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DECONTAMINATION OF FINITE RECTANGULAR AREAS

By

A. W. Starbird

For

Office of Civil Defense
Office of the Secretary of the Army
Washington, D.C. 20310

Through The

Technical Management Office
U. S. Naval Radiological Defense Laboratory
San Francisco, California 94135

Final Report

Contract No. DAHC20-70-C-0216
Subtask 3216B

FLOW CORPORATION

electronic instrumentation

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DETACHABLE SUMMARY

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Flow Corporation
Nuclear Division
127 Coolidge Hill Road
Watertown, Massachusetts

SUMMARY

The CONSTRIP III computer code utilizing Monte Carlo multiple scatter data was used to determine decontamination importance factor curves for rectangular areas adjacent to single story structures. Decontamination factors were determined for both 1.25 Mev and 0.66 Mev radiation. Decontamination of 0.66 Mev source areas is eight percent more effective in reducing exposure rates within the structures than the decontamination of comparable 1.25 Mev source areas.

The CONSTRIP code separates the non-wall scattered and wall scattered reduction factor components from the total contribution. In addition, the code makes it possible to study the radiation components arriving from segments of building walls, permitting analysis of wall scattered radiation arriving from both above and below the detector plane. Comparisons were made with Engineering Method reduction factors. Analysis of the CONSTRIP reduction factor components for a series of square and rectangular single story buildings having wall mass thickness of 0.5, 1.0, and 4.0 mean free paths led to the following conclusions:

1. Separate directional response curves for wall scattered radiation should be used for wall scatter from above and from below the detector plane. Directional response for wall scattered radiation from above the detector plane is strongly influenced by finite field widths.

2. There should be a building shape factor for non-wall scattered (direct) radiation that is a function of wall mass thickness.

3. CONSTRIP total reduction factor values are in good general agreement with Engineering Method calculated values.

4. CONSTRIP wall scatter reduction factor components are generally lower than Engineering Method values. The difference becomes smaller as the source field width and building floor plan areas increase. The difference becomes larger as wall mass thickness increase.

5. CONSTRIP non-wall scattered (direct) reduction factor components are higher than Engineering Method values. For the buildings studied in this report CONSTRIP direct components were up to three times higher than Engineering Method values. The difference increases with increase in wall mass thickness and source field width and decreases as the length to width ratios of the buildings becomes larger.

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ABSTRACT

The CONSTRIP III computer code was used to calculate the reduction factors within single story rectangular buildings due to finite rectangular areas of contamination surrounding the buildings. The CONSTRIP code permitted breaking the reduction factors into wall scattered and non-wall scattered components from finite source strips up to 200 ft wide. Decontamination importance factors were determined for finite areas subjected to both 1.25 Mev and 0.66 Mev contamination. The directional responses for wall scattered radiation coming from above and below the detector plane were determined separately for finite source fields.

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The author is indebted to Mr. Jack LeDoux, Mr. Joseph Velletri, and Mr. Robert Wright of Flow Corporation, and Mr. Charles Eisenhauer of the National Bureau of Standards for their helpful suggestions and criticisms. The author is also indebted to F. A. Bryan Jr. of Research Triangle Institute for furnishing the required Monte Carlo decks.

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The CONSTRIP III computer code utilizing Monte Carlo multiple scatter data was used to determine decontamination importance factor curves for rectangular areas adjacent to single story structures. Decontamination factors were determined for both 1.25 Mev and 0.66 Mev radiation. Decontamination of 0.66 Mev source areas is eight percent more effective in reducing exposure rates within the structures than the decontamination of comparable 1.25 Mev source areas.

The CONSTRIP code separates the non-wall scattered and wall scattered reduction factor components from the total contribution. In addition, the code makes it possible to study the radiation components arriving from segments of building walls, permitting analysis of wall scattered radiation arriving from both above and below the detector plane. Comparisons were made with Engineering Method reduction factors. Analysis of the CONSTRIP reduction factor components for a series of square and rectangular single story buildings having wall mass thickness of 0.5, 1.0, and 4.0 mean free paths led to the following conclusions:

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CHAPTER 1

INTRODUCTION

In post attack recovery operations it is necessary that importance factors for decontamination of limited areas adjacent to critical facilities be known. The CONSTRIP codes used in this study are applicable to the determination of the exposure contribution within structures from finite rectangular areas of contamination fully or partially surrounding the structures. These contributions can in turn be expressed as a fraction or percentage of the exposure rates present within the structures prior to decontamination.

The CONSTRIP codes allow determination of the wall scattered and non-wall scattered (direct) radiation components in addition to the total exposure rates within the buildings permitting the study of the components making the total contribution. The codes also allow breaking the components into their contributions arriving from above and below the detector plane. By proper choice of building configuration insight can be gained into both response functions for wall scattered radiation from both above and below the detector plane for finite source areas and building shape effects.

