	6.42e4	6.74e4	3.62e3	8.03e3	8.61e4	6.55e3	1.03e3	1.68e5
4d	2.27e3	4.19e4	4.24e4	1.87e3	5.24e3	5.58e4	3.39e3	6.72e2	1.10e5
8d	1.32e3	2.15e4	2.25e4	1.09e3	2.69e3	2.86e4	1.97e3	3.45e2	5.69e4
16d	4.61e2	8.40e3	8.74e3	3.81e2	1.05e3	1.12e4	6.88e2	1.34e2	2.35e4
32d	5.63e1	3.93e3	4.05e3	4.65e1	4.91e2	5.11e3	8.41e1	6.30e1	1.01e4
64d	1.59e0	2.86e3	2.94e3	1.31e0	3.58e2	3.80e3	2.37e0	4.60e1	7.44e3
128d	7.70e-1	2.53e3	2.60e3	6.35e-1	3.16e2	3.36e3	1.15e0	4.05e1	6.69e3
256d	5.22e-1	2.19e3	2.27e3	6.21e-1	2.74e2	2.94e3	1.12e0	3.15e1	5.71e3
1y	7.38e-1	1.97e3	2.04e3	6.09e-1	2.46e2	2.64e3	1.10e0	3.16e1	5.30e3

Table C.14

Surry Case 2 Annulus Beta Dose Rates

	A			C			E		
	a	f	w	a	f	w	a	f	w
1h	2.11e6	5.17e5	5.92e5	2.11e6	-	5.92e5	2.11e6	-	5.92e5
2h	8.83e5	1.24e6	7.34e5	8.83e5	-	7.34e5	8.83e5	-	7.34e5
4h	4.94e5	9.5e5	5.60e5	4.94e5	-	5.60e5	4.94e5	-	5.60e5
8h	2.80e5	7.42e5	4.17e5	2.80e5	-	4.17e5	2.80e5	-	4.17e5
16h	2.11e5	3.58e5	3.48e5	2.11e5	-	3.48e5	2.11e5	-	3.48e5
1d	1.78e5	4.10e5	2.35e5	1.78e5	-	2.35e5	1.78e5	-	2.35e5
2d	1.13e5	2.37e5	1.51e5	1.13e5	-	1.51e5	1.13e5	-	1.51e5
4d	8.03e4	1.58e5	1.09e5	8.03e4	-	1.09e5	8.03e4	-	1.09e5
8d	4.61e4	8.63e4	7.93e4	4.61e4	-	7.93e4	4.61e4	-	7.93e4
16d	1.71e4	3.99e4	2.23e4	1.71e4	-	2.23e4	1.71e4	-	2.23e4
32d	2.90e3	2.01e4	1.17e4	2.90e3	-	1.17e4	2.90e3	-	1.17e4
64d	8.36e2	1.32e4	8.34e3	8.36e2	-	8.34e3	8.36e2	-	8.34e3
128d	7.64e2	9.25e3	4.78e3	7.64e2	-	4.78e3	7.64e2	-	4.78e3
256d	7.50e2	5.10e3	6.87e2	7.50e2	-	6.87e2	7.50e2	-	6.87e2
1y	7.45e2	3.52e3	2.15e3	7.45e2	-	2.15e3	7.45e2	-	2.15e3

Table C.15

Surry Case 2 Dome Gamma Dose Rates

	H			I			J		
	a	f	w	a	f	w	a	f	w
1h	1.08e6	1.62e5	4.28e5	1.83e6	9.71e4	2.43e5	1.71e6	4.42e4	3.56e5
2h	3.67e5	3.66e5	3.87e5	6.13e5	2.23e5	3.34e5	5.85e5	1.01e5	4.84e5
4h	1.84e5	3.05e5	3.08e5	2.84e5	1.90e5	2.76e5	2.67e5	8.66e4	4.10e5
8h	5.07e4	2.63e5	2.63e5	8.59e4	1.68e5	2.38e5	8.07e4	7.65e4	3.61e5
16h	2.83e4	2.04e5	2.27e5	4.81e4	1.33e5	1.94e5	4.53e4	6.08e4	2.91e5
1d	1.93e4	1.73e5	1.93e5	3.27e4	1.14e5	1.66e5	3.08e4	5.21e4	2.49e5
2d	8.02e3	1.25e5	1.44e5	1.36e4	8.40e4	1.21e5	1.28e4	3.83e4	1.81e5
4d	2.73e3	3.66e4	1.41e5	3.73e3	5.49e4	8.14e4	5.62e3	2.50e4	1.19e5
8d	1.59e3	1.88e4	7.23e4	2.17e3	2.82e4	4.25e4	3.27e3	1.28e4	6.12e4
16d	5.54e2	7.34e3	2.79e4	7.57e2	1.10e4	1.64e4	1.14e3	5.02e3	2.37e4
32d	6.78e1	3.43e3	1.28e4	9.25e1	5.14e3	7.27e3	1.39e2	2.34e3	1.08e4
64d	1.91e0	2.51e3	9.39e3	2.61e0	3.75e3	5.45e3	3.92e0	1.71e3	8.02e3
128d	9.26e-1	2.21e3	8.39e3	1.26e0	3.31e3	4.84e3	1.90e0	1.51e3	7.15e3
256d	9.05e-1	1.91e3	7.29e3	1.23e0	2.87e3	4.21e3	1.85e0	1.30e3	6.28e3
1y	8.88e-1	1.72e3	2.87e3	1.21e0	2.58e3	8.30e2	1.82e0	1.17e3	4.21e3

Table C.16

Surry Case 2 Dome Beta Dose Rates

	H			I			J		
	a	f	w	a	f	w	a	f	w
1h	5.65e6	9.90e3	4.04e5	5.65e6	9.90e3	8.77e2	5.65e6	-	3.30e5
2h	2.22e6	5.87e4	5.99e5	2.22e6	5.87e4	2.41e2	2.22e6	-	4.45e5
4h	1.31e6	8.89e3	5.37e5	1.31e6	8.89e3	1.82e2	1.31e6	-	3.70e5
8h	6.76e5	5.18e3	4.68e5	6.76e5	5.18e3	-	6.76e5	-	3.25e5
16h	5.52e5	2.62e4	3.72e5	5.52e5	2.62e4	2.44e1	5.52e5	-	2.49e5
1d	4.49e5	7.53e3	3.20e5	4.49e5	7.53e3	-	4.49e5	-	1.90e5
2d	2.76e5	1.79e2	2.35e5	2.76e5	1.79e2	-	2.76e5	-	1.37e5
4d	1.83e5	1.67e1	1.56e5	1.83e5	1.67e1	-	1.83e5	-	8.63e4
8d	1.12e5	1.88e1	9.25e4	1.12e5	1.88e1	-	1.12e5	-	4.98e4
16d	3.98e4	5.84e1	4.56e4	3.98e4	-	-	3.98e4	-	2.50e4
32d	7.04e3	1.78e1	2.40e4	7.04e3	1.78e1	-	7.04e3	-	1.28e4
64d	2.01e3	-	1.53e4	2.01e3	-	-	2.01e3	-	8.38e3
128d	1.79e3	-	1.23e4	1.79e3	-	-	1.79e3	-	6.31e3
256d	1.76e3	-	1.00e4	1.76e3	-	-	1.76e3	-	4.91e3
1y	1.74e3	-	9.11e3	1.74e3	-	-	1.74e3	-	4.35e3

Table C.17

Surry Case 2 Steam Generator A Cubicle Gamma Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	8.73e5	4.94e4	7.26e4	4.77e5	3.98e4	1.57e5	4.59e5	3.99e4	1.57e5
2h	2.96e5	1.13e5	1.00e5	1.61e5	9.15e4	2.18e5	1.55e5	9.18e4	2.16e5
4h	1.34e5	9.66e4	8.54e4	7.37e4	7.78e4	1.85e5	7.10e4	7.81e4	1.83e5
8h	4.07e4	8.52e4	7.41e4	2.22e4	6.87e4	1.62e5	2.14e4	6.89e4	1.62e5
16h	2.27e4	6.77e4	5.96e4	1.24e4	5.46e4	1.29e5	1.20e4	5.47e4	1.28e5
1d	1.55e4	5.79e4	5.06e4	8.49e3	4.66e4	1.10e5	8.17e3	4.68e4	1.09e5
2d	6.44e3	4.26e4	3.75e4	3.52e3	3.43e4	8.12e4	3.39e3	3.44e4	8.02e4
4d	3.34e3	2.78e4	2.45e4	1.82e3	2.24e4	5.31e4	1.76e3	2.25e4	5.27e4
8d	1.94e3	1.43e4	1.26e4	1.06e3	1.15e4	2.72e4	1.02e3	1.15e4	2.71e4
16d	6.78e2	5.57e3	4.85e3	3.71e2	4.49e3	1.05e4	3.57e2	4.51e3	1.04e4
32d	8.29e1	2.60e3	2.27e3	4.53e1	2.10e3	4.91e3	4.36e1	2.10e3	4.90e3
64d	2.33e0	1.90e3	1.67e3	1.27e0	1.53e3	3.61e3	1.23e0	1.53e3	3.60e3
128d	1.13e0	1.67e3	1.48e3	6.18e-1	1.35e3	3.20e3	5.95e-1	1.35e3	3.20e3
256d	1.10e0	1.45e3	1.29e3	6.04e-1	1.17e3	2.79e3	5.82e-1	1.17e3	2.78e3
1y	1.08e0	1.30e3	1.16e3	5.93e-1	1.05e3	2.51e3	5.71e-1	1.05e3	2.50e3

Table C.18

Surry Case 2 Steam Generator Cubicle A Beta Dose Rates

	C			D			E		
	a	f	w	a	f	w	a	f	w
1h	7.78e6	2.37e2	6.28e2	7.78e6	5.48e5	7.83e5	7.78e6	5.28e5	6.90e5
2h	3.35e6	5.83e2	8.96e2	3.35e6	1.38e6	1.10e6	3.35e6	1.20e6	1.07e6
4h	1.86e6	4.80e6	6.92e2	1.86e6	1.34e6	1.06e6	1.86e6	1.11e6	9.15e5
8h	1.02e6	4.10e2	4.92e2	1.02e6	9.55e5	8.89e5	1.02e6	9.04e5	8.73e5
16h	8.42e5	3.31e2	4.24e2	8.42e5	8.45e5	7.02e5	8.42e5	7.66e5	6.55e5
1d	6.89e5	2.63e2	2.72e2	6.89e5	6.87e5	5.75e5	6.89e5	6.04e5	5.56e5
2d	4.38e5	1.85e2	1.77e2	4.38e5	4.79e5	4.02e5	4.38e5	4.25e5	4.06e5
4d	3.04e5	1.16e2	1.05e2	3.04e5	3.23e5	2.68e5	3.04e5	2.89e5	2.55e5
8d	1.79e5	6.99e1	5.19e1	1.79e5	1.75e5	1.69e5	1.79e5	1.85e5	1.43e5
16d	6.52e4	3.54e1	2.64e1	6.52e4	9.27e4	8.52e4	6.52e4	9.02e4	7.26e4
32d	3.42e4	1.86e1	1.47e1	3.42e4	4.87e4	4.11e4	3.42e4	4.54e4	3.62e4
64d	3.20e3	1.20e1	9.52e-1	3.20e3	3.31e4	2.73e4	3.20e3	2.98e4	2.37e4
128d	2.88e3	8.83e0	6.31e-1	2.88e3	2.24e4	2.20e4	2.88e3	2.09e4	1.98e4
256d	2.81e3	6.50e-1	3.49e-1	2.81e3	1.87e4	1.69e4	2.81e3	1.70e4	1.61e4
1y	2.79e3	6.29e-1	2.58e-1	2.79e3	1.80e4	1.64e4	2.79e3	1.64e4	1.37e4

Table C.19

Surry Case 3 Basement Gamma Dose Rate

	A		F	
	s	a	s	a
1h	7.56e5	9.40e4	5.49e5	6.10e4
2h	6.01e5	7.27e4	4.36e5	4.80e4
4h	4.99e5	5.05e4	3.62e5	3.33e4
8h	3.91e5	3.00e4	2.83e5	2.07e4
16h	3.05e5	1.75e4	2.22e5	1.14e4
1d	2.60e5	1.25e4	1.88e5	7.81e3
2d	1.93e5	5.40e3	1.40e5	3.92e3
4d	1.33e5	2.40e3	9.64e4	1.63e3
8d	7.17e4	1.50e3	5.60e4	9.80e2
16d	3.88e4	5.50e2	2.81e4	3.80e2
32d	2.17e4	1.10e2	1.58e4	3.96e1
64d	1.43e4	9.00e1	1.05e4	1.11e0
128d	1.04e4	8.23e-1	7.56e3	5.41e-1
256d	7.27e3	8.05e-1	5.28e3	5.30e-1
1y	6.12e3	7.90e-1	4.44e3	5.20e-1

s - sump contribution
a - airborne contribution

Table C.20

Surry Case 3 Annulus Gamma Dose Rate

	A		C		E	
	s	a	s	a	s	a
1h						
2h	3.08e5	7.10e4	2.97e4	5.36e4	3.65e3	9.64e4
4h	2.55e5	4.97e4	2.46e4	3.73e4	3.02e3	6.75e4
8h	2.00e5	2.96e4	1.93e4	2.24e4	2.37e3	4.05e4
16h	1.57e5	1.64e4	1.51e4	1.25e4	1.84e3	2.27e4
1d	1.33e5	1.06e4	1.28e4	8.60e3	1.57e3	1.54e4
2d	9.91e4	4.90e3	9.57e3	3.53e3	1.17e3	6.41e3
4d	6.80e4	2.40e3	6.57e3	1.83e3	8.03e2	3.32e3
8d	3.95e4	1.40e3	3.82e3	1.07e3	4.66e2	1.93e3
16d	1.99e4	5.50e2	1.92e3	3.70e2	2.34e2	6.75e2
32d	1.12e4	4.60e1	1.07e3	4.54e1	1.31e2	8.23e1
64d	7.38e3	1.29e0	7.13e2	1.28e0	8.73e1	2.32e0
128d	5.34e3	6.22e-1	5.16e2	6.20e-1	6.31e1	1.13e0
256d	3.72e3	6.08e-1	3.60e2	5.89e-1	4.41e1	1.10e0
1y	3.13e3	5.96e-1	3.03e2	5.94e-1	3.71e1	1.08e0