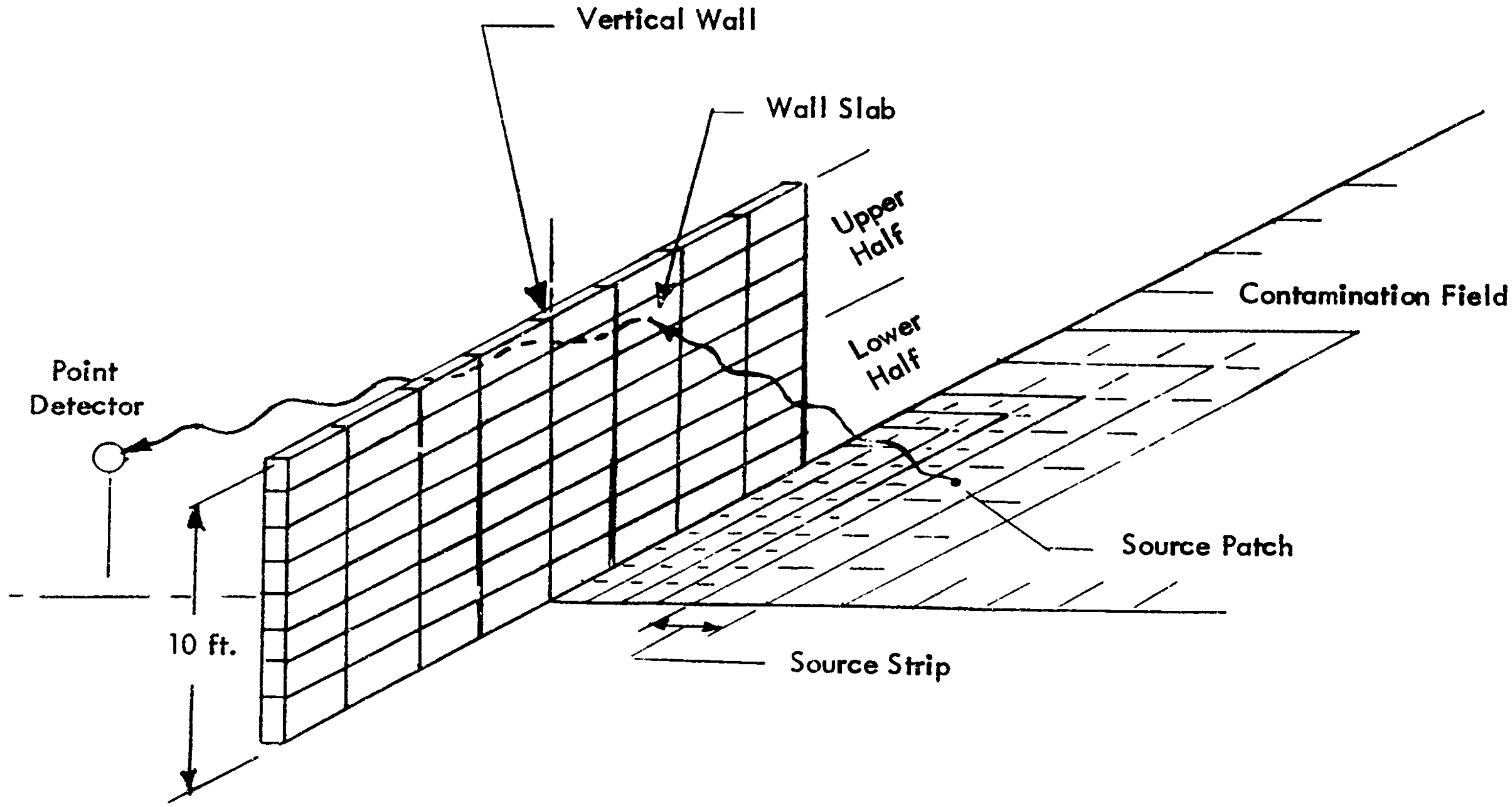
CHAPTER 2

DESCRIPTION OF THE CONSTRIP CODE AND ENGINEERING METHOD FINITE FIELD PROCEDURES

2.1 CONSTRIP COMPUTER CODE

The CONSTRIP computer programs [1] utilize the Monte Carlo transmission and scattering coefficients of Berger and Morris [2] in determining the exposure rates behind vertical walls from horizontal rectangular areas of contamination. Both the CONSTRIP II program developed by Eisenhauer at the National Bureau of Standards and a refined version with increased flexibility, CONSTRIP III, coded by Research Triangle Institute are covered in detail in Reference 1. All of the CONSTRIP results given in this report are based on CONSTRIP III. Initially results were obtained both with the CONSTRIP II and the CONSTRIP III codes to be certain that the CONSTRIP III code was being handled correctly and to verify that identical results could be obtained by the two codes. The main differences in the two code versions are that CONSTRIP III allows determination of the exposure rate for both the case with no wall present (zero wall thickness) and for the case with the detector against the rear surface of the vertical wall. In addition CONSTRIP III computation allows inclusion of air-ground effects through the incorporation of an experimental build-up-air-attenuation factor. Only Monte Carlo data for the penetration of Co-60 (1.25 Mev) radiation and Cs-137 (.66 Mev) through 0.5, 1.0, and 4.0 mean free path (mfp) concrete barriers were used in this study.

The CONSTRIP program is designed to calculate the exposure rate behind a vertical rectangular wall from a horizontal source area. The geometric arrangement for the CONSTRIP codes slanted for rectangular building calculations is shown in Fig. 2.1. Both the source area and wall are broken into differential area elements with a point at the center of the elements assumed to represent the entire differential area. The source area is broken into square source patches and the wall into rectangular patches. The codes calculate three components of exposure at an isotropic detector due to radiation from each source patch passing through each of the wall slabs: (1) radiation not scattered in passing through the wall (direct), (2) single wall scatter, and (3) multiple wall scatter. In CONSTRIP III these components can be weighted for air absorption and air-ground build up. Components for each of the source patch-wall slab combinations are summed by the programs for both total values from the entire source and wall areas and for certain sections of each.

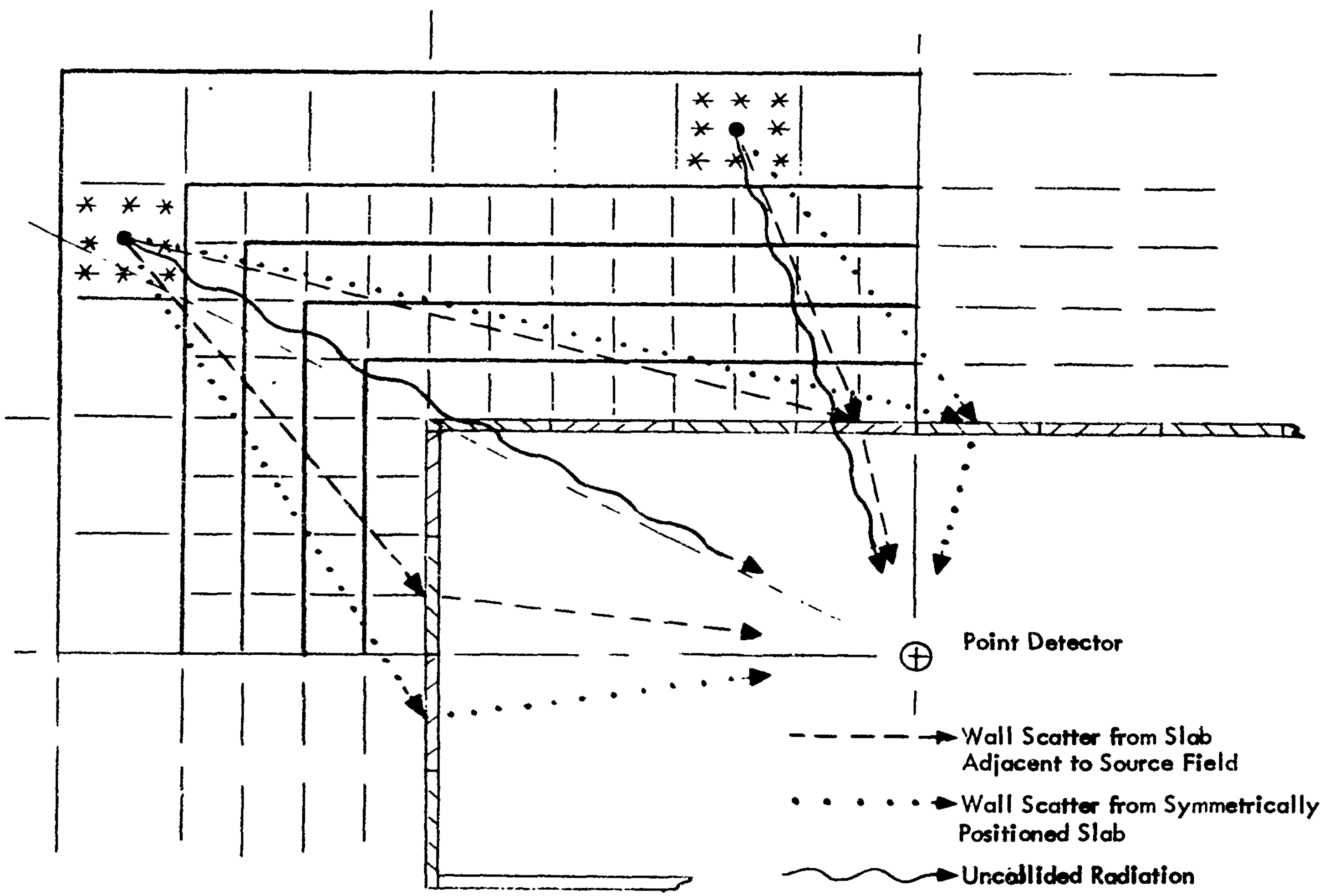


CONSTRIP GEOMETRIC CONFIGURATION

Figure 2.1

For this study the CONSTRIP code results for a vertical wall are adapted to the case of rectangular strips of contamination surrounding rectangular structures of varying floor plan size, width to length ratios, and wall mass thickness. The arrangement for applying the CONSTRIP differential data to a rectangular structure is illustrated in Figs. 2.1 and 2.2. Because of restrictions in the size of the source grid that can be used the quarter symmetry of the structures is used in setting up the problem. Figure 2.1 shows the CONSTRIP geometric configuration for one wall of a rectangular structure using the quarter symmetry method and Fig. 2.2 shows the overall interaction of radiation components through two perpendicular walls of a rectangular structure. Radiation from source patches directly opposite the vertical wall (see Fig. 2.2) can reach the detector by passing directly through the wall without scattering, by scattering in the wall adjacent to the quarter field and by scattering as shown by the dotted lines, in that part of the wall not bounded by the quarter source field. The latter will be referred to as symmetry scatter and must be included in the wall scatter totals. The scatter and direct radiation for the two long walls or the two short walls from a source patch directly opposite the respective walls (corner sources not included) are equal to four times the CONSTRIP results for a wall as shown in Fig. 2.1 and will include the symmetry scatter component.

For a corner source patch position, as shown in Fig. 2.2, the detector receives scattered radiation from the entire area of the two adjacent walls. Thus for the wall scatter component the corner source area must be included in CONSTRIP calculations for each of the two walls and must also include the symmetry component. Since the source is assumed to be concentrated at the center of the source patch, the direct component from a patch in the source field corner region will pass through one wall or the other but not both. This does not pose a problem except for source patches in line with the diagonal from the detector to the building corners. Thus, as shown in Fig. 2.2, the exposure contribution from a source patch on the diagonal line will be changed to the wall on the side of the diagonal having the most source patch area. Note that the corner direct component would be charged first to one wall and then to the other as one proceeds outward along the diagonal. Ideally, the exposure from a patch on the diagonal would be calculated for each wall based on the actual patch area on each side of the diagonal. This is not practical to handle in CONSTRIP code for the minor improvement in accuracy that would be obtained for most structures. This was checked by hand calculations for the diagonal positions for several structures. For the structure series used the error in the direct component was less than one percent except for square buildings where errors up to 6 percent for the direct component were obtained. This error is dependent on source grid size, errors are minimized with small grid size. For the square buildings machine calculations are made for only one wall with results multiplied by 8 for a full building. In this case, the source patches on the diagonal have been counted twice. Hand calculations were made for these patches on the diagonal to permit correcting the direct component values for the double count.



CONSTRIP QUARTER SYMMETRY ARRANGEMENT FOR RECTANGULAR STRUCTURES

Figure 2.2

Initially CONSTRIP differential source patch-wall slab values for the long and short sides of the structures were summed by hand to give results for rectangular strips surrounding the structures. The results for the two walls were combined and multiplied by four. This procedure proved very time consuming, especially for fine wall and source patch grids. The summations for the basic CONSTRIP III program are for linear source strips and are not directly applicable to source strips adajcent to more than one side of a structure. Additional summation instructions were incorporated in the CONSTRIP III deck for handling the L-shaped source strips associated with rectangular source areas surrounding rectangular structures. Results from the modified program are printed for a particular wall by source strip for direct, wall scatter, and total radiation components for each horizontal or vertical section of the wall, for its upper and lower half, and for the total wall. The modifications made in the summation procedures of the CONSTRIP III code listed in Reference 1 are given in Appendix D of this report.

Computer results from individual source strips for the long and short sides of rectangular structures were combined by hand to give direct, wall scatter and total reduction factor contribution from the lower half, upper half and total building. Source field widths extended horizontally out to 70 feet from the walls of the buildings. Results for 1.25 Mev source fields between 70 and 200 feet from the walls and all of 0.66 Mev data were combined to give only the direct, wall scatter and total reduction factors for the total building wall only. For square structures machine computations are made for one wall of the structure and hand calculations made for the direct component from the source patches on the diagonal. Results of each field width for the one wall of a square structure are multiplied by 8 to obtain reduction factor values from a source field surrounding the building. There are minor radiation contributions that are not included in CONSTRIP III computations such as radiation reaching the detector by back scattering from the walls, and ceiling. The calculations are for radiation contribution reaching the detector from ground sources of contamination by passing through or scattering within the walls of the structure. The roof is considered infinitely thick so there is no roof contribution either from sources on the roof or from air scattered radiation (skyshine).

2.2 THE ENGINEERING METHOD OF COMPUTATION

The Engineering Method of shelter computation described in the manual Shelter Design and Analysis, Volume 1, Fallout Shielding [3] presents rules for computing the ground-based contributions for structures subjected to radiation from both infinite and limited fields of contamination. In this method, the radiation arriving at a point within a structure is subdivided into three components: (1) radiation that has passed directly through the building walls without scattering, (2) radiation that has been scattered by the walls, (3) and radiation that has been scattered by the atmosphere. Non wall scattered radiation from below the detector plane (direct radiation) for an infinite field of contamination is determined by multiplying the cumulative angular distribution of non-wall scattered radiation, $G_d(\omega, h)$ as viewed from the point of interest in the structure, by a height-dependent wall-barrier factor, $B(X_e, h)$, by the fraction of radiation not scattered by the structure walls, $(1-S_w)$, and where applicable by the floor-barrier factor, $B_f(X_f)$. Calculations for the finite-field case are similar, except that the cumulative angular distribution of non-wall scattered radiation is differenced to account for the finite field.

The wall-scattered component for an infinite field case is determined by multiplying the cumulative angular distribution of radiation scattered from the structure walls, $G_s(\omega)$, by the height-dependent wall-barrier factor $B(X_e, h)$, eccentricity factor, E, the fraction of emergent radiation scattered, S_w, and where applicable a floor-barrier factor, $B_f(X_f)$, or ceiling factor, $B_c(X_c)$. The floor-barrier factor is used for attenuating wall-scattered radiation reaching the detector position from the floor below in a multistory structure and the ceiling-barrier factor is used for wall-scattered radiation reaching the detector position from the story above. For the finite field case, this procedure is modified by applying a different wall-barrier factor, $B_{\omega s}(\omega s, X_e)$, in place of the infinite field wall-barrier factor, $B(X_e, h)$. This finite field wall-barrier factor is expressed as a function of the solid angle of the field of contamination as viewed from the wall of the structure at midstory height.

The atmospheric scattered component for both the finite and infinite field of contamination cases are determined by multiplying the cumulative angular distribution of skyshine radiation, $G_a(\omega)$, by the wall barrier, $B(X_e, h)$; the fraction of radiation not scattered in passing through the structure walls, $(1-S_w)$; and the ceiling barrier, $B_c(X_c)$, when appropriate. The assumption is normally made that the atmospheric scattered component for a finite field is identical to that of the infinite field case. In decontamination of finite areas adajcent to structures, the skyshine component is not noticeably reduced because the bulk of the skyshine component generally arrives from ground sources outside the cleared areas. However, in order to relate the amount of radiation originating in the area to be decontaminated to the infinite field values the skyshine component had to also be determined for the finite area. Skyshine curves from Reference 4 were used in determining the skyshine finite field contribution. The skyshine component is small for close in contaminated areas and is in the order of 18 percent of the infinite field skyshine value for areas up to 70 ft wide.