Table C.21

Surry Case 4 Basement Gamma Dose Rate

	A		F	
	s	a	s	a
1h	7.56e5	9.40e4	5.49e5	6.10e4
2h	5.71e5	7.17e4	4.14e5	4.79e4
4h	4.12e5	4.92e4	2.98e5	3.30e4
8h	3.20e5	2.95e4	2.31e5	2.00e4
16h	2.50e5	1.67e4	1.82e5	1.11e4
1d	2.12e5	1.18e4	1.55e5	7.30e3
2d	1.55e5	5.40e3	1.13e5	3.11e3
4d	1.01e5	2.20e3	7.33e4	1.73e3
8d	5.12e4	1.51e3	3.72e4	1.00e3
16d	1.96e4	5.10e2	1.42e4	3.86e2
32d	9.35e3	7.00e1	6.79e3	4.60e1
64d	7.01e3	9.00e0	5.09e3	9.00e0
128d	6.22e3	-	4.52e3	-
256d	5.40e3	-	3.92e3	-
1y	4.85e3	-	3.52e3	-

Table C.22

Surry Case 4 Annulus Gamma Dose Rate

	A		C		E	
	s	a	s	a	s	a
1h	3.88e5	9.24e4	3.74e4	6.96e4	4.59e3	1.27e5
2h	2.93e5	7.10e4	2.82e4	5.36e4	3.47e3	9.65e4
4h	2.11e5	4.87e4	2.03e4	3.73e4	2.49e3	6.75e4
8h	1.63e5	2.97e4	1.58e4	2.23e4	1.93e3	4.05e4
16h	1.29e5	1.64e4	1.24e4	1.25e4	1.51e3	2.27e4
1d	1.09e5	1.09e4	1.05e4	8.60e3	1.28e3	1.54e4
2d	7.96e4	4.60e3	7.69e3	3.51e3	9.41e2	6.42e3
4d	5.17e4	2.40e3	4.99e3	1.84e3	6.10e2	3.32e3
8d	2.62e4	1.52e3	2.53e3	1.07e3	3.09e2	1.94e3
16d	1.00e4	4.60e2	9.71e2	3.69e2	1.18e2	6.75e2
32d	4.79e3	6.00e1	4.63e2	4.60e1	5.66e1	8.24e1
64d	3.60e3	-	3.49e2	-	4.25e1	2.40e0
128d	3.18e3	1.00e1	3.08e2	1.00e0	3.77e1	1.20e0
256d	2.76e3	8.00e0	2.67e2	-	3.27e1	1.10e0
1y	2.48e3	6.00e0	2.40e2	-	2.94e1	-

Table C.23

Peach Bottom Case 1 Drywell Gamma Dose Rates

	A			B			C		
	a	f	w	a	f	w	a	f	w
1h	2.57e5	7.20e5	2.80e5	3.22e5	9.13e5	2.42e5	2.72e5	7.61e5	1.76e5
2h	3.69e5	5.51e5	2.63e5	4.62e5	7.02e5	2.23e5	3.90e5	5.83e5	1.64e5
4h	3.72e5	5.21e5	2.59e5	4.66e5	6.62e5	2.20e5	3.93e5	5.50e5	1.61e5
8h	2.15e5	3.39e5	1.58e5	2.68e5	4.31e5	1.34e5	2.27e5	3.58e5	9.90e4
16h	1.19e5	2.61e5	1.20e5	1.49e5	3.32e5	1.02e5	1.26e5	2.76e5	7.50e4
1d	8.05e4	2.23e5	1.03e5	1.01e5	2.84e5	8.70e4	8.50e4	2.36e5	6.40e4
2d	3.27e4	1.64e5	7.60e4	4.09e4	2.08e5	6.50e4	3.46e4	1.73e5	4.70e4
4d	1.67e4	1.07e5	5.00e4	2.09e4	1.36e5	4.20e4	1.77e4	1.13e5	3.11e4
8d	9.74e3	5.47e4	2.59e4	1.22e4	6.94e4	2.22e4	1.03e4	5.78e4	1.60e4
16d	3.39e3	2.10e4	1.04e4	4.24e3	2.68e4	8.70e3	3.58e3	2.23e4	6.40e3
32d	4.15e2	9.74e3	5.16e3	5.19e2	1.24e4	4.40e3	4.38e2	8.96e3	4.57e3
64d	1.27e1	7.09e3	4.07e3	1.59e1	9.02e3	3.45e3	1.34e1	7.50e3	2.53e3
128d	6.61e0	6.25e3	3.72e3	8.26e0	7.95e3	3.15e3	6.98e0	6.61e3	2.31e3
256d	6.43e0	5.40e3	3.29e3	8.04e0	6.86e3	2.80e3	6.79e0	5.71e3	2.04e3
1y	6.30e0	4.85e3	2.98e3	7.87e0	6.16e3	2.53e3	6.65e0	5.12e3	1.86e3

Table C.23

Peach Bottom Case 1 Drywell Gamma Dose Rates (Continued)

	D			E			F		
	a	f	w	a	f	w	a	f	w
1h	3.54e5	6.96e5	1.97e5	4.26e5	9.10e5	2.70e5	3.07e5	6.66e5	3.20e5
2h	5.09e5	5.32e5	1.85e5	6.11e5	6.98e5	2.56e5	4.41e5	5.10e5	2.99e5
4h	5.13e5	5.02e5	1.87e5	6.16e5	6.58e5	2.53e5	4.45e5	4.81e5	2.95e5
8h	2.95e5	3.28e5	1.10e5	3.55e5	4.29e5	1.55e5	2.56e5	3.13e5	1.81e5
16h	1.64e5	2.51e5	8.50e4	1.97e5	3.30e5	1.18e5	1.43e5	2.42e5	1.36e5
1d	1.11e5	2.15e5	7.30e4	1.33e5	2.82e5	1.01e5	9.61e4	2.07e5	1.16e5
2d	4.50e4	1.58e5	5.30e4	5.41e4	2.08e5	7.40e4	3.91e4	1.52e5	8.60e4
4d	2.30e4	1.03e5	3.50e4	2.76e4	1.35e5	4.90e4	2.00e4	9.90e4	5.68e4
8d	1.34e4	5.28e4	1.82e4	1.61e4	6.92e4	2.53e4	1.16e4	5.06e4	2.94e4
16d	4.67e3	2.03e4	7.30e3	5.61e3	2.67e4	1.01e4	4.05e3	1.95e4	1.18e4
32d	5.72e2	9.40e3	3.67e3	6.87e2	1.23e4	5.13e3	4.96e2	9.01e3	5.94e3
64d	1.75e1	6.86e3	2.85e3	2.10e1	8.98e3	3.96e3	1.52e1	6.57e3	5.23e3
128d	9.10e0	6.04e3	2.61e3	1.09e1	7.91e3	3.63e3	7.89e0	5.78e3	4.52e3
256d	8.85e0	5.22e3	2.30e3	1.06e1	6.83e3	3.22e3	7.68e0	5.00e3	3.74e3
1y	8.66e0	4.68e3	2.09e3	1.04e1	6.13e3	2.91e3	7.52e0	4.48e3	3.39e3

Table C.23

Peach Bottom Case 1 Drywell Gamma Dose Rates (Continued)

	J			K			L		
	a	f	w	a	f	w	a	f	w
1h	1.76e5	7.59e4	2.10e5	2.04e5	8.97e4	1.95e5	1.65e5	7.44e4	1.02e5
2h	2.53e5	5.82e4	1.96e5	2.93e5	6.88e4	1.81e5	2.37e5	5.71e4	9.49e4
4h	2.55e5	5.48e4	1.93e5	2.95e5	6.48e4	1.79e5	2.39e5	5.38e4	9.42e4
8h	1.47e5	3.58e4	1.18e5	1.70e5	4.23e4	1.10e5	1.38e5	3.50e4	5.77e4
16h	8.16e4	2.75e4	8.95e4	9.45e4	3.25e4	8.35e4	7.65e4	2.70e4	4.39e4
1d	5.50e4	2.36e4	7.64e4	6.37e4	2.78e4	7.15e4	5.16e4	2.31e4	3.75e4
2d	2.23e4	1.73e4	5.69e4	2.59e4	2.04e4	5.28e4	2.10e4	1.70e4	2.77e4
4d	1.14e4	1.13e4	3.73e4	1.32e4	1.34e4	3.46e4	1.07e4	1.11e4	1.81e4
8d	6.64e3	5.79e3	1.93e4	7.70e3	6.82e3	1.79e4	6.24e3	5.66e3	9.34e3
16d	2.31e3	2.22e3	7.77e3	2.68e3	2.63e3	2.20e3	2.17e3	2.18e3	3.79e3
32d	2.83e2	1.03e3	3.90e3	3.28e2	1.22e3	3.61e3	2.66e2	1.01e3	1.90e3
64d	8.68e0	7.50e2	3.03e3	1.01e1	8.86e2	2.81e3	8.14e0	7.35e2	1.48e3
128d	4.52e0	6.61e2	2.77e3	5.24e0	7.81e2	2.57e3	4.24e0	6.48e2	1.34e3
256d	4.40e0	5.70e2	2.46e3	5.10e0	6.74e2	2.28e3	4.12e0	5.59e2	1.20e3
1y	4.30e0	5.12e2	2.22e3	4.99e0	6.05e2	2.06e3	4.04e0	5.02e2	1.08e3

Table C.24

Peach Bottom Case 1 Drywell Beta Dose Rates

	A,B,C		A	B	C	D,E,F		D	E	F
	a	f	w	w	w	a	f	w	w	w
1h	2.35e5	1.18e6	3.86e5	3.44e4	5.97e5	2.35e5	4.46e6	5.97e5	3.44e4	3.86e5
2h	4.70e5	8.56e5	3.55e5	2.93e4	5.01e5	4.70e5	3.19e6	5.01e5	2.93e4	3.55e5
4h	9.95e5	1.37e6	6.81e5	9.10e4	1.02e6	9.95e5	6.47e6	1.02e6	9.10e4	6.81e5
8h		1.37e6	4.59e5	7.44e4	7.23e5		5.19e6	7.23e5	7.44e4	4.59e5
16h	1.02e6	8.59e5	3.02e5	4.13e4	4.83e5	1.02e6	3.55e6	4.83e5	4.13e4	3.02e5
1d	8.25e5	8.07e5	2.56e5	2.75e4	4.20e5	8.25e5	2.94e6	4.20e5	2.75e4	2.56e5
2d	5.15e5	5.04e5	1.72e5	1.96e4	2.63e5	5.15e5	2.08e6	2.63e5	1.96e4	1.72e5
4d	3.58e5	3.31e5	1.15e5	1.04e4	1.71e5	3.58e5	1.36e6	1.71e5	1.04e4	1.15e5
8d	2.11e5	1.99e5	5.94e4	4.64e4	9.00e4	2.11e5	7.61e5	9.00e4	4.64e3	5.94e4
16d	7.72e4	9.09e4	2.75e4	1.09e3	4.20e4	7.72e4	3.43e5	4.20e4	1.09e3	2.75e4
32d	1.36e4	4.39e4	1.32e4	2.86e2	2.08e4	1.36e4	1.91e5	2.08e4	2.86e2	1.32e4
64d	4.23e3	3.07e4	1.00e4	1.48e2	1.42e4	4.23e3	1.25e5	1.42e4	1.48e2	1.00e4
128d	3.81e3	2.29e4	8.83e3	8.52e1	1.33e4	3.81e3	9.27e4	1.33e4	8.52e1	8.83e3
256d	3.69e3	1.80e4	8.39e3	3.59e1	1.28e4	3.69e3	7.67e4	1.28e4	3.59e1	8.39e3
1y	3.62e3	1.78e4	8.27e3	2.90e1	1.17e4	3.62e3	6.76e4	1.17e4	2.90e1	8.27e3

Table C.24

Peach Bottom Case 1 Drywell Beta Dose Rates (Continued)

	G,H,I		G	H	I	J,K,L		J	K,L
	a	f	w	w	w	a	f	w	w
1h	2.35e5	3.24e4	3.86e5	3.44e4	5.97e5	2.35e5	-	1.44e5	5.97e5
2h	4.70e5	1.89e4	3.55e5	2.93e4	5.01e5	4.70e5	-	1.31e5	5.01e5
4h	9.95e5	1.61e5	6.81e5	9.1e4	1.02e6	9.95e5	-	2.43e5	1.02e6
8h		6.18e4	4.59e5	7.44e4	7.23e5			1.82e5	7.23e5
16h	1.02e6	2.89e4	3.02e5	4.13e4	4.83e5	1.02e6	-	1.14e5	4.83e5
1d	8.25e5	1.09e4	2.56e5	2.75e4	4.20e5	8.25e5	-	9.56e4	4.20e5
2d	5.15e5		1.72e5	1.96e4	2.63e5	5.15e5	-	6.96e4	2.63e5
4d	3.58e5		1.15e5	1.04e4	1.71e5	3.58e5	-	4.18e4	1.71e5
8d	2.11e5	4.01e3	5.94e4	4.64e3	9.00e4	2.11e5	-	2.26e4	9.00e4
16d	7.72e4		2.75e4	1.09e3	4.20e4	7.72e4	-	1.06e4	4.20e4
32d	1.36e4	2.88e3	1.32e4	2.86e2	2.08e4	1.36e4	-	5.27e3	2.08e4
64d	4.23e3		1.00e4	1.48e2	1.42e4	4.23e3	-	3.83e3	1.42e4
128e	3.81e3		8.83e3	8.52e1	1.33e4	3.81e3	-	3.38e3	1.33e4
256e	3.69e3	1.36e3	8.39e3	3.59e1	1.28e4	3.69e3	-	3.06e3	1.28e4
1y	3.62e3	2.66e2	8.27e3	2.90e1	1.17e4	3.62e3	-	3.06e3	1.17e4

Table C.25

Surry Case 1 Wetwell Gamma Dose Rates

	A			B		
	s	a	w	s	a	w
1h	1.68e4	2.99e5	5.58e4	-	4.16e1	2.40e0
2h	1.22e4	1.58e5	4.26e4	-	2.14e1	1.42e0
4h	9.43e3	6.01e4	3.14e4	-	7.61e0	6.90e-1
8h	6.88e3	3.39e4	2.47e4	-	2.73e0	3.86e-1
16h	5.16e3	1.68e4	1.95e4	-	3.83e-1	2.17e-1
1d	4.29e3	1.02e4	1.67e4	-	5.49e-2	1.45e-1
2d	3.06e3	2.49e3	1.23e4	-	-	-
4d	1.95e3	4.26e2	7.93e3	-	-	-
8d	9.63e2	2.07e2	3.99e3	-	-	-
16d	3.53e2	7.05e1	1.49e3	-	-	-
32d	1.74e2	9.56e0	7.01e2	-	-	-
64d	1.35e2	1.42e0	5.40e2	-	-	-
128d	1.20e2	1.27e0	4.95e2	-	-	-
256d	1.04e2	1.24e0	4.38e2	-	-	-
1y	9.43e1	1.21e0	3.96e2	-	-	-

Table C.26

Peach Bottom Case 2 Drywell Gamma Dose Rates

	A			B			C		
	a	f	w	a	f	w	a	f	w
1h	2.57e5	7.20e5	2.80e5	3.22e5	9.16e5	2.39e5	2.72e5	7.61e5	1.76e5
2h	3.69e5	5.52e5	2.62e5	4.62e5	7.02e5	2.23e5	3.90e5	5.83e5	1.64e5
4h	3.57e5	4.15e5	2.04e5	4.47e5	5.27e5	1.74e5	3.77e5	4.38e5	1.27e5
8h	2.14e5	3.25e5	1.60e5	2.68e5	4.13e5	1.36e5	2.27e5	3.43e5	1.00e5
16h	1.19e5	2.59e5	1.26e5	1.49e5	3.29e5	1.07e5	1.26e5	2.73e5	7.90e4
1d	8.05e4	1.78e5	1.52e5	1.01e5	2.81e5	9.20e4	8.5e4	2.33e5	6.80e4
2d	3.27e4	1.62e5	8.10e4	4.09e4	2.06e5	6.80e4	3.45e4	1.72e5	4.90e4
4d	1.67e4	1.05e5	5.30e4	2.09e4	1.34e5	4.50e4	1.76e4	1.11e5	3.34e4
8d	9.73e3	5.28e4	2.85e4	1.22e4	6.73e4	2.40e4	1.03e4	5.59e4	1.77e4
16d	3.39e3	1.95e4	1.22e4	4.23e3	2.48e4	1.03e4	3.58e3	2.06e4	7.60e3
32d	4.14e2	8.71e3	6.59e3	5.18e2	1.11e4	5.50e3	4.38e2	9.20e3	4.11e3
64d	1.24e1	6.48e3	5.22e3	1.55e1	8.24e3	4.46e3	1.31e1	6.85e3	3.25e3
128d	6.40e0	5.90e3	4.80e3	8.0e0	7.51e3	4.09e3	6.76e0	6.24e3	3.01e3
256d	-	5.25e3	4.29e3	-	6.67e3	3.63e3	-	5.54e3	2.68e3
1y	-	4.74e3	3.89e3	-	6.03e3	3.30e3	-	4.94e3	2.50e3

Table C.26

Peach Bottom Case 2 Drywell Gamma Dose Rates (Continued)

	D			E			F		
	a	f	w	a	f	w	a	f	w
1h	3.54e5	6.96e5	2.00e5	4.26e5	9.10e5	2.70e5	3.07e5	6.66e5	3.20e5
2h	5.09e5	5.32e5	1.85e5	6.11e5	6.98e5	2.56e5	4.41e5	5.32e5	2.77e5
4h	4.92e5	4.00e5	1.44e5	5.91e5	5.23e5	2.01e5	4.27e5	3.82e5	2.34e5
8h	2.95e5	3.14e5	1.12e5	3.55e5	4.11e5	1.57e5	2.56e5	3.01e5	1.82e5
16h	1.64e5	2.49e5	9.00e4	1.97e5	3.27e5	1.24e5	1.42e5	2.40e5	1.43e5
1d	1.11e5	2.13e5	7.70e4	1.33e5	2.79e5	1.07e5	1.33e5	2.05e5	1.23e5
2d	4.50e4	1.57e5	5.60e4	5.41e4	2.05e4	7.90e4	3.91e4	1.50e5	9.20e4
4d	2.30e4	1.02e5	3.70e4	2.76e4	1.33e5	5.24e4	2.00e4	9.74e4	6.08e4
8d	1.34e4	5.11e4	2.00e4	1.61e4	6.69e4	2.79e4	1.16e4	4.90e4	3.23e4
16d	4.66e3	1.89e4	8.50e3	5.60e3	2.48e4	1.18e4	4.05e3	1.81e4	1.38e4
32d	5.71e2	8.42e3	4.63e3	6.85e2	1.10e4	6.48e3	4.95e2	8.06e3	7.44e3
64d	1.71e1	6.27e3	3.70e3	2.05e1	8.19e3	5.17e3	1.48e1	6.00e3	6.01e3
128d	8.81e0	5.71e3	3.39e3	1.06e1	7.47e3	4.74e3	7.65e0	5.47e3	5.50e3
256d	-	5.06e3	3.02e3	-	6.63e3	4.21e3	-	4.86e3	4.88e3
1y	-	4.57e3	2.74e3	-	6.00e3	3.80e3	-	4.39e3	4.42e3

Table C.26

Peach Bottom Case 2 Drywell Gamma Dose Rates (Continued)

	G			H			I		
	a	f	w	a	f	w	a	f	w
1h	2.76e5	5.83e5	4.27e5	3.59e5	6.21e5	3.25e5	2.95e5	4.19e5	2.01e5
2h	3.96e5	4.46e5	4.04e5	5.15e5	4.76e5	3.03e5	4.24e5	3.22e5	1.86e5
4h	3.84e5	3.35e5	3.15e5	4.98e5	3.57e5	2.37e5	4.10e5	2.41e5	1.46e5
8h	2.30e5	2.63e5	2.46e5	3.00e5	2.81e5	1.84e5	2.46e5	1.89e5	1.14e5
16h	1.28e5	2.09e5	1.95e5	1.66e5	2.23e5	1.47e5	1.37e5	1.50e5	9.10e4
1d	8.64e4	1.78e5	1.68e5	1.12e5	1.90e5	1.26e5	9.23e4	1.28e5	7.80e4
2d	3.51e4	1.31e5	1.24e5	4.56e4	1.39e5	9.40e4	3.75e4	9.46e4	5.74e4
4d	1.79e4	8.52e4	8.18e4	2.33e4	9.09e4	6.11e4	1.91e4	6.13e4	3.82e4
8d	1.05e4	4.28e4	4.37e4	1.35e4	4.57e4	3.28e4	1.12e4	3.08e4	2.03e4
16d	3.64e3	1.58e4	1.87e4	4.71e3	1.69e4	1.40e4	3.88e3	1.14e4	8.68e3
32d	4.46e2	2.05e3	1.02e4	5.76e2	7.52e3	7.63e3	4.75e2	5.08e3	4.72e3
64d	1.33e1	5.25e3	8.05e3	1.73e1	5.59e3	6.01e3	1.42e1	3.78e3	3.77e3
128d	6.88e0	4.78e3	7.42e3	8.91e0	5.10e3	5.50e3	7.34e0	3.44e3	3.46e3
256d	-	4.24e3	6.56e3	-	4.52e3	4.97e3	-	3.06e3	3.06e3
1y	-	3.84e3	3.47e3	-	4.10e3	4.49e3	-	2.76e3	2.78e3

Table C.26

Peach Bottom Case 2 Drywell Gamma Dose Rates (Continued)

	J			K			L		
	a	f	w	a	f	w	a	f	w
1h	1.76e5	7.59e4	2.10e5	2.04e5	8.97e4	1.94e5	1.65e5	7.44e4	1.02e5
2h	2.53e5	5.82e4	1.96e5	2.93e5	6.88e4	1.81e5	2.37e5	5.71e4	9.49e4
4h	2.44e5	4.36e4	1.52e5	2.83e5	5.16e4	1.41e5	2.29e5	4.28e4	7.42e4
8h	1.47e5	3.43e4	1.19e5	1.70e5	4.05e4	1.11e5	1.38e5	3.36e4	5.83e4
16h	8.15e4	2.73e4	9.47e4	9.45e4	3.22e4	8.78e4	7.65e4	2.68e4	4.62e4
1d	5.50e4	2.33e4	8.07e4	6.37e4	2.76e4	7.54e4	5.16e4	2.29e4	3.96e4
2d	2.23e4	1.72e4	6.03e4	2.59e4	2.02e4	5.60e4	2.10e4	1.68e4	2.94e4
4d	1.14e4	1.11e4	4.00e4	1.32e4	1.31e4	3.71e4	1.07e4	1.09e4	1.95e4
8d	6.33e3	5.60e3	2.12e4	7.44e3	6.61e3	1.97e4	6.14e3	5.48e3	1.03e4
16d	2.20e3	2.07e3	9.07e3	2.59e3	2.44e3	8.41e3	2.14e3	2.02e3	4.43e3
32d	2.70e2	9.21e2	4.93e3	3.17e2	1.09e3	4.57e3	2.62e2	9.03e2	2.40e3
64d	8.10e1	6.85e2	3.95e3	9.50e1	8.10e2	3.65e3	7.84e1	6.72e2	1.92e3
128d	7.34e0	6.24e2	3.62e3	4.17e0	7.38e2	3.35e3	4.05e0	6.12e2	1.76e3
256d	-	5.54e2	3.21e3	-	6.56e2	2.97e3	-	5.43e2	1.56e3
1y	-	5.01e2	2.90e3	-	5.93e2	2.69e3	-		

Table C.27

Peach Bottom Case 2 Drywell Beta Dose Rates

	A,B,C		A	B	C	D,E,F		D	E	F
	a	f	w	w	w	a	f	w	w	w
1h	2.44e5	1.11e6	3.84e5	3.58e4	5.97e5	2.44e5	4.34e6	5.97e5	3.58e4	3.84e5
2h	6.63e5	9.43e5	4.72e5	6.54e4	7.06e5	6.63e5	3.34e6	7.06e5	6.45e4	4.72e5
4h	5.88e5	5.61e5	2.77e5	2.17e4	4.18e5	5.88e5	2.56e6	4.18e5	2.17e4	2.77e5
8h	5.09e5	4.86e5	2.09e5	7.92e3	3.06e5	5.09e5	1.89e6	3.06e5	7.92e3	2.09e5
16h	5.06e5	3.52e5	1.89e5	7.01e3	2.90e5	5.06e5	1.43e6	2.90e5	7.01e3	1.89e5
1d	4.14e5	2.91e5	1.53e5	6.66e3	2.35e5	4.14e5	1.14e6	2.35e5	6.66e3	1.53e5
2d	2.65e5	2.04e5	1.06e5	1.96e3	1.57e5	2.65e5	7.60e5	1.57e5	1.96e3	1.06e5
4d	2.43e5	1.25e5	6.68e4	1.70e3	1.04e5	2.43e5	4.70e5	1.04e5	1.70e3	6.68e4
8d	1.07e5	6.13e4	3.54e4	7.25e2	5.37e4	1.07e5	2.44e5	5.37e4	7.25e2	3.54e4
16d	3.98e4	2.72e4	1.66e4	2.28e2	2.62e4	3.98e4	1.01e5	2.62e4	2.28e2	1.66e4
32d	6.82e3	1.11e4	8.49e3	8.27e1	1.30e4	6.82e3	4.24e4	1.36e4	8.27e1	8.49e3
64d	2.17e3	7.29e3	6.55e3	2.48e1	9.91e3	2.17e3	2.85e4	9.91e3	2.48e1	6.55e3
128d	1.99e3	6.78e3	6.42e3	2.31e1	9.25e3	1.99e3	2.68e4	9.25e3	2.31e1	6.42e3
256d	1.93e3	6.69e3	5.93e3		8.81e3	1.93e3	2.51e4	8.81e3		5.93e3
1y	1.91e3	6.12e3	5.48e3	2.29e1	8.49e3	1.91e3	2.39e4	8.49e3	2.29e1	5.48e3