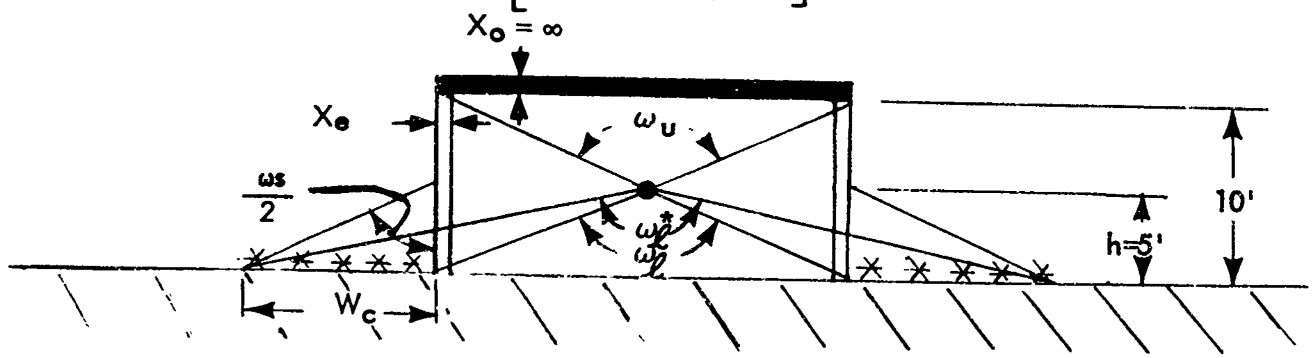
The three radiation components, direct, wall-scattered and skyshine are then summed to give the total contribution. The general equation for the total ground contamination within a multistory structure situated in a limited field of contamination is presented, with a sketch of the idealized building arrangement, in Fig. 2.3. The nomenclature for the sketch and equation in Fig. 2.3 is:

X_e	=	exterior wall mass thickness, psf
X_o	=	roof mass thickness, psf
h	=	detector height, ft
ω	=	solid-angle fraction (the solid angle divided by 2π)
ω_ℓ	=	solid-angle fraction of the floor immediately below the detector
ω_u	=	solid-angle fraction of the roof above the detector.
ω^*	=	solid-angle fraction of finite field as observed from the detector.
ω_s	=	solid-angle fraction of finite field as observed from mid-wall position
W_c	=	width of contaminated area from base of structure, ft
$B(X_e,h)$	=	attenuation introduced by a vertical wall to an infinite field of contamination
$B_{\omega s}(X_e,\omega s)$	=	attenuation introduced by a vertical wall to an finite field of contamination
$G_d(\omega^*,h)$	=	cumulative angular distribution of direct radiation from finite source field
$G_d(\omega,h)$	=	cumulative angular distribution of direct radiation for an infinite field
$G_a(\omega)$	=	cumulative angular distribution of skyshine plus ceiling shine radiation for an infinite field
$G_s(\omega)$	=	cumulative angular distribution of wall scattered radiation for an infinite field

Ground Contribution (Cg) = Non Wall-Scattered from Below Detector Plane Plus Skyshine and Wall Scattered

$$C_g = B(X_e, h)\left[G_d(\omega_\ell, h) - G_d(\omega_\ell^*, h)\right]\left[1 - S_w(X_e)\right] + B(X_e, h)\, G_a(\omega_u)\left[1 - S_w(X_e)\right] C +$$

$$B_{\omega s}(\omega_s, X_e)\left[G_s(\omega_\ell) + G_s(\omega_u)\right] S_w(X_e)\; E$$



ENGINEERING METHOD FINITE FIELD CALCULATIONS
FOR SOURCE AREA SURROUNDING A SINGLE STORY STRUCTURE

Figure 2.3

$S_w(X_e)$	=	fraction of radiation scattered by a vertical wall
E	=	eccentricity factor for the structure
C	=	percent of infinite field skyshine components for finite area

Published charts [3] for determining the geometric and barrier-reduction factors used in structure-shielding calculations were derived from the basic data on radiation penetration developed by Spencer [5] for 1.12 hour fallout. Most experimental verification of the Engineering Method calculational procedures, however, have been and are being performed using Co-60 radiation. The CONSTRIP computer program [6] is applicable to the Co-60 case using 1.25 Mev Monte Carlo transmission coefficients, and cannot be used at present for the fallout case. Charts for the Engineering Manual computational method have, however, been developed [6] for 1.25 Mev radiation in identical fashion to those for fallout, using data of Spencer [5]. Unfortunately, data was not available to develop a new chart 10 [3] for use in obtaining the finite field wall-barrier factor, $B_{\omega s}(\omega s, X_e)$, for 1.25 Mev radiation. Therefore, fallout values for $B_{\omega s}(\omega s, X_e)$ were used in this study for calculating 1.25 Mev reduction factors for comparison with the CONSTRIP results. The error in the finite wall-barrier factor in using fallout values instead of Co-60 can be estimated by considering the differences between fallout and Co-60 infinite field wall-barrier factors. For the infinite field case, the Co-60 barrier factor is of the order of five percent less than the fallout value for 100 psf exterior walls, and 25 percent less at 200 psf wall thickness. Since the maximum wall thickness values used in this study is 144 psf, the effect of this error is expected to be small (less than 15 percent).

CHAPTER 3

CONSTRIP III RESULTS FOR 1.25 MEV FINITE AREAS OF CONTAMINATION

Reduction factor components and total at the center of three series of single story structures surrounded by finite rectangular fields of contamination were calculated using the CONSTRIP III computer code. The series was arranged to vary one structure parameter at a time. The first series of structures was five square buildings ranging from 5 x 5 ft to 80 x 80 ft, having a wide range of exterior wall solid angle factors as observed from mid-floor detector positions on the vertical centerline of the structures. The second series is for four rectangular structures having a width to length ratio of 0.5 and for three structures having a width to length ratio of 0.25, and the third series gives results for three structures having different shapes but constant wall solid angle fractions.

The calculations were made for exterior wall mass thickness values of 0.5, 1.0, and 4.0 mean free paths (18, 36 and 144 psf of concrete) representing relatively thin, medium, and thick walled structures. Finite field contamination was represented by uniform 1.25 Mev plane source areas. Finite rectangular fields surrounding the structures ranged in width from 5 to 200 feet with detailed breakdown of the radiation components carried only to a finite field width of 70 ft. Exposure rates within the structures from the 70 ft wide contaminated areas give 50-60 percent of the exposure rate that would have been observed from an infinite source plane. Extending the field width to 200 ft gives approximately 80 percent of the infinite field exposure rates. The detector position in each structure was at a mid-floor height of 5 ft to facilitate comparisons of wall scattered radiation from the lower and upper half of each structure.

Reduction factors obtained by use of the CONSTRIP III code are given in Tables A-1 through A-14 of Appendix A. For each structure, reduction factor components are listed for the wall scattered radiation from both the lower and upper half of the structure, for the direct radiation, and for the components combined to give total reduction factors. Results are given for each structure for wall mass thickness values of 18, 36, and 144 psf (0.5, 1.0, and 4.0 mfp) and for contamination field widths of 5, 10, 15, 20, 30, 40, 50, 60, and 70 ft. Comparable Engineering Method values are also presented in each of these Tables as well as ratios of the results from the two methods. CONSTRIP III results are extended in Tables A-15, A-16, and A-17 of Appendix A to give wall scatter, direct, and total building reduction factors for source field widths of 80, 100, 120, 140, 160, 180 and 200 ft. Basic source patch size ranged from 1 1/4 by 1 1/4 feet at close-in source positions to 10 by 10 ft between 50 and 100 ft, and 20 by 20 ft for source positions between 100 and 200 ft from the walls of the structures.

3.1 DECONTAMINATION IMPORTANCE FACTORS FOR RECTANGULAR SOURCE AREAS

The effect of decontaminating rectangular source areas surrounding structures can be obtained by ratioing the reduction factor contribution for these finite areas to the reduction factor if the structures were oriented at the center of a smooth, uniformly contaminated plane. Finite field reduction factors for both square and rectangular single story structures are given in Appendix A for source field widths (W_c) extending from 5 to 200 ft from the walls of the buildings. CONSTRIP finite field data are included in Appendix A for 9 building configurations having walls from 10 to 80 ft long and wall mass thickness values of 0.5, 1.0, and 4.0 mfp (18, 36 and 144 psf). Reduction factor estimates for infinite fields of contamination are given in Appendix C with a description of the method of obtaining them. The infinite field values used in comparison with the finite field data were obtained by estimating the far field contribution that would have been obtained if the CONSTRIP III cumulative values, to a distance of 200 ft from the walls, had been extended to an infinite distance. The far field estimates were based on the CONSTRIP contributions obtained for the outermost rectangular annuli (160 to 200 ft from the structure walls). The far field contribution is approximately 20 percent of the infinite field contribution, therefore an error in the far field estimate will contribute an error in the infinite field value only one fifth as large (i.e., a 10 percent error in the far field estimate contributes only a 2 percent error to the infinite field values).