Table C.27

Peach Bottom Case 2 Drywell Beta Dose Rates (Continued)

	G,H,I		G	H	I	J,K,L		J	K,L
	a	f	w	w	w	a	f	w	w
1h	2.44e5	3.27e4	3.84e5	3.58e4	5.97e5	2.44e5	-	1.43e5	5.97e5
2h	6.63e5	9.65e4	4.72e5	6.45e4	7.06e5	6.63e5	-	1.87e5	7.06e5
4h	5.88e5	1.70e4	2.77e5	2.17e4	4.18e5	5.88e5	-	1.06e5	4.18e5
8h	5.09e5	9.65e3	2.09e5	7.92e3	3.06e5	5.09e5	-	7.56e4	3.06e5
16h	5.06e5	7.82e3	1.89e5	7.01e3	2.90e5	5.06e5	-	7.20e4	2.90e5
1d	4.14e5		1.53e5	6.66e3	2.35e5	4.14e5	-	5.86e4	2.35e5
2d	2.65e5	1.58e2	1.06e5	1.96e3	1.57e5	2.65e5	-	4.38e4	1.57e5
4d	2.43e5		6.68e4	1.70e3	1.04e5	2.43e5	-	2.46e4	1.04e5
8d	1.07e5		3.59e4	7.25e2	5.37e4	1.07e5	-	1.36e4	5.37e4
16d	3.98e4		1.66e4	2.28e2	2.62e4	3.98e4	-	6.53e3	2.62e4
32d	6.82e3		8.49e3	8.27e1	1.36e4	6.82e3	-	3.21e3	1.36e4
64d	2.17e3		6.55e3	2.48e1	9.91e3	2.17e3	-	2.45e3	9.91e3
128d	1.99e3		6.42e3	2.31e1	9.25e3	1.99e3	-	2.38e3	9.25e3
256d	1.93e3		5.93e3		8.81e3	1.93e3	-	2.21e3	8.81e3
1y	1.91e3		5.48e3	2.29e1	8.49e3	1.91e3	-	2.10e3	8.49e3

Table C.28

Peach Bottom Case 2 Wetwell Gamma Dose Rates

	A			B		
	s	a	w	s	a	w
1h	1.68e4	2.99e5	5.59e4	-	4.16e1	2.44e0
2h	1.23e4	1.55e5	4.26e4	-	2.13e1	1.40e0
4h	8.66e3	6.86e4	3.09e4	-	7.79e0	6.11e-1
8h	6.49e3	4.08e4	2.43e4	-	2.84e0	3.96e-1
16h	4.91e3	2.22e4	1.93e4	-	4.49e-1	2.01e-1
1d	4.08e3	1.49e4	1.65e4	-	1.02e-1	1.38e-1
2d	2.91e3	5.84e3	1.21e4	-	2.91e-2	9.09e-2
4d	1.85e3	2.53e3	7.81e3	-	-	-
8d	8.99e2	1.17e3	3.92e3	-	-	-
16d	3.17e2	3.23e2	1.47e3	-	-	-
32d	1.54e2	5.35e1	6.90e2	-	-	-
64d	1.26e2	1.49e1	5.32e2	-	-	-
128d	1.16e2	1.20e1	4.87e2	-	-	-
256d		1.07e1	4.33e2	-	-	-
1y	9.32e1	9.83e0	3.91e2			

Table C.29

Peach Bottom Case 3 Wetwell Gamma Dose Rates

	A			B		
	s	a	w	s	a	w
1h	2.17e4	2.99e5	5.58e4	-	4.16e1	2.25e0
2h	1.57e4	1.58e5	4.26e4	-	2.14e1	1.28e0
4h	1.55e4	6.01e4	3.14e4	-	7.62e0	6.74e-1
8h	1.15e4	3.39e4	2.47e4	-	2.73e0	3.75e-1
16h	8.69e3	1.68e4	1.95e4	-		
1d	7.21e3	1.02e4	1.67e4	-	5.49e-2	1.42e-1
2d	5.15e3	2.49e3	1.23e4	-	3.11e-4	8.71e-2
4d	3.32e3	4.26e2	7.93e3	-	-	5.46e-2
8d	1.99e3	2.07e2	3.99e3	-	-	2.41e-2
16d	6.62e2	7.04e1	1.49e3	-	-	5.92e-3
32d	3.38e2	9.56e0	7.01e2	-	-	
64d	2.52e2	1.42e0	5.40e2	-	-	
128d	2.13e2	1.27e0	4.94e2	-	-	1.01e-3
256d	1.78e2	1.24e0	4.38e2	-	-	8.99e-4
1y	1.59e2	1.21e0	3.96e2	-	-	-

Table C.30

Peach Bottom Case 4 Wetwell Gamma Dose Rates

	A			B		
	s	a	w	s	a	w
1h	2.17e4	2.99e5	5.58e4	-	4.16e1	2.25e0
2h	1.57e4	1.55e5	4.26e4	-	2.13e1	1.29e0
4h	1.43e4	6.86e4	3.09e4	-	7.57e0	6.66e-1
8h	1.07e4	4.08e4	2.42e4	-	2.84e0	3.70e-1
16h	8.11e3	2.22e4	1.83e4	-	4.49e-1	2.01e-1
1d	6.74e3	1.49e4	1.65e4	-	1.02e-1	1.40e-1
2d	4.80e3	5.84e3	1.21e4	-	2.91e-2	8.58e-2
4d	3.04e3	2.52e3	7.80e3	-	1.77e-2	5.37e-2
8d	1.46e3	1.17e3	3.92e3	-	7.51e-3	2.39e-2
16d	5.07e2	3.23e2	1.47e3	-	1.41e-3	5.80e-3
32d	2.42e2	5.35e1	8.19e2	-	-	-
64d	1.96e2	1.49e1	5.32e2	-	-	-
128d	1.80e2	1.20e1	4.87e2	-	-	-
256d	1.59e2	1.07e1	4.33e2	-	-	-
1y	1.44e2	9.83e1	3.91e2	-	-	-

APPENDIX D

MAJOR ISOTOPE CONTRIBUTORS TO TOTAL DOSE

Table D.1

Surry Major Radionuclide Contributors to Gamma Dose

	Case 1						Case 2					
	A		F		W		A		F		W	
1h	I134	(.24)	I134	(.28)	I134	(.28)	I134	(.24)	I134	(.28)	I134	(.28)
	I132	(.20)	I132	(.23)	I132	(.23)	I132	(.20)	I132	(.23)	I132	(.23)
	I135	(.15)	I135	(.17)	I135	(.17)	I135	(.15)	I135	(.17)	I135	(.18)
2h	KR88	(.18)	I132	(.30)	I132	(.31)	KR88	(.20)	I132	(.30)	I132	(.30)
	I132	(.16)	I134	(.22)	I134	(.22)	I132	(.19)	I134	(.22)	I134	(.22)
	I134	(.12)	I135	(.21)	I135	(.21)	I134	(.14)	I135	(.21)	I135	(.21)
4h	KR88	(.17)	I132	(.36)	I132	(.39)	KR88	(.27)	I132	(.41)	I132	(.41)
	I132	(.12)	I135	(.20)	I135	(.22)	I132	(.19)	I135	(.23)	I135	(.23)
	SR91	(.07)	I133	(.13)	I133	(.14)	XE135	(.11)	I133	(.15)	I133	(.15)
8h	XE135	(.29)	I132	(.39)	I132	(.46)	XE135	(.41)	I132	(.50)	I132	(.50)
	KR88	(.24)	I135	(.15)	I135	(.17)	KR88	(.34)	I135	(.19)	I135	(.19)
	XE133	(.08)	I133	(.13)	I133	(.15)	XE133	(.11)	I133	(.16)	I133	(.17)
16h	XE135	(.57)	I132	(.46)	I132	(.53)	XE135	(.62)	I132	(.59)	I132	(.59)
	XE133	(.18)	I133	(.12)	I133	(.14)	XE133	(.20)	I133	(.16)	I133	(.16)
	KR88	(.08)	I135	(.08)	I135	(.09)	KR88	(.09)	I135	(.10)	I135	(.10)
1d	XE135	(.63)	I132	(.50)	I132	(.58)	XE135	(.63)	I132	(.64)	I132	(.64)
	XE133	(.28)	I133	(.11)	I133	(.13)	XE133	(.28)	I133	(.14)	I133	(.14)
	XE135M	(.05)	I131	(.07)	I131	(.08)	XE135M	(.05)	I131	(.09)	I131	(.09)
2d	XE133	(.63)	I132	(.54)	I132	(.64)	XE133	(.63)	I132	(.70)	I132	(.71)
	XE135	(.35)	I131	(.08)	I131	(.09)	XE135	(.35)	I131	(.11)	I131	(.11)
	XE133M	(.01)	LA140	(.08)	I133	(.08)	XE133M	(.01)	I133	(.09)	I133	(.09)
4d	XE133	(.96)	I132	(.50)	I132	(.62)	XE133	(.96)	I132	(.70)	I132	(.71)
	XE135	(.02)	LA140	(.10)	I131	(.12)	XE135	(.02)	I131	(.14)	I131	(.14)
	XE133M	(.01)	I131	(.10)	CS134	(.06)	XE133M	(.01)	CS134	(.06)	CS134	(.06)

Table D.1

Surry Major Radionuclide Contributors to Gamma Dose
(Continued)

	Case 1						Case 2					
	A		F		W		A		F		W	
8d	XE133	(.99)	I132	(.36)	I132	(.48)	XE133	(.99)	I132	(.58)	I132	(.59)
	XE133M	(.007)	LA140	(.14)	I131	(.15)	XE133M	(.007)	I131	(.19)	I131	(.19)
	KR85	(.0006)	I131	(.12)	CS134	(.10)	KR85	(.0006)	CS134	(.12)	CS134	(.12)
16d	XE133	(.99)	LA140	(.18)	CS134	(.22)	XE133	(.99)	CS134	(.31)	CS134	(.32)
	KR85	(.0017)	CS134	(.14)	I132	(.19)	KR85	(.002)	I132	(.27)	I132	(.28)
	XE133M	(.0016)	I132	(.13)	I131	(.18)	XE133M	(.002)	I131	(.25)	I131	(.25)
32d	XE133	(.99)	CS134	(.25)	CS134	(.42)	XE133	(.99)	CS134	(.66)	CS134	(.67)
	KR85	(.014)	NB95	(.21)	NB95	(.14)	KR85	(.01)	I131	(.13)	I131	(.14)
	XE133M	(.0001)	ZR95	(.16)	ZR95	(.10)	XE133M	(.0001)	CS136	(.07)	CS136	(.07)
64d	XE133	(.51)	CS134	(.38)	CS134	(.60)	XE133	(.51)	CS134	(.87)	CS134	(.89)
	KR85	(.49)	NB95	(.27)	NB95	(.17)	KR85	(.49)	NB95	(.03)	NB95	(.03)
			ZR95	(.17)	ZR95	(.11)			ZR95	(.02)	CS136	(.02)
128d	KR85	(.9998)	CS134	(.50)	CS134	(.72)	KR85	(.99)	CS134	(.93)	CS134	(.944)
	XE133	(.0002)	NB95	(.23)	NB95	(.13)	XE133	(.0002)	NB95	(.02)	BA137M	(.02)
			ZR95	(.12)	BA137M	(.07)			BA137M	(.02)	NB95	(.02)
256d	KR85	(1.0)	CS134	(.66)	CS134	(.83)	KR85	(1.0)	CS134	(.96)	CS134	(.96)
			BA137M	(.17)	BA137M	(.09)			BA137M	(.03)	BA137M	(.02)
			NB95	(.10)	NB95	(.05)			NB95	(.008)	NB95	(.006)
1y	KR85	(1.0)	CS134	(.72)	CS134	(.86)	KR85	(1.0)	CS134	(.96)	CS134	(.97)
			BA137M	(.2)	BA137M	(.10)			BA137M	(.03)	BA137M	(.02)
			NB95	(.04)	NB95	(.02)			SB125	(.004)	SB125	(.003)

Table D.1

Surry Major Radionuclide Contributors to Gamma Dose
(Continued)

	Case 3				Case 4			
	A		S		A		S	
1h	KR88	(.60)	I134	(.28)	KR88	(.60)	I134	(.28)
	KR87	(.13)	I132	(.22)	KR87	(.13)	I132	(.22)
	XE135	(.09)	I135	(.18)	XE135	(.09)	I135	(.18)
2h	KR88	(.62)	I132	(.28)	KR88	(.62)	I132	(.29)
	XE135	(.13)	I134	(.20)	XE135	(.13)	I134	(.22)
	KR87	(.10)	I135	(.20)	KR87	(.10)	I135	(.22)
4h	KR88	(.54)	I132	(.33)	KR88	(.54)	I132	(.40)
	XE135	(.22)	I135	(.20)	XE135	(.22)	I135	(.24)
	XE135M	(.10)	I133	(.12)	XE135M	(.10)	I133	(.14)
8h	XE135	(.41)	I132	(.41)	XE135	(.41)	I132	(.50)
	KR88	(.34)	I135	(.17)	KR88	(.34)	I135	(.20)
	XE135M	(.11)	I133	(.13)	XE133	(.11)	I133	(.16)
16h	XE135	(.62)	I132	(.49)	XE135	(.62)	I132	(.60)
	XE133	(.20)	I133	(.13)	XE133	(.20)	I133	(.16)
	KR88	(.09)	I135	(.09)	KR88	(.09)	I135	(.11)
1d	XE135	(.63)	I132	(.54)	XE135	(.63)	I132	(.65)
	XE133	(.28)	I133	(.12)	XE133	(.28)	I133	(.14)
	XE135M	(.05)	I131	(.06)	XE133M	(.05)	I131	(.07)
2d	XE133	(.63)	I132	(.58)	XE133	(.63)	I132	(.72)
	XE135	(.35)	LA140	(.07)	XE135	(.35)	I131	(.09)
	XE133M	(.01)	I131	(.07)	XE133M	(.01)	I133	(.09)
4d	XE133	(.96)	I132	(.55)	XE133	(.96)	I132	(.73)
	XE135	(.02)	LA140	(.10)	XE135	(.02)	I131	(.12)
	XE133M	(.01)	I131	(.09)	XE133M	(.01)	CS134	(.06)

Table D.1

Surry Major Radionuclide Contributors to Gamma Dose
(Concluded)

	Case 3				Case 4			
	A		S		A		S	
8d	XE133	(.99)	I132	(.41)	XE133	(.99)	I132	(.61)
	XE133M	(.007)	LA140	(.14)	XE133M	(.007)	I131	(.16)
	KR85	(.0006)	I131	(.11)	KR85	(.0006)	CS134	(.13)
16d	XE133	(.997)	LA140	(.18)	XE133	(.997)	CS134	(.33)
	KR85	(.002)	CS134	(.17)	KR85	(.002)	I132	(.29)
	XE133M	(.001)	I132	(.15)	XE133M	(.001)	I131	(.21)
32d	XE133	(.99)	CS134	(.29)	XE133	(.99)	CS134	(.68)
	KR85	(.009)	NB95	(.20)	KR85	(.009)	I131	(.11)
	XE133M	(.0001)	ZR95	(.15)	XE133M	(.0001)	CS136	(.07)
64d	XE133	(.51)	CS134	(.43)	XE133	(.51)	CS134	(.88)
	KR85	(.49)	NB95	(.25)	KR85	(.49)	NB95	(.03)
			ZR95	(.16)			ZR95	(.02)
128d	KR85	(.9998)	CS134	(.56)	KR85	(.9998)	CS134	(.94)
	XE133	(.0002)	NB95	(.21)	XE133	(.0002)	NB95	(.02)
			ZR95	(.11)			BA137M	(.02)
256d	KR85	(1.0)	CS134	(.71)	KR85	(1.0)	CS134	(.96)
			BA137M	(.14)			BA137M	(.02)
			NB95	(.08)			NB95	(.001)
1y	KR85	(1.0)	CS134	(.76)	KR85	(1.0)	CS134	(.96)
			BA137M	(.17)			BA137M	(.03)
			NB95	(.03)			SB125	(.004)

A: Airborne W: Wall
F: Floor S: Sump

Table D.2

Surry Major Radionuclide Contributors to Beta Dose

	Case 1						Case 2					
	A		F		W		A		F		W	
1h	RB88	(.16)	RB88	(.22)	RB88	(.22)	RB88	(.16)	RB88	(.22)	RB88	(.22)
	I134	(.12)	I134	(.16)	CS138	(.16)	I134	(.12)	I134	(.16)	CS138	(.16)
	CS138	(.12)	CS138	(.16)	I134	(.16)	CS138	(.12)	CS138	(.16)	I134	(.16)
2h	XE133	(.10)	RB88	(.23)	RB88	(.24)	XE133	(.13)	RB88	(.24)	RB88	(.24)
	KR87	(.09)	I133	(.18)	I133	(.18)	KR87	(.11)	I133	(.18)	I133	(.18)
	RB88	(.08)	I132	(.16)	I132	(.16)	RB88	(.11)	I132	(.16)	I132	(.16)
4h	XE133	(.13)	I133	(.17)	I133	(.21)	XE133	(.24)	I133	(.24)	I133	(.24)
	XE135	(.10)	I132	(.16)	I132	(.20)	XE135	(.20)	I132	(.22)	I132	(.22)
	SR91	(.08)	RB88	(.15)	RB88	(.18)	KR88	(.09)	RB88	(.20)	RB88	(.20)
8h	XE133	(.35)	I132	(.16)	I132	(.23)	XE133	(.44)	I132	(.29)	I132	(.30)
	XE135	(.32)	I133	(.16)	I133	(.22)	XE135	(.41)	I133	(.28)	I133	(.29)
	KR88	(.05)	SR89	(.09)	I135	(.10)	KR88	(.06)	I135	(.13)	I135	(.13)
16h	XE133	(.51)	I132	(.19)	I132	(.28)	XE133	(.53)	I132	(.37)	I132	(.38)
	XE135	(.40)	I133	(.15)	I133	(.22)	XE135	(.42)	I133	(.30)	I133	(.30)
	XE133M	(.02)	SR89	(.12)	I131	(.08)	XE133M	(.02)	I131	(.11)	I131	(.11)
1d	XE133	(.61)	I132	(.21)	I132	(.31)	XE133	(.61)	I132	(.42)	I132	(.43)
	XE135	(.34)	SR89	(.14)	I133	(.20)	XE135	(.34)	I133	(.27)	I133	(.28)
	XE133M	(.02)	I123	(.14)	I131	(.09)	XE133M	(.02)	I131	(.13)	I131	(.13)
2d	XE133	(.84)	I132	(.22)	I132	(.34)	XE133	(.84)	I132	(.49)	I132	(.50)
	XE135	(.12)	SR89	(.19)	I133	(.12)	XE135	(.12)	I133	(.18)	I133	(.18)
	XE133M	(.03)	BA140	(.16)	SR89	(.12)	XE133M	(.03)	I131	(.17)	I131	(.17)
4d	XE133	(.95)	SR89	(.23)	I132	(.31)	XE133	(.95)	I132	(.50)	I132	(.51)
	XE133M	(.03)	I132	(.19)	SR89	(.17)	XE133M	(.03)	I131	(.22)	I131	(.23)
	KR85	(.008	BA140	(.18)	I131	(.14)	KR85	(.008)	SR89	(.07)	SR89	(.06)

Table D.2

Surry Major Radionuclide Contributors to Beta Dose
(Continued)

	Case 1						Case 2					
	A		F		W		A		F		W	
8d	XE133	(.96)	SR89	(.29)	SR89	(.23)	XE133	(.96)	I132	(.37)	I132	(.39)
	KR85	(.01)	BA140	(.20)	I132	(.20)	KR85	(.013)	I131	(.27)	I131	(.29)
	XE133M	(.01)	I132	(.11)	BA140	(.16)	XE133M	(.012)	SR89	(.11)	SR89	(.10)
16d	XE133	(.93)	SR89	(.37)	SR89	(.33)	XE133	(.93)	I131	(.28)	I131	(.30)
	KR85	(.04)	BA140	(.18)	BA140	(.16)	KR85	(.04)	SR89	(.20)	SR89	(.19)
	XE131M	(.02)	PR144	(.11)	I131	(.11)	XE131M	(.02)	I132	(.14)	I132	(.15)
32d	XE133	(.70)	SR89	(.44)	SR89	(.41)	XE133	(.70)	SR89	(.31)	SR89	(.29)
	KR85	(.23)	PR144	(.16)	PR144	(.14)	KR85	(.23)	CS137	(.14)	CS137	(.15)
	XE131M	(.08)	BA140	(.11)	BA140	(.10)	XE131M	(.08)	I131	(.13)	CS134	(.15)
64d	KR85	(.90)	SR89	(.45)	SR89	(.42)	KR85	(.90)	SR89	(.32)	SR89	(.30)
	XE131M	(.06)	PR144	(.23)	PR144	(.20)	XE131M	(.06)	CS137	(.22)	CS137	(.24)
	XE133	(.04)	Y91	(.08)	CS137	(.07)	XE133	(.04)	CS134	(.21)	CS134	(.23)
128d	KR85	(.99)	PR144	(.34)	SR89	(.29)	KR85	(.998)	CS137	(.31)	CS137	(.33)
	XE131M	(.002)	SR89	(.32)	PR144	(.28)	XE131M	(.002)	CS134	(.28)	CS134	(.30)
	XE133	(-)	Y91	(.07)	CS137	(.12)	XE133	(-)	SR89	(.19)	SR89	(.17)
256d	KR85	(1.0)	PR144	(.48)	PR144	(.36)	KR85	(1.0)	CS137	(.42)	CS137	(.44)
	XE131M	(-)	CS137	(.11)	CS137	(.21)	XE131M	(-)	CS134	(.34)	CS134	(.36)
	XE133	(-)	SR89	(.11)	CS134	(.17)	XE133	(-)	PR144	(.10)	PR144	(.08)
1y	KR85	(1.0)	PR144	(.49)	PR144	(.34)	KR85	(1.0)	CS137	(.46)	CS137	(.48)
	XE131M	(-)	CS137	(.14)	CS137	(.26)	XE131M	(-)	CS134	(.34)	CS134	(.36)
	XE133	(-)	CS134	(.11)	CS134	(.19)	XE133	(-)	PR144	(.09)	PR144	(.07)

Table D.2

Surry Major Radionuclide Contributors to Beta Dose
(Continued)

	Case 3				Case 4			
	A		S		A		S	
1h	KR87	(.34)	RB88	(.21)	KR87	(.34)	RB88	(.21)
	XE133	(.23)	I134	(.16)	XE133	(.23)	I134	(.16)
	KR88	(.17)	CS138	(.16)	KR88	(.17)	CS138	(.16)
2h	XE133	(.29)	RB88	(.20)	XE133	(.29)	RB88	(.23)
	KR87	(.25)	I133	(.15)	KR87	(.25)	I133	(.17)
	XE135	(.20)	I132	(.14)	XE135	(.20)	I132	(.15)
4h	XE133	(.37)	I133	(.15)	XE133	(.37)	I133	(.23)
	XE135	(.30)	I132	(.14)	XE135	(.30)	I132	(.22)
	KR88	(.13)	RB88	(.13)	KR88	(.13)	RB88	(.20)
8h	XE133	(.44)	I132	(.17)	XE133	(.44)	I132	(.29)
	XE135	(.41)	I133	(.17)	XE135	(.41)	I133	(.28)
	KR88	(.06)	SR89	(.09)	KR88	(.06)	I135	(.13)
16h	XE133	(.52)	I132	(.22)	XE133	(.53)	I132	(.38)
	XE135	(.42)	I133	(.17)	XE135	(.42)	I133	(.30)
	XE133M	(.02)	SR89	(.11)	XE133M	(.22)	I131	(.11)
1d	XE133	(.61)	I132	(.24)	XE133	(.62)	I132	(.42)
	XE135	(.34)	I133	(.15)	XE135	(.34)	I133	(.28)
	XE133M	(.02)	SR89	(.13)	XE133M	(.02)	I131	(.13)
2d	XE133	(.84)	I132	(.25)	XE133	(.84)	I132	(.49)
	XE135	(.12)	SR89	(.17)	XE135	(.12)	I133	(.18)
	XE133M	(.03)	BA140	(.14)	XE133M	(.03)	I131	(.17)
4d	XE133	(.95)	SR89	(.22)	XE133	(.95)	I132	(.50)
	XE133M	(.03)	I132	(.22)	XE133M	(.03)	I131	(.22)
	KR85	(.008)	BA140	(.17)	KR85	(.008)	SR89	(.06)

Table D.2

Surry Major Radionuclide Contributors to Beta Dose
(Concluded)

	Case 3				Case 4			
	A		S		A		S	
8d	XE133	(.96)	SR89	(.28)	XE133	(.96)	I132	(.38)
	KR85	(.013)	BA140	(.19)	KR85	(.013)	I131	(.28)
	XE133M	(.012)	I132	(.12)	XE133M	(.012)	SR89	(.11)
16d	XE133	(.93)	SR89	(.36)	XE133	(.94)	I131	(.29)
	KR85	(.04)	BA140	(.17)	KR85	(.04)	SR89	(.20)
	XE131M	(.02)	PR144	(.11)	XE131M	(.02)	I132	(.14)
32d	XE133	(.70)	SR89	(.43)	XE133	(.70)	SR89	(.31)
	KR85	(.23)	PR144	(.15)	KR85	(.23)	CS137	(.14)
	XE131M	(.08)	BA140	(.11)	XE131M	(.08)	CS134	(.14)
64d	KR85	(.90)	SR89	(.44)	KR85	(.90)	SR89	(.31)
	XE131M	(.06)	PR144	(.22)	XE131M	(.06)	CS137	(.23)
	XE133	(.04)	Y91	(.08)	XE133	(.04)	CS134	(.22)
128d	KR85	(.998)	PR144	(.33)	KR85	(.998)	CS137	(.32)
	XE131M	(.002)	SR89	(.32)	XE131M	(.0017)	CS134	(.29)
	XE133	(-)	CS137	(.07)	XE133	(-)	SR89	(.18)
256d	KR85	(1.0)	PR144	(.45)	KR85	(1.0)	CS137	(.42)
	XE131M	(-)	CS137	(.13)	XE131M	(-)	CS134	(.34)
	XE133	(-)	CS134	(.10)	XE133	(-)	PR144	(.10)
1y	KR85	(1.0)	PR144	(.46)	KR85	(1.0)	CS137	(.47)
	XE131M	(-)	CS137	(.17)	XE131M	(-)	CS134	(.35)
	XE133	(-)	CS134	(.12)	XE133	(-)	PR144	(.08)