The ratios of the finite field reduction factor to the infinite field values expressed as percent are given in Table 3.1 for five square buildings, three buildings having a wall width to length values of 0.5, and two having a width to length value of 0.25. Percent of infinite field reduction factors are given for 14 cumulative source field widths (W_c) ranging from 5 to 200 ft. Inspection of Table 3.1 shows, first of all, that there is no detectable difference in the percentages given for 0.5 mfp and 1.0 mfp cases. The percentage effect in reducing the initial radiation level within a particular structure is the same whether the walls are light (0.5 mfp) or of medium mass thickness (1.0 mfp). Even for the thick wall case (4.0 mfp) the results are not significantly different than the lighter wall percentages except for the very close-in (W_c=10 ft). Decontamination for the thick wall case for the small buildings does not appear to be as effective (up to 30 percent) as for the lighter wall cases. There is , however, a definite building size effect. For example, a source field having a W_c = 10 ft contains approximately 20 percent of the infinite field contribution in the 10 x 10 ft building case, but only 10 percent in the 80 x 80 ft building case. At W_c = 50 ft, the percentage is 49 for the 10 x 10 building and 34 for the 80 x 80 building. At W_c = 200 ft, the difference is small, the 10 x 10 building percentage being 77 and the 80 x 80 building approximately 69. It is interesting to note that the decontamination percentage for the 10 x 10, 10 x 20, and 10 x 40 ft buildings are essentially identical. The 20 x 20, 20 x 40 and 20 x 80 ft buildings also have very similar percentages.

TABLE 3.1

Percent of Infinite Field of Contamination for Finite Rectangular Source Fields Surrounding Square and Rectangular Structures

(Wall Height, 10 ft; Detector Height, 5 ft; 1.25 Mev)

Bldg. (ft x ft)	X_e (mfp)	Field Width, Wc (ft)													
		5	10	15	20	30	40	50	60	70	80	100	120	160	200
10 x 10	0.5	12	21	27	32	40	46	50	54	57	60	64	68	74	78
	1.0	11	19	25	30	38	44	49	52	56	59	63	67	73	77
	4.0	7	15	21	27	35	41	46	50	53	56	60	65	71	75
20 x 20	0.5	10	18	24	29	36	42	47	51	54	56	61	65	71	76
	1.0	12	18	24	30	37	44	45	52	56	59	64	68	74	79
	4.0	8	15	21	27	35	41	46	50	53	56	68	65	71	76
40 x 40	0.5	8	15	20	25	32	38	43	47	51	54	60	65	73	77
	1.0	8	15	20	25	32	38	43	47	51	54	60	64	72	77
	4.0	7	14	19	25	32	38	43	47	50	54	59	63	70	74
80 x 80	1.5	5	10	14	17	23	29	33	37	41	44	50	54	62	68
	1.0	4	10	15	18	24	30	34	38	42	45	51	55	63	69
	4.0	5	11	16	21	28	34	38	42	46	49	54	59	65	71
10 x 20	0.5	12	20	26	31	39	44	49	53	56	58	63	67	72	77
	1.0	11	19	26	31	38	44	48	52	55	58	62	66	72	76
	4.0	9	17	24	29	37	44	48	52	56	59	63	68	74	78
20 x 40	1.0	9	17	23	27	35	40	45	49	52	55	60	64	70	75
	4.0	7	14	21	26	34	40	45	49	52	55	60	64	70	75
40 x 80	1.0	7	13	18	23	30	35	40	44	47	51	56	60	67	72
	4.0	5	12	18	23	31	37	42	47	49	53	58	62	69	74
10 x 40	0.5	11	19	25	29	36	41	45	49	52	54	58	62	69	74
	1.0	11	19	26	31	38	44	49	52	55	58	63	66	72	76
	4.0	7	16	23	29	39	46	51	55	58	60	65	68	74	78
20 x 80	0.5	10	19	25	29	37	43	48	52	55					
	1.0	10	18	24	29	37	43	48	52	55	58	63	66	73	78
	4.0	7	15	22	28	37	44	50	54	58	60	65	68	73	78

The 1.0 mfp data of Table 3.1 is plotted in Fig. 3.1 to give curves for a specific decontaminated field. The curves show decontamination effect in percentage of the infinite field exposure rate versus building area in square feet. This 1.0 mfp data is essentially the same as the 0.5 mfp results, and therefore represents both 0.5 and 1.0 mfp results. There is some spread in data values at a particular building area due to differences in building eccentricity. Curves are drawn through the data points to give a series of percentage of infinite field versus building area curves for 5 to 200 ft values of rectangular field width surrounding single story structures. Similar curves for thick walled structures (4.0 mfp) are shown as dashed lines in Fig. 3.1 and are not significantly different from the curves for thinner walls.

Another way to look at the CONSTRIP data is in terms of the effect of breaking the finite rectangular areas into width increments. The data of Table 3.1 for 1.0 and 4.0 mfp walls is differenced to give values by breaking up the 200 ft wide finite field into 8 wide increments. This incremental data is given in Table 3.2. Table 3.2 shows that for the decontamination of rectangular areas beyond the very close-in contamination (0-10 ft) the percentage effect for a particular strip width does not fluctuate by more than approximately 20 percent regardless of building size or shape. The primary differences occur in the very close-in percentages. The decontamination percentages given in Table 3.1, Table 3.2 and Fig. 3.1 are for rectangular areas or annuli surrounding single story structures. These decontamination percentages can be applied to source areas that do not extend completely around a building by multiplying by the azimuthal fraction represented by a partial rectangular source strip.

3.2 REDUCTION FACTOR COMPONENTS

The CONSTRIP computer program permits breaking the output into both finite areas of contamination and the scattered and unscattered radiation arriving within a structure from individual sections of exterior walls of building. In the proceeding section (3.1) the combined scattered and unscattered radiation arriving at the center of square and rectangular buildings was obtained for a series of rectangular finite areas of contamination surrounding the structures. These were compared with infinite field values to obtain decontamination importance factors for various source field widths. The CONSTRIP output also permits looking at the scattered and unscattered radiation components in addition to the combined or overall radiation level. It permits breaking the wall scattered radiation component into that arriving from below and from above the detector plane. For the buildings covered in the present study the detector was located at the mid-floor height (5 ft.).