Table D.3

Peach Bottom Drywell Major Radionuclide Contributors to Gamma Dose

	Case 1						Case 2					
	A		F		W		A		F		W	
1h	I134	(.20)	I134	(.28)	I134	(.26)	I134	(.20)	I134	(.28)	I134	(.26)
	KR88	(.17)	I132	(.23)	I132	(.22)	KR88	(.17)	I132	(.23)	I132	(.22)
	I132	(.16)	I135	(.17)	I135	(.16)	I132	(.16)	I135	(.17)	I135	(.16)
2h	KR88	(.47)	I132	(.30)	I132	(.30)	KR88	(.47)	I132	(.30)	I132	(.30)
	XE135	(.11)	I134	(.22)	I134	(.21)	XE135	(.11)	I134	(.22)	I134	(.21)
	KR87	(.07)	I135	(.21)	I135	(.20)	KR87	(.07)	I135	(.21)	I135	(.20)
4h	KR88	(.51)	I132	(.34)	I132	(.32)	KR88	(.53)	I132	(.41)	I132	(.40)
	XE135	(.23)	I135	(.19)	I135	(.18)	XE135	(.24)	I135	(.23)	I135	(.22)
	XE135M	(.09)	I133	(.12)	I133	(.12)	XE135M	(.10)	I133	(.15)	I133	(.15)
8h	XE135	(.43)	I132	(.48)	I132	(.48)	XE135	(.43)	I132	(.51)	I132	(.49)
	KR88	(.33)	I135	(.18)	I135	(.18)	KR88	(.33)	I135	(.20)	I135	(.19)
	XE133	(.11)	I133	(.16)	I133	(.16)	XE135M	(.11)	I133	(.17)	I133	(.17)
16h	XE135	(.63)	I132	(.58)	I132	(.59)	XE135	(.63)	I132	(.60)	I132	(.59)
	XE133	(.19)	I133	(.16)	I133	(.16)	XE133	(.19)	I133	(.16)	I133	(.16)
	KR88	(.09)	I135	(.10)	I135	(.10)	KR88	(.08)	I135	(.10)	I135	(.10)
1d	XE135	(.65)	I132	(.64)	I132	(.64)	XE135	(.65)	I132	(.65)	I132	(.64)
	XE133	(.27)	I133	(.14)	I133	(.14)	XE133	(.27)	I133	(.15)	I133	(.14)
	XE135M	(.05)	I131	(.08)	I131	(.08)	XE135M	(.05)	I131	(.09)	I131	(.08)
2d	XE133	(.61)	I132	(.70)	I132	(.71)	XE133	(.61)	I132	(.72)	I132	(.69)
	XE135	(.36)	I131	(.10)	I131	(.11)	XE135	(.36)	I131	(.11)	I131	(.11)
	XE135M	(.01)	I133	(.09)	I133	(.09)	XE133M	(.01)	I133	(.09)	I133	(.09)
4d	XE133	(.96)	I132	(.70)	I132	(.70)	XE133	(.96)	I132	(.73)	I132	(.68)
	XE135	(.02)	I131	(.14)	I131	(.14)	XE135	(.02)	I131	(.14)	I131	(.13)
	XE133M	(.01)	CS134	(.06)	CS134	(.08)	XE133M	(.01)	CS134	(.06)	CS134	(.10)

Table D.3

Peach Bottom Drywell Major Radionuclide Contributors to Gamma Dose
(Continued)

	Case 1						Case 2					
	A		F		W		A		F		W	
8d	XE133	(.99)	I132	(.59)	I132	(.58)	XE133	(.99)	I132	(.61)	I132	(.55)
	XE133M	(.007)	I131	(.19)	I131	(.19)	XE133M	(.007)	I131	(.20)	CS134	(.19)
	KR85	(.0007)	CS134	(.12)	CS134	(.16)	KR85	(.0007)	CS134	(.12)	I131	(.18)
16d	XE133	(.996)	CS134	(.31)	CS134	(.39)	XE133	(.996)	CS134	(.33)	CS134	(.44)
	KR85	(.002)	I132	(.27)	I132	(.26)	KR85	(.002)	I132	(.30)	I132	(.23)
	XE133M	(.002)	I131	(.25)	I131	(.24)	XE133M	(.002)	I131	(.27)	I131	(.21)
32d	XE133	(.98)	CS134	(.65)	CS134	(.77)	XE133	(.98)	CS134	(.74)	CS134	(.80)
	KR85	(.019)	I131	(.14)	I131	(.12)	KR85	(.019)	I131	(.15)	I131	(.10)
	SB125	(.0004)	CS136	(.07)	CS136	(.08)	XE133M	(.0001)	CS136	(.08)	CS136	(.09)
64d	KR85	(.51)	CS134	(.87)	CS134	(.96)	KR85	(.52)	CS134	(.96)	CS134	(.96)
	XE133	(.47)	NB95	(.04)	CS136	(.02)	XE133	(.48)	CS136	(.02)	CS136	(.02)
	SB125	(.01)	ZR95	(.03)	I131	(.01)	XE133M	(-)	I131	(.01)	I131	(.008)
128d	KR85	(.97)	CS134	(.93)	CS134	(.99)	KR85	(.9998)	CS134	(.993)	CS134	(.997)
	SB125	(.029)	NB95	(.03)	SB125	(.002)	XE133	(.0002)	SB125	(.0045)	SB125	(.002)
	TE129M	(.002)	BA137M	(.02)	BA137M	(.001)			BA137M	(.001)	CS136	(.0007)
256d	KR85	(.97)	CS134	(.96)	CS134	(.996)	KR85	(1.0)	CS134	(.994)	CS134	(.9978)
	SB125	(.02)	BA137M	(.02)	SB125	(.002)			SB125	(.0049)	SB125	(.002)
	BA137M	(.001)	NB95	(.01)	BA137M	(.002)			BA137M	(.0013)	BA137M	(.0005)
1y	KR85	(.97)	CS134	(.97)	CS134	(.99)	KR85	(1.0)	CS134	(.994)	CS134	(.9978)
	SB125	(.02)	BA137M	(.02)	SB125	(.002)			SB125	(.0049)	SB125	(.002)
	BA137M	(.001)	SB125	(.01)	BA137M	(.002)			BA137M	(.0013)	BA137M	(.0005)

Table D.3

Peach Bottom Drywell Radionuclide Contributors to Gamma Dose
(Continued)

	Case 3		Case 4	
	A		A	
1h	KR88	(.59)	KR88	(.59)
	KR87	(.13)	KR87	(.13)
	XE135	(.10)	XE135	(.10)
2h	KR88	(.61)	KR88	(.61)
	XE135	(.15)	XE135	(.15)
	KR87	(.09)	KR87	(.09)
4h	KR88	(.53)	KR88	(.53)
	XE135	(.24)	XE135	(.24)
	XE135M	(.10)	XE135M	(.10)
8h	XE135	(.43)	XE135	(.43)
	KR88	(.33)	KR88	(.33)
	XE135M	(.11)	XE133	(.11)
16h	XE135	(.63)	XE135	(.63)
	XE133	(.33)	XE133	(.19)
	KR88	(.11)	KR88	(.09)
1d	XE135	(.65)	XE135	(.65)
	XE133	(.27)	XE133	(.27)
	XE135M	(.05)	XE135M	(.05)
2d	XE133	(.62)	XE133	(.62)
	XE135	(.36)	XE135	(.36)
	XE133M	(.012)	XE133M	(.01)
4d	XE133	(.96)	XE133	(.96)
	XE135	(.02)	XE135	(.02)
	XE133M	(.014)	XE133M	(.01)

Table D.3

Peach Bottom Drywell Radionuclide Contributors to Gamma Dose
(Concluded)

	Case 3		Case 4	
	A		A	
8d	XE133	(.99)	XE133	(.99)
	XE133M	(.007)	XE133M	(.007)
	KR85	(.0007)	KR85	(.0007)
16d	XE133	(.996)	XE133	(.996)
	KR85	(.0019)	KR85	(.002)
	XE133M	(.0019)	XE133M	(.002)
32d	XE133	(.98)	XE133	(.98)
	KR85	(.019)	KR85	(.016)
	XE133M	(.0001)	XE133M	(.0001)
64d	KR85	(.52)	KR85	(.52)
	XE133	(.48)	XE133	(.48)
	XE133M	(-)	XE133M	(-)
128d	KR85	(.9998)	KR85	(.9998)
	XE133	(.0002)	XE133	(.0002)
250d	KR85	(1.0)	KR85	(1.0)
1y	KR85	(1.0)	KR85	(1.0)

A: Airborne W: Wall
F: Floor S: Sump

Table D.4

Peach Bottom Drywell Radionuclide Contributors to Beta Dose

	Case 1						Case 2					
	A		F		W		A		F		W	
1h	KR87	(.13)	RB88	(.22)	RB88	(.28)	KR87	(.13)	RB88	(.22)	RB88	(.28)
	RB88	(.13)	CS138	(.16)	CS138	(.20)	RB88	(.13)	CS138	(.16)	CS138	(.20)
	CS138	(.09)	I134	(.16)	I134	(.14)	CS138	(.09)	I134	(.16)	I134	(.14)
2h	XE133	(.24)	RB88	(.24)	RB88	(.30)	XE133	(.24)	RB88	(.25)	RB88	(.30)
	KR87	(.21)	I133	(.21)	I133	(.18)	KR87	(.21)	I133	(.18)	I133	(.16)
	XE135	(.20)	I132	(.16)	I132	(.16)	XE135	(.20)	I132	(.16)	I132	(.14)
4h	XE133	(.33)	I133	(.15)	RB88	(.16)	XE133	(.35)	I133	(.24)	RB88	(.32)
	XE135	(.32)	I132	(.14)	I133	(.14)	XE135	(.33)	I132	(.23)	I133	(.21)
	KR88	(.12)	RB88	(.14)	I132	(.13)	KR88	(.13)	RB88	(.22)	I132	(.20)
8h	XE135	(.27)	I132	(.43)	I132	(.31)	XE135	(.43)	I132	(.31)	I132	(.29)
	XE133	(.26)	I133	(.42)	I133	(.30)	XE133	(.42)	I133	(.30)	I133	(.28)
	KR88	(.13)	I135	(.06)	RB88	(.14)	KR88	(.06)	I135	(.14)	RB88	(.18)
16h	XE133	(.51)	I132	(.38)	I132	(.40)	XE133	(.51)	I132	(.41)	I132	(.40)
	XE135	(.43)	I133	(.30)	I133	(.32)	XE135	(.43)	I133	(.32)	I133	(.32)
	XE133M	(.02)	I131	(.11)	I131	(.11)	XE133M	(.21)	I131	(.12)	I131	(.11)
1d	XE133	(.60)	I132	(.43)	I132	(.46)	XE133	(.60)	I132	(.46)	I132	(.46)
	XE135	(.36)	I133	(.28)	I133	(.30)	XE135	(.36)	I133	(.30)	I133	(.30)
	XE133M	(.02)	I131	(.13)	I131	(.14)	XE133M	(.24)	I131	(.14)	I131	(.14)
2d	XE133	(.83)	I132	(.50)	I132	(.54)	XE133	(.83)	I132	(.54)	I132	(.54)
	XE135	(.12)	I133	(.18)	I133	(.20)	XE135	(.12)	I133	(.20)	I133	(.20)
	XE133M	(.03)	I131	(.17)	I131	(.18)	XE133M	(.03)	I131	(.19)	I131	(.18)
4d	XE133	(.95)	I132	(.51)	I132	(.58)	XE133	(.95)	I132	(.58)	I132	(.57)
	XE133M	(.02)	I131	(.23)	I131	(.26)	XE133M	(.03)	I131	(.26)	I131	(.25)
	KR85	(.009)	I133	(.06)	I133	(.07)	KR85	(.009)	I133	(.07)	I133	(.06)

Table D.4

Peach Bottom Drywell Radionuclide Contributors to Beta Dose
(Continued)