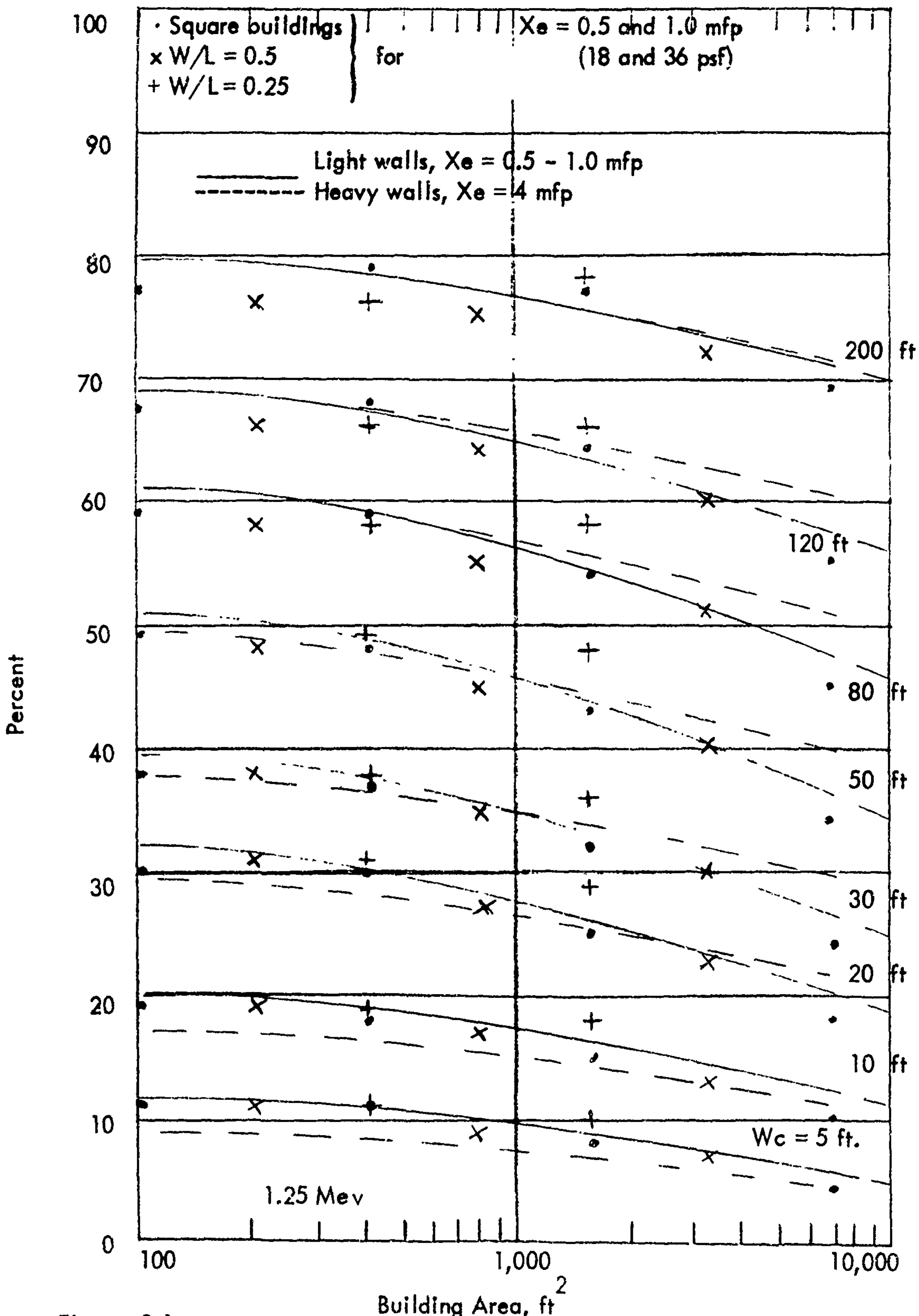


Figure: 3.1 EFFECT OF DECONTAMINATING RECTANGULAR AREAS SURROUNDING SINGLE STORY STRUCTURES

(Percent of Reduction Factor Before Decontamination)

Table 3.2

EFFECT OF DECONTAMINATING RECTANGULAR ANNULI SURROUNDING SINGLE STORY STRUCTURES

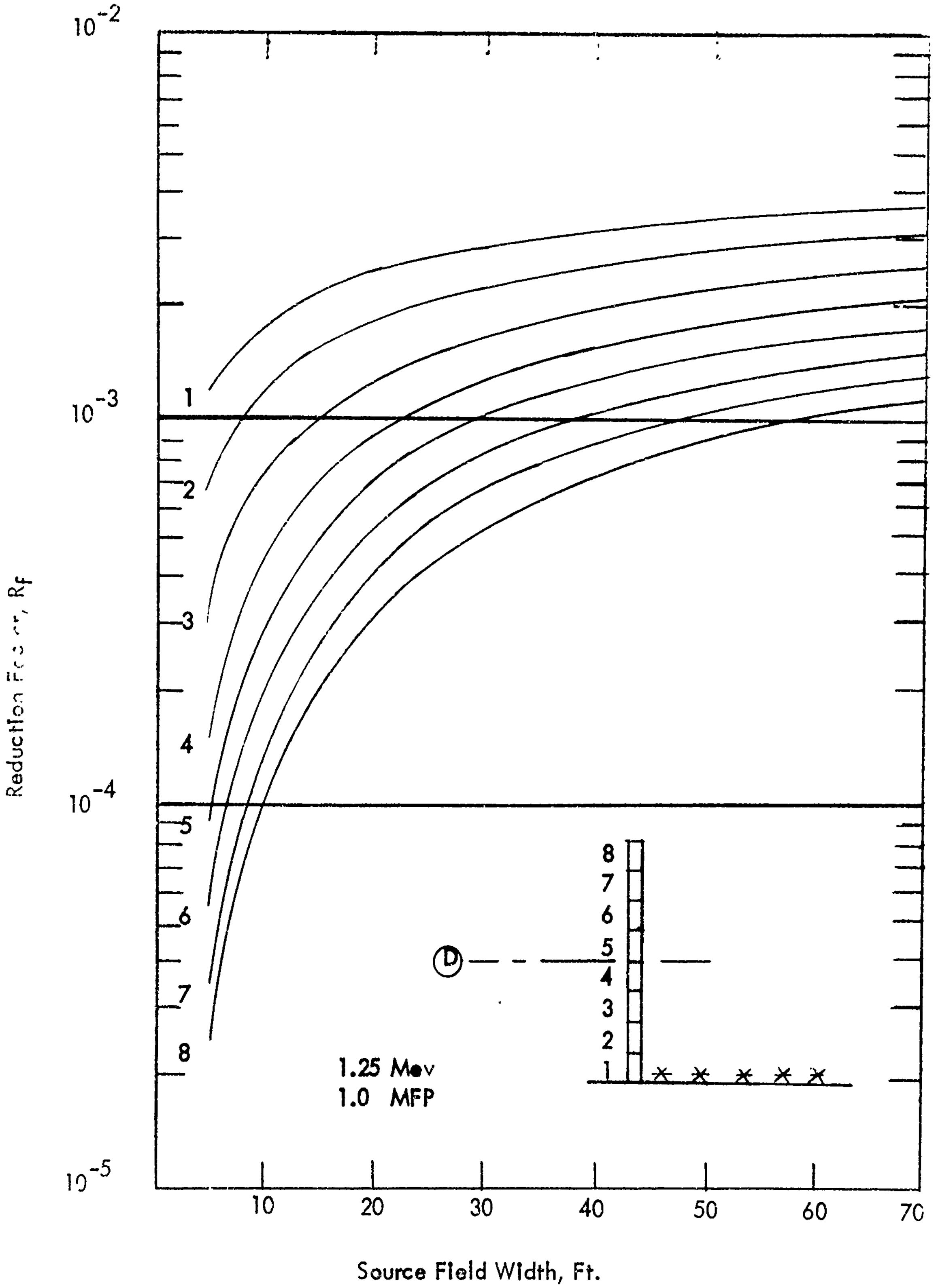
(Percent of Reduction Factor From Infinite Field Surrounding Building)

Building (ft x ft)	Area (ft^2)	Decontaminated Strip Position Relative to Wall (ft)							
		0-5	5-10	10-20	20-30	30-50	50-80	80-120	120-200
1 mfp									
10 x 10	100	11	8	11	8	11	10	8	10
10 x 20	200	11	8	12	7	10	10	8	10
10 x 40	400	11	8	12	7	11	9	8	10
20 x 20	400	12	6	12	7	11	11	9	11
20 x 40	800	9	8	10	8	10	10	9	11
20 x 80	1600	10	8	11	8	11	10	18	12
40 x 40	1600	8	7	10	7	11	11	10	13
40 x 80	3200	7	6	10	7	10	11	9	12
80 x 80	6400	4	6	8	6	12	11	10	14
4 mfp									
10 x 10	100	7	8	12	8	11	10	9	10
10 x 20	200	9	8	12	8	11	11	9	10
10 x 40	400	7	9	13	10	12	9	8	10
20 x 20	400	8	7	12	8	11	10	9	11
20 x 40	800	7	7	12	8	11	10	9	11
20 x 80	1600	7	8	13	9	13	10	8	10
40 x 40	1600	7	7	11	7	11	11	9	11
40 x 80	3200	5	7	11	8	11	11	9	12
80 x 80	6400	5	6	10	7	10	11	10	12

1.25 Mev Contamination

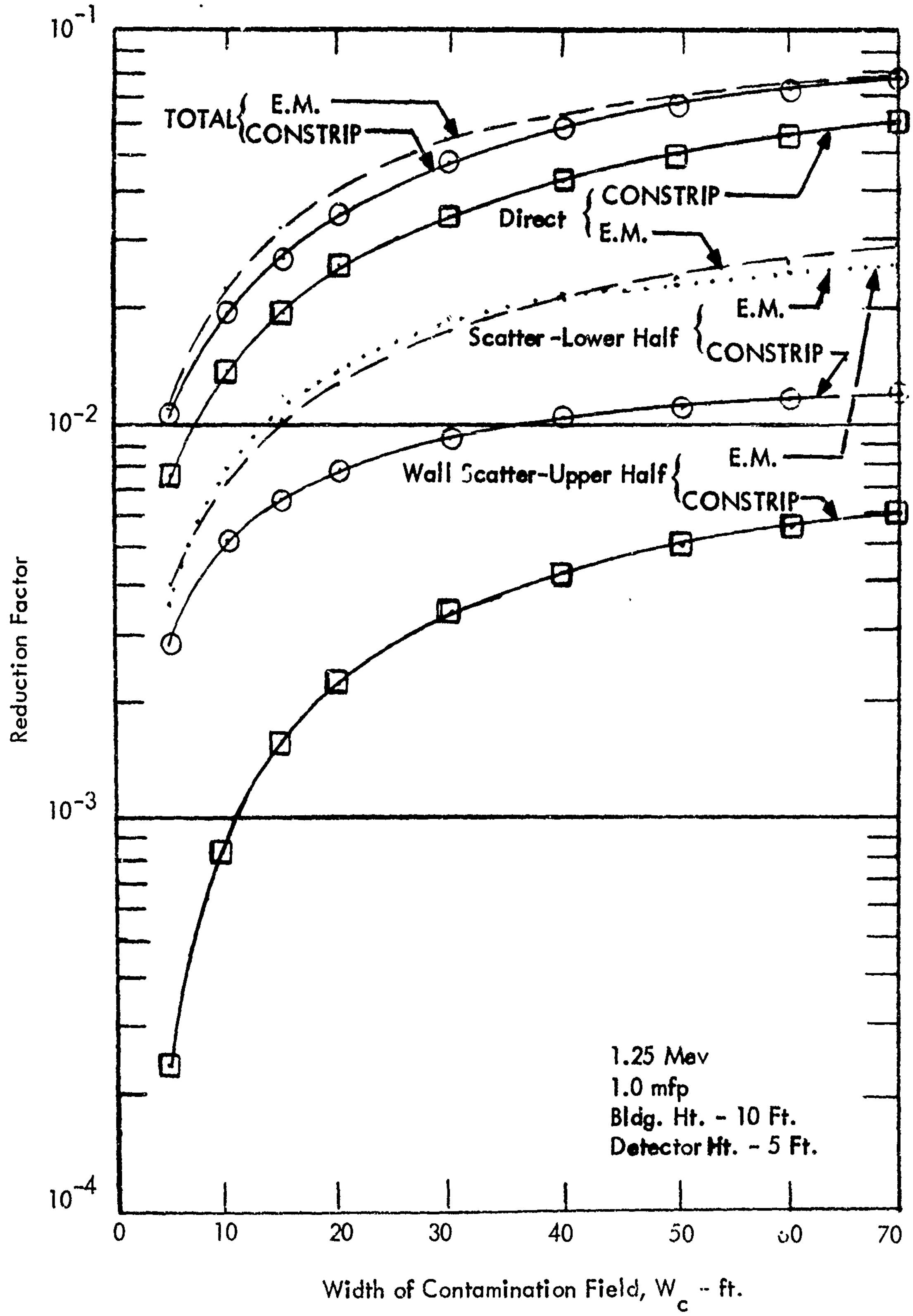
In the CONSTRIP computations the walls of each structure were broken into eight height increments as shown in Fig. 3.2. Initially the CONSTRIP output for the eight height increments was summed manually to give radiation contributions from both the lower half and upper half of the building walls, but it proved to be too time consuming to be practical. A typical plot of the wall scatter reduction factor contributions for each of the eight height segments of an 80 ft square building is shown in Fig. 3.2. This case is for a 10 ft high building with one mfp (36 psf) walls subjected to 1.25 Mev contamination. The spread between wall scatter contributions for the eight wall height segments are greatest for small source field widths. The CONSTRIP program was also altered to sum the wall scatter contributions for the upper half, the lower half and the total wall. These components plus the unscattered (direct) component are recorded in Appendix A for 14 single story configurations having 0.5, 1.0 and 4.0 mfp wall mass thickness values. A typical plot of the breakdown of the reduction factor components for the 80 ft square building is shown in Fig. 3.3. This figure gives the scattered component for both the upper and lower halves of the wall, the unscattered or direct component, and the combined or total reduction factor for rectangular strips of contamination ranging from 5 to 70 ft wide. Figure 3.3 also shows Engineering Method values. Breaking the CONSTRIP reduction factor values into components gives additional insight into how the radiation from the finite fields of contamination reaches a detector position within the structure and permits comparisons to be made with theory, by component, as well as by total contribution. Calculated values using the Engineering Method [3] for the scattered, direct and the total contribution are also itemized in Table A-1 through A-14 of Appendix A. Ratios of the CONSTRIP reduction factors to the Engineering Method factors are given in each of these tables to indicate the degree of agreement or disagreement between the two methods.

The reduction factor values for the wall scattered and direct components showing both source field width and building floor plan effects are illustrated in Table 3.3. The comparison is for square buildings and is presented as ratio of wall scattered to direct reduction factors. For the thin walled structures, wall scatter contribution is much less than direct, with ratios varying from .14 to .40 depending on building size and source field width. For the medium wall cases the ratio varies from .30 to .88 and for the thick wall cases, the direct component is smaller than the scatter with ratios between 1.49 and 4.80. The scatter to direct ratios becomes smaller as building size increases. As building size increases, the direct contribution becomes larger in relation to the wall scatter contribution with approximately a factor of two ratio change going from a 5 x 5 (25 sq ft) to an 80 x 80 ft (6400 sq ft) building. In general, the fraction of wall scatter contribution decreases as the rectangular source fields become wider. Exceptions occur for the 1.0 and 4.0 mfp