	Case 1						Case 2					
	A		F		W		A		F		W	
8d	XE133	(.96)	I132	(.39)	I132	(.47)	XE133	(.96)	I132	(.49)	I132	(.46)
	KR85	(.02)	I131	(.29)	I131	(.35)	KR85	(.02)	I131	(.36)	I131	(.34)
	XE133M	(.01)	SR89	(.07)	CS137	(.07)	XE133M	(.01)	CS137	(.05)	CS137	(.09)
16d	XE133	(.93)	I131	(.31)	I131	(.41)	XE133	(.93)	I131	(.46)	I131	(.39)
	KR85	(.04)	I132	(.15)	I132	(.20)	KR85	(.04)	I132	(.22)	CS137	(.20)
	XE131M	(.02)	SR89	(.14)	CS137	(.17)	XE131M	(.02)	CS137	(.13)	I132	(.19)
32d	XE133	(.67)	SR89	(.22)	CS137	(.36)	XE133	(.68)	CS137	(.33)	CS137	(.39)
	KR85	(.25)	CS137	(.18)	CS134	(.29)	KR85	(.25)	I131	(.28)	CS134	(.33)
	XE131M	(.07)	I131	(.15)	I131	(.23)	XE131M	(.07)	CS134	(.27)	I131	(.20)
64d	KR85	(.91)	CS137	(.28)	CS137	(.50)	KR85	(.91)	CS137	(.50)	CS137	(.53)
	XE131M	(.05)	CS134	(.23)	CS134	(.41)	XE131M	(.05)	CS134	(.40)	CS134	(.42)
	XE133	(.04)	SR89	(.22)	SR89	(.03)	XE133	(.04)	I131	(.03)	I131	(.02)
128d	KR85	(.998)	CS137	(.37)	CS137	(.55)	KR85	(.998)	CS137	(.55)	CS137	(.56)
	XE131M	(.015)	CS134	(.28)	CS134	(.42)	XE131M	(.0015)	CS134	(.42)	CS134	(.43)
	TE127	(-)	SR89	(.12)	SR89	(.01)	XE133	(-)	SR89	(.01)	SR89	(.004)
250d	KR85	(.999)	CS137	(.47)	CS137	(.59)	KR85	(.999)	CS137	(.59)	CS137	(.59)
	SB125	(-)	CS134	(.32)	CS134	(.14)	XE131M	(-)	CS134	(.40)	CS134	(.40)
	TE127	(-)	PR144	(.11)	PR144	(.004)	XE133	(-)	SB125	(.004)	SB125	(.0014)
1y	KR85	(1.0)	CS137	(.52)	CS137	(.61)	KR85	(1.0)	CS137	(.61)	CS137	(.61)
	SB125	(-)	CS134	(.32)	CS134	(.38)	XE131M	(-)	CS134	(.38)	CS134	(.38)
	TE127	(-)	PR144	(.10)	PR144	(.004)	XE133	(-)	SB125	(.004)	SB125	(.0014)

Table D.4

Peach Bottom Drywell Radionuclide Contributors to Beta Dose
(Continued)

	Case 3		Case 4	
	A		A	
1h	KR87	(.33)	KR87	(.33)
	XE133	(.22)	XE133	(.22)
	KR88	(.16)	KR88	(.16)
2h	XE133	(.27)	XE133	(.27)
	KR87	(.24)	KR87	(.24)
	XE135	(.23)	XE135	(.23)
4h	XE133	(.35)	XE133	(.35)
	XE135	(.33)	XE135	(.33)
	KR88	(.13)	KR88	(.13)
8h	XE135	(.43)	XE135	(.43)
	XE133	(.42)	XE133	(.42)
	KR88	(.06)	KR88	(.06)
16h	XE133	(.51)	XE133	(.51)
	XE135	(.43)	XE135	(.43)
	XE133M	(.02)	XE133M	(.02)
1d	XE133	(.60)	XE133	(.60)
	XE135	(.36)	XE135	(.36)
	XE133M	(.02)	XE133M	(.02)
2d	XE133	(.83)	XE133	(.83)
	XE135	(.12)	XE135	(.12)
	XE133M	(.03)	XE133M	(.03)
4d	XE133	(.95)	XE133	(.95)
	XE133M	(.03)	XE133M	(.03)
	KR85	(.009)	KR85	(.009)

Table D.4

Peach Bottom Drywell Radionuclide Contributors to Beta Dose
(Concluded)

	Case 3		Case 4	
	A		A	
8d	XE133	(.96)	XE133	(.96)
	KR85	(.02)	KR85	(.02)
	XE133M	(.01)	XE133M	(.01)
16d	XE133	(.93)	XE133	(.93)
	KR85	(.04)	KR85	(.04)
	XE131M	(.02)	XE131M	(.02)
32d	XE133	(.68)	XE133	(.68)
	KR85	(.25)	KR85	(.25)
	XE131M	(.07)	XE131M	(.07)
64d	KR85	(.91)	KR85	(.91)
	XE131M	(.05)	XE131M	(.05)
	XE133	(.04)	XE133	(.04)
128d	KR85	(.998)	KR85	(.998)
	XE131M	(.0015)	XE131M	(.0015)
	XE133	(-)	XE133	(-)
256d	KR85	(1.0)	KR85	(1.0)
	XE131M	(-)	XE131M	(-)
	XE133	(-)	XE133	(-)
1y	KR85	(1.0)	KR85	(1.0)
	XE131M	(-)	XE131M	(-)
	XE133	(-)	XE133	(-)

A: Airborne W: Wall
F: Floor S: Sump

Table D.5

Peach Bottom Wetwell Major Radionuclide Contributors to Gamma Dose

	Case 1						Case 2					
	A		W		S		A		W		S	
1h	KR88	(.53)	I134	(.28)	I134	(.27)	KR88	(.53)	I134	(.28)	I134	(.27)
	KR87	(.11)	I132	(.23)	I135	(.20)	KR87	(.11)	I132	(.23)	I135	(.20)
	XE135	(.08)	I135	(.17)	I132	(.20)	XE135	(.08)	I135	(.17)	I132	(.20)
	KR88	(.78)	CS138	(.33)			KR88	(.78)	CS138	(.33)		
	KR87	(.13)	I134	(.23)			KR87	(.13)	I134	(.23)		
	XE138	(.04)	I135	(.17)			XE138	(.04)	I135	(.17)		
2h	KR88	(.57)	I132	(.31)	I132	(.27)	KR88	(.58)	I132	(.31)	I132	(.27)
	XE135	(.13)	I134	(.22)	I135	(.26)	XE135	(.13)	I134	(.22)	I135	(.26)
	KR87	(.09)	I135	(.21)	I134	(.22)	KR87	(.09)	I135	(.21)	I134	(.22)
	KR88	(.86)	I135	(.27)			KR88	(.86)	I135	(.27)		
	KR87	(.11)	I134	(.24)			KR87	(.11)	I134	(.24)		
	I135	(.007)	RB88	(.19)			I135	(.007)	RB88	(.19)		
4h	KR88	(.58)	I132	(.42)	I132	(.37)	KR88	(.51)	I132	(.42)	I132	(.39)
	XE135	(.24)	I135	(.23)	I135	(.28)	XE135	(.21)	I135	(.23)	I135	(.30)
	XE135M	(.11)	I133	(.15)	I133	(.12)	XE135M	(.10)	I133	(.15)	I133	(.13)
	KR88	(.94)	I135	(.42)			KR88	(.91)	I135	(.42)		
	KR87	(.059)	RB88	(.22)			KR87	(.06)	RB88	(.22)		
	XE135M	(.0005)	I132	(.17)			I135	(.01)	I132	(.17)		
8h	XE135	(.45)	I132	(.49)	I132	(.60)	XE135	(.38)	I132	(.52)	I132	(.50)
	KR88	(.38)	I135	(.30)	I135	(.14)	KR88	(.32)	I135	(.20)	I135	(.26)
	XE135M	(.13)	RB88	(.15)	I133	(.14)	XE135M	(.11)	I133	(.17)	I133	(.15)
	KR88	(.97)	I132	(.61)			KR88	(.94)	I135	(.50)		
	KR87	(.02)	I133	(.17)			I135	(.02)	I132	(.30)		
	XE135M	(.001)	I135	(.11)			KR87	(.02)	RB88	(.15)		

Table D.5

Peach Bottom Wetwell Major Radionuclide Contributors to Gamma Dose
(Continued)

	Case 1						Case 2					
	A		W		S		A		W		S	
16h	XE135	(.74)	I132	(.61)	I132	(.60)	XE135	(.56)	I132	(.61)	I132	(.62)
	XE135M	(.11)	I133	(.17)	I135	(.14)	I132	(.15)	I133	(.17)	I135	(.15)
	KR88	(.11)	I135	(.11)	I133	(.14)	XE135M	(.08)	I135	(.11)	I133	(.15)
	KR88	(.99)	I132	(.51)			KR88	(.84)	I132	(.51)		
	XE135M	(.003)	I135	(.39)			I132	(.08)	I135	(.39)		
	XE135	(.002)	I133	(.04)			I135	(.06)	I133	(.04)		
1d	XE135	(.84)	I132	(.66)	I132	(.67)	XE135	(.58)	I132	(.66)	I132	(.69)
	XE135M	(.08)	I133	(.15)	I133	(.13)	I132	(.21)	I133	(.15)	I133	(.14)
	XE133	(.05)	I131	(.08)	I135	(.07)	XE135M	(.05)	I131	(.08)	I135	(.08)
	KR88	(.98)	I132	(.68)			KR88	(.52)	I132	(.68)		
	XE135	(.01)	I135	(.24)			I132	(.33)	I135	(.24)		
	XE135M	(.01)	I133	(.04)			I135	(.12)	I133	(.04)		
2d	XE135	(.76)	I132	(.73)	I132	(.76)	I132	(.44)	I132	(.73)	I132	(.79)
	XE133	(.19)	I131	(.10)	I133	(.08)	XE135	(.33)	I131	(.10)	I133	(.09
	XE135M	(.03)	I133	(.09)	CS134	(.04)	XE133	(.08)	I133	(.09)	CS134	(.04)
	KR88	(.48)	I132	(.90)			I132	(.91)	I132	(.90)		
	XE135	(.37)	I135	(.03)			I133	(.03)	I135	(.03)		
	XE135M	(.12)	I133	(.03)			I135	(.03)	I133	(.03)		
4d	XE133	(.79)	I132	(.74)	I132	(.78)	I132	(.65)	I132	(.74)	I132	(.81)
	XE135	(.13)	CS136	(.13)	CS134	(.06)	XE133	(.15)	I131	(.13)	CS134	(.07)
	XE133M	(.08)	CS134	(.07)	I131	(.05)	I131	(.11)	CS134	(.07)	I131	(.05)
	XE135	(.45)	I132	(.94)			I132	(.98)	I132	(.94)		
	TE131M	(.34)	CS136	(.03)			I133	(.01)	CS136	(.02)		
	KR85	(.09)	CS134	(.02)			TE131M	(.004)	CS134	(.02)		

Table D.5

Peach Bottom Wetwell Major Radionuclide Contributors to Gamma Dose
(Continued)

	Case 1						Case 2					
	A		W		S		A		W		S	
8d	XE133	(.94)	I132	(.63)	I132	(.67)	I132	(.60)	I132	(.63)	I132	(.71)
	XE133M	(.049)	I131	(.18)	CS134	(.13)	XE133	(.19)	I131	(.18)	CS134	(.14)
	KR85	(.005)	CS134	(.14)	I131	(.08)	I131	(.17)	CS134	(.14)	I131	(.08)
	KR85	(.52)	I132	(.90)			I132	(.98)	I132	(.90)		
	TE131M	(.21)	CS134	(.05)			I131	(.005)	CS134	(.05)		
	SB127	(.11)	CS136	(.05)			CS134	(.004)	CS136	(.05)		
16d	XE133	(.97)	CS134	(.36)	CS134	(.34)	I132	(.39)	CS134	(.36)	CS134	(.40)
	KR85	(.02)	I132	(.30)	I132	(.33)	I131	(.31)	I132	(.31)	I132	(.37)
	XE133M	(.01)	I131	(.24)	I131	(.10)	XE133	(.24)	I131	(.24)	I131	(.11)
	KR85	(.81)	I132	(.66)			I132	(.95)	I132	(.67)		
	LA140	(.05)	CS134	(.19)			CS134	(.02)	CS134	(.20)		
	SB127	(.04)	CS136	(.12)			I131	(.01)	CS136	(.13)		
32d	XE133	(.88)	CS134	(.76)	CS134	(.69)	I131	(.48)	CS134	(.77)	CS134	(.81)
	KR85	(.11)	I131	(.13)	CS136	(.08)	CS134	(.19)	I131	(.13)	CS136	(.10)
	SB125	(.003)	CS136	(.08)	I131	(.05)	XE133	(.18)	CS136	(.08)	I131	(.06)
	KR85	(.90)	CS134	(.70)			I132	(.51)	CS134	(.71)		
	TE129M	(.03)	CS136	(.20)			CS134	(.32)	CS136	(.20)		
	LA140	(.02)	I132	(.08)			CS136	(.09)	I132	(.08)		
64d	KR85	(.87)	CS134	(.96)	CS134	(.86)	CS134	(.70)	CS134	(.97)	CS134	(.96)
	XE133	(.10)	CS136	(.02)	BA137M	(.04)	I131	(.11)	CS136	(.02)	CS136	(.02)
	SB125	(.02)	I131	(.01)	NB95	(.03)	KR85	(.08)	I131	(.01)	I131	(.005)
	KR85	(.95)	CS134	(.94)			CS134	(.89)	CS134	(.94)		
	SB125	(.01)	CS136	(.05)			CS136	(.05)	CS136	(.05)		
	TE129M	(.01)	LA140	(.002)			KR85	(.02)	I131	(.001)		

Table D.5

Peach Bottom Wetwell Major Radionuclide Contributors to Gamma Dose
(Concluded)