WALL SCATTER FROM WALL HEIGHT
SUBDIVISIONS FOR EIGHTY FOOT SQUARE BUILDING

Figure 3.2



RADIATION COMPONENTS FOR 80 FOOT SQUARE BUILDING FROM FINITE RECTANGULAR SOURCE FIELDS

Figure 3.3

TABLE 3.3

Ratio of Wall Scattered to Direct Radiation For Square Building Series

Bldg ft x ft	X_e mfp	Field Width W_c, ft								
		5	10	15	20	30	40	50	60	70
5 x 5	0.5	.40	.37	.35	.34	.34	.34	.34	.34	.34
	1.0	.82	.88	.73	.71	.71	.71	.71	.71	.71
	4.0	4.80	4.05	3.86	3.77	3.66	3.60	3.52	3.51	3.50
10 x 10	0.5	.37	.35	.34	.33	.32	.32	.31	.31	.31
	1.0	.75	.71	.67	.68	.66	.65	.64	.64	.63
	4.0	3.75	3.50	3.40	3.39	3.32	3.26	3.23	3.20	3.18
20 x 20	0.5	.28	.27	.27	.26	.25	.25	.24	.24	.24
	1.0	.44	.55	.54	.53	.52	.51	.50	.50	.49
	4.0	2.35	2.55	2.60	2.62	2.62	2.62	2.58	2.56	2.56
40 x 40	0.5	.23	.23	.22	.21	.20	.20	.19	.18	.18
	1.0	.45	.45	.44	.43	.42	.40	.39	.38	.38
	4.0	1.63	1.92	2.00	2.03	1.97	1.99	1.95	1.93	1.90
80 x 80	0.5	.22	.21	.20	.19	.18	.17	.16	.15	.14
	1.0	.39	.42	.41	.39	.36	.34	.32	.31	.30
	4.0	1.51	1.72	1.91	1.76	1.72	1.64	1.58	1.52	1.49

cases, particularly for the 20 x 20 to 80 x 80 ft buildings; in these cases the wall scatter ratio increased for field widths up to 15 ft and the wall scatter contribution decreased for source field widths greater than 10 or 15 ft. The decrease in the scatter to direct ratio (excluding very close-in effects to the contrary) was on the order of 25 percent for field widths between 5 and 70 ft. The fraction of wall scattered radiation relative to direct decreased with both increase in building size and increase in source field width. Conversely, the relative scatter components are larger for small buildings and for small source field widths of contamination. These general patterns hold for one story structures having two to one and four to one length to width ratios. The reduction factor data for these additional cases is given in Appendix A and could be presented in form similar to Table 3.3. This data together with that of Table 3.3 could be cross plotted to obtain a more detailed investigation of the relative effects on the wall scatter and direct components of field width building size, and building shape.

The data in Appendix A permits breaking the wall scatter contribution into that arriving at the detector from both the upper half and the lower half of the building. Reduction factor components for the lower half of the building are given for direct and wall scattered radiation. The only component from the upper half of the wall is the wall scatter component. In the CONSTRIP calculations air-ground buildup factors have been applied to all of the reduction factor components, thus both the direct and the wall scatter include the effects of air attenuation, ground buildup, and air scatter. In Table 3.4 ratios are given for the radiation contribution from the upper half of the walls to the contribution from the lower half. For ground sources large distances from a building the wall scatter contribution received at a mid-floor detector position from the upper half of the building would be nearly equal to that received from the lower half. However, for finite source fields there can be a sizeable difference between contributions from the upper and lower halves as is illustrated in Table 3.4. Table 3.4 shows that as the source field becomes small the wall scatter contribution from lower half of the building reaches 20 times that from the upper half. The upper to lower half wall scatter ratios in Table 3.4 in general show very little variation due to wall thickness for a particular building and field width. The most noticeable variation is in the first 10 ft of field width with ratios for thin walls higher than for thick walls. CONSTRIP calculational errors are a maximum for these very close-in fields making it difficult to say if the very close-in variations for different wall thickness are valid. The fraction coming from the upper half of the wall increases with building floor plan area. At a source field width of 70 ft the fraction of wall scatter from the upper half of the wall is approximately 0.38 for a 100 sq ft building and increases by one-third to 0.49 for a 6400 sq ft building. The percentage increase in the upper wall half scatter with building size is somewhat larger for smaller field widths. Variations with building size seems to be mainly a function of floor area with little evidence of a building eccentricity or shape effect. There is no discernable

TABLE 3.4

RATIO OF WALL SCATTERED RADIATION FROM UPPER HALF OF BUILDING TO SCATTERED RADIATION FROM LOWER HALF OF BUILDING FOR FINITE RECTANGULAR FIELDS OF CONTAMINATION

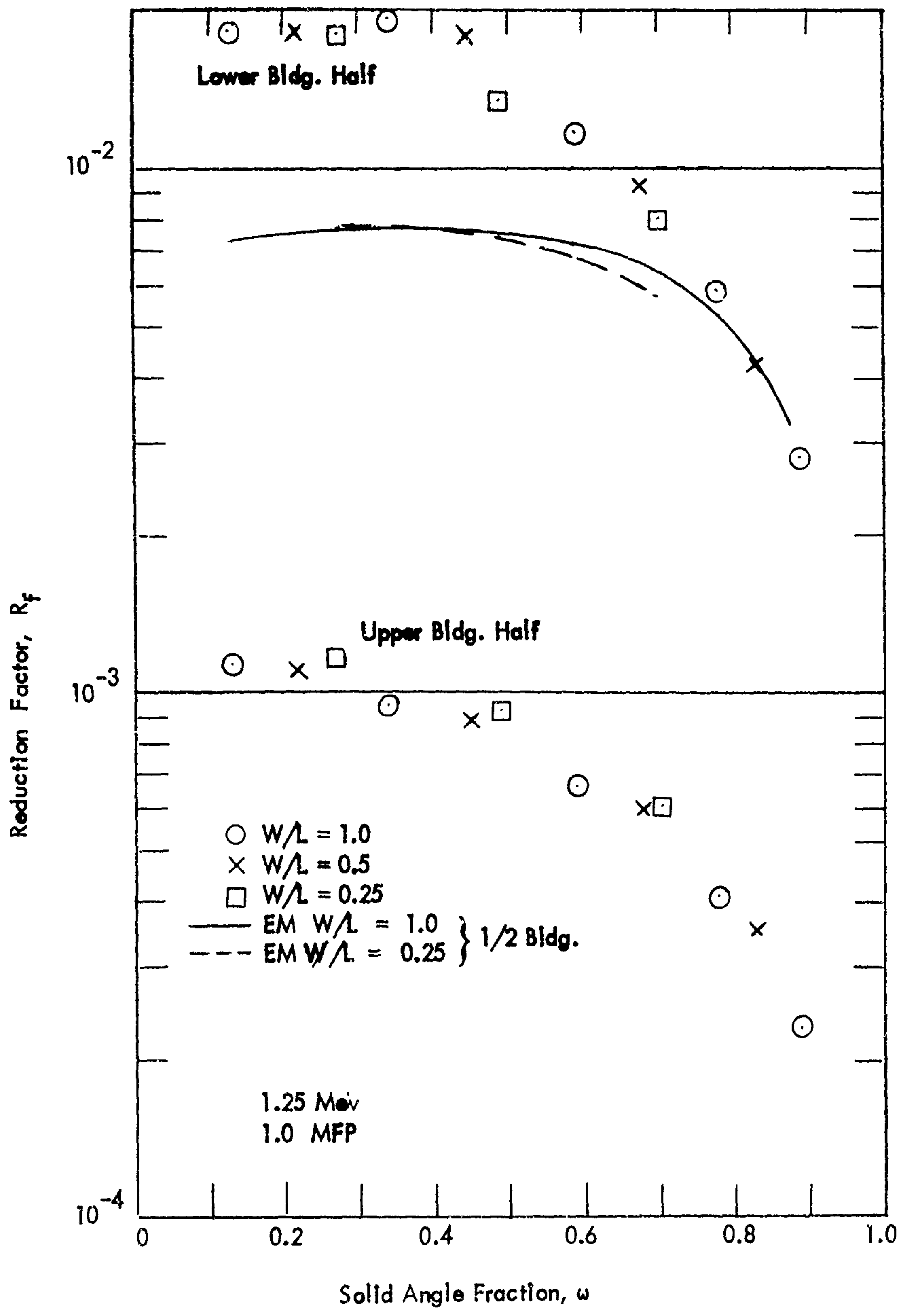
(Wall Height - 10 feet, Detector Height - 5 feet, 1.25 Mev)

Bldg ft x ft	X_e mfp	Field Width, Wc