	Case 1						Case 2					
	A		W		S		A		W		S	
128d	KR85	(.97)	CS134	(.99)	CS134	(.91)	CS134	(.82)	CS134	(.99)	CS134	(.994)
	SB125	(.02)	SB125	(.002)	BA137M	(.04)	KR85	(.10)	SB125	(.002)	SB125	(.003)
	BA137M	(.002)	BA137M	(.002)	NB95	(.02)	SB125	(.05)	CS136	(.0007)	BA137M	(.001)
	KB85	(.97)	CS134	(.996)			CS134	(.95)	CS134	(.997)		
	SB125	(.014)	CS136	(.002)			KR85	(.03)	CS136	(.002)		
	TE129M	(.004)	PR144	(.0004)			SB125	(.01)	SB125	(.003)		
256d	KR85	(.97)	CS134	(.996)	CS134	(.94)	CS134	(.82)	CS134	(.997)	CS134	(.995)
	SB125	(.02)	SB125	(.0025)	BA137M	(.05)	KR85	(.11)	SB125	(.002)	SB125	(.003)
	BA137M	(.002)	BA137M	(.002)	NB95	(.007)	SB125	(.05)	BA137M	(.0004)	BA137M	(.001)
	KR85	(.98)	CS134	(.999)			CS134	(.95)	CS134	(.9996)		
	SB125	(.01)	SB125	(.0004)			KR85	(.03)	SB125	(.0003)		
	BA137M	(.002)	BA137M	(.0004)			SB125	(.01)	BA137M	(.0001)		
1y	KR85	(.98)	CS134	(.996)	CS134	(.94)	CS134	(.81)	CS134	(.9977)	CS134	(.995)
	SB125	(.018)	SB125	(.0026)	BA137M	(.05)	KR85	(.12)	SB125	(.0018)	SB125	(.003)
	BA137M	(.002)	BA137M	(.0018)	SB125	(.007)	SB125	(.05)	BA137M	(.0004)	BA137M	(.001)
	KR85	(.984)	CS134	(.9988)			CS134	(.95)	CS134	(.999)		
	SB125	(.013)	SB125	(.0004)			KR85	(.03)	SB125	(.0003)		
	BA137M	(.002)	BA137M	(.0004)			SB125	(.01)	BA137M	(.0001)		

Table D.6

Peach Bottom Wetwell Major Radionuclide Contributors to Beta Dose

	Case 3											
	A		W		S		A		W		S	
1h	KR88	(.53)	I134	(.28)	I134	(.27)	KR88	(.53)	I134	(.28)	I134	(.27)
	KR87	(.11)	I132	(.23)	I135	(.20)	KR87	(.11)	I132	(.23)	I135	(.20)
	XE135	(.08)	I135	(.17)	I132	(.20)	XE135	(.08)	I135	(.17)	I132	(.20)
	KR88	(.78)	CS138	(.33)			KR88	(.78)	CS138	(.33)		
	KR87	(.13)	I134	(.23)			KR87	(.13)	I134	(.23)		
	XE138	(.04)	I135	(.17)			XE138	(.04)	I135	(.17)		
2h	KR88	(.57)	I132	(.31)	I132	(.27)	KR88	(.58)	I132	(.31)	I132	(.27)
	XE135	(.13)	I134	(.22)	I135	(.26)	XE135	(.13)	I134	(.22)	I135	(.26)
	KR87	(.09)	I135	(.21)	I134	(.22)	KR87	(.09)	I135	(.21)	I134	(.22)
	KR88	(.86)	I135	(.27)			KR88	(.86)	I135	(.27)		
	KR87	(.11)	I134	(.24)			KR87	(.11)	I134	(.24)		
	I135	(.007)	RB88	(.19)			I135	(.007)	RB88	(.19)		
4h	KR88	(.58)	I132	(.42)	I132	(.36)	KR88	(.51)	I132	(.42)	I132	(.38)
	XE135	(.24)	I135	(.23)	I135	(.27)	XE135	(.21)	I135	(.23)	I135	(.29)
	XE135M	(.11)	I133	(.15)	I133	(.12)	XE135M	(.10)	I133	(.15)	I133	(.12)
	KR88	(.94)	I135	(.42)			KR88	(.91)	I135	(.42)		
	KR87	(.059)	RB88	(.22)			KR87	(.06)	RB88	(.22)		
	XE135M	(.0005)	I132	(.17)			I135	(.01)	I132	(.17)		
8h	XE135	(.45)	I132	(.52)	I132	(.46)	XE135	(.38)	I132	(.52)	I132	(.49)
	KR88	(.38)	I135	(.20)	I135	(.24)	KR88	(.32)	I135	(.20)	I135	(.26)
	XE135M	(.13)	I133	(.17)	I133	(.14)	XE135M	(.11)	I133	(.17)	I133	(.14)
	KR88	(.97)	I135	(.50)			KR88	(.94)	I135	(.50)		
	KR87	(.02)	I132	(.30)			I135	(.02)	I132	(.30)		
	XE135M	(.001)	RB88	(.15)			KR87	(.02)	RB88	(.15)		

Table D.6

Peach Bottom Wetwell Major Radionuclide Contributors to Beta Dose
(Continued)

	Case 1						Case 2					
	A		W		S		A		W		S	
16h	XE135	(.74)	I132	(.61)	I132	(.58)	XE135	(.56)	I132	(.61)	I132	(.61)
	XE135M	(.11)	I133	(.17)	I135	(.14)	I133	(.15)	I135	(.17)	I135	(.15)
	KR88	(.11)	I135	(.11)	I133	(.14)	XE135M	(.08)	I135	(.11)	I133	(.15)
							KR88	(.84)	I132	(.51)		
							I132	(.08)	I135	(.39)		
							I135	(.06)	I133	(.04)		
1d	XE135	(.84)	I132	(.66)	I132	(.64)	XE135	(.78)	I132	(.66)	I132	(.69)
	XE135M	(.08)	I133	(.15)	I133	(.13)	I132	(.21)	I133	(.15)	I133	(.14)
	XE133	(.05)	I131	(.08)	I135	(.07)	XE135M	(.05)	I131	(.08)	I135	(.08)
	KR88	(.98)	I132	(.68)			KR88	(.52)	I132	(.68)		
	XE135	(.001)	I135	(.24)			I132	(.33)	I135	(.24)		
	XE135M	(.009)	I133	(.04)			I135	(.12)	I133	(.04)		
2d	XE135	(.76)	I132	(.73)	I132	(.73)	I132	(.44)	I132	(.73)	I132	(.78)
	XE133	(.19)	I131	(.10)	I133	(.08)	XE135	(.33)	I131	(.10)	I133	(.09)
	XE135M	(.02)	I133	(.02)	CS134	(.04)	XE133	(.08)	I133	(.09)	CS134	(.04)
	KR88	(.48)	I132	(.90)			I132	(.91)	I132	(.89)		
	XE135	(.37)	I135	(.03)			I133	(.03)	I135	(.03)		
	XE135M	(.12)	I133	(.03)			I135	(.03)	I133	(.03)		
4d	XE133	(.79)	I132	(.74)	I132	(.74)	I132	(.65)	I132	(.74)	I132	(.80)
	XE135	(.13)	I131	(.13)	CS134	(.06)	XE133	(.15)	I131	(.13)	CS134	(.07)
	XE133M	(.08)	CS134	(.07)	I131	(.05)	I131	(.11)	CS134	(.07)	I131	(.05)
	XE135	(.45)	I132	(.94)			I132	(.98)	I132	(.93)		
	TE131M	(.34)	CS136	(.03)			I133	(.01)	CS136	(.03)		
	KR85	(.09)	CS134	(.02)			TE131M	(.004)	CS134	(.02)		

Table D.6

Peach Bottom Wetwell Major Radionuclide Contributors to Betaa Dose
(Continued)

	Case 1						Case 2					
	A		W		S		A		W		S	
8d	XE133	(.94)	I132	(.63)			I132	(.60)	I132	(.63)	I132	(.71)
	XE133M	(.04)	I131	(.18)			XE133	(.19)	I131	(.18)	CS134	(.14)
	KR85	(.005)	CS134	(.14)			I131	(.17)	CS134	(.14)	I131	(.08)
	KR85	(.52)	I132	(.90)			I132	(.98)	I132	(.90)		
	TE131M	(.21)	CS134	(.05)			I131	(.005)	CS134	(.05)		
	SB127	(.11)	CS136	(.05)			CS134	(.004)	CS136	(.05)		
16d	XE133	(.97)	CS134	(.36)	CS134	(.30)	I132	(.39)	CS134	(.36)	CS134	(.39)
	KR85	(.015)	I132	(.30)	I132	(.29)	I131	(.31)	I132	(.30)	I132	(.37)
	XE133M	(.01)	I131	(.24)	I131	(.09)	XE133	(.24)	I131	(.24)	I131	(.12)
	KR85	(.81)	I132	(.67)			I132	(.95)	I132	(.67)		
	LA140	(.05)	CS134	(.19)			CS134	(.02)	CS134	(.20)		
	SB127	(.04)	CS136	(.12)			I131	(.01)	CS136	(.13)		
32d	XE133	(.88)	CS134	(.76)	CS134	(.58)	I131	(.48)	CS134	(.77)	CS134	(.80)
	KR85	(.11)	I131	(.13)	NB95	(.07)	CS134	(.19)	I131	(.13)	CS136	(.09)
	SB125	(.003)	CS136	(.08)	CS136	(.07)	XE133	(.18)	CS136	(.08)	I131	(.06)
	KR85	(.90)	CS134	(.70)			I132	(.51)	CS134	(.71)		
	TE129M	(.026)	CS136	(.20)			CS134	(.32)	CS136	(.20)		
	LA140	(.02)	I132	(.08)			CS136	(.09)	I132	(.08)		
64d	KR85	(.87)	CS134	(.96)	CS134	(.75)	CS134	(.70)	CS134	(.97)	CS134	(.96)
	XE133	(.10)	CS136	(.02)	NB95	(.08)	I131	(.11)	CS136	(.02)	CS136	(.02)
	SB125	(.02)	I131	(.01)	ZR95	(.05)	KR85	(.08)	I131	(.01)	SB125	(.007)
	KR85	(.95)	S134	(.94)			CS134	(.89)	CS134	(.95)		
	SB125	(.01)	CS136	(.05)			CS136	(.05)	CS136	(.05)		
	TE129M	(.01)	LA140	(.002)			KR85	(.02)	I131	(.0008)		

Table D.6

Peach Bottom Wetwell Major Radionuclide Contributors to Betaa Dose
(Concluded)

	Case 1						Case 2					
	A		W		S		A		W		S	
128d	KR85	(.97)	CS134	(.994)	CS134	(.83)	CS134	(.82)	CS134	(.996)	CS134	(.99)
	SB125	(.02)	SB125	(.002)	NB95	(.06)	KR85	(.10)	SB125	(.002)	SB125	(.008)
	BA137M	(.002)	BA137M	(.0015)	BA137M	(.06)	SB125	(.05)	CS136	(.001)	BA137M	(.002)
	KR85	(.97)	CS134	(.996)			CS134	(.95)	CS134	(.997)		
	SB125	(.01)	CS136	(.002)			KR85	(.03)	CS136	(.002)		
	TE129M	(.004)	PR144	(.0004)			SB125	(.01)	SB125	(.0003)		
256d	KR85	(.97)	CS134	(.996)	CS134	(.89)	CS134	(.82)	CS134	(.997)	CS134	(.98)
	SB125	(.02)	SB125	(.0025)	BA137M	(.07)	KR85	(.11)	SB125	(.002)	SB125	(.0076)
	BA137M	(.002)	BA137M	(.002)	NB95	(.02)	SB125	(.05)	BA137M	(.0004)	BA137M	(.002)
	KR85	(.98)	CS134	(.998)			CS134	(.956)	CS134	(.9996)		
	SB125	(.014)	SB125	(.0004)			KR85	(.03)	SB125	(.0003)		
	BA137M	(.002)	BA137M	(.0004)			SB125	(.01	BA137M	(.0001)		
1y	KR85	(.98)	CS134	(.995)	CS134	(.90)	CS134	(.81)	CS134	(.9977)	CS134	(.99)
	SB125	(.018)	SB125	(.0026)	BA137M	(.08)	KR85	(.12)	SB125	(.0018)	SB125	(.008)
	BA137M	(.0019)	BA137M	(.0018)	SB125	(.01)	SB125	(.05)	BA137M	(.0004)	BA137M	(.002)
	KR85	(.98)	CS134	(.998)			CS134	(.95)	CS134	(.9996)		
	SB125	(.013)	SB125	(.0004)			KR85	(.03)	SB125	(.0003)		
	BA137M	(.0019)	BA137M	(.0004)			SB125	(.01)	BA137M	(.0001)		

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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

Analyses of gamma and beta dose in selected regions in PWR and BWR containment buildings have been performed for a range of fission product releases from selected severe accidents. The objective of this study was to determine the radiation dose that safety-related equipment could experience during the selected severe accident sequences. The resulting dose calculations demonstrate the extent to which design basis accident qualified equipment would also be qualified for the severe accident environments. Surry was chosen as the representative PWR plant while Peach Bottom was selected to represent BWRs. Battelle Columbus Laboratory performed the source term release analyses. The AB epsilon scenario (an intermediate to large LOCA with failure to recover onsite or offsite electrical power) was selected as the base case surry accident, and the AE scenario (a large break LOCA with one initiating event and a combination of failures in two emergency cooling systems) was selected as the base case Peach Bottom accident. Radionuclide release was bounded for both scenarios by including spray operation and arrested sequences as variations of the base scenarios. Sandia National Laboratories used the source terms to calculate dose to selected containment regions. Scenarios with sprays operational resulted in a total dose comparable to that (2.20×10^8 rads) used in current equipment qualification testing (for design basis accidents or Regulatory Guide 1.89). The base case scenarios resulted in some calculated doses roughly an order of magnitude above the current 2.20×10^8 rad equipment qualification test region.

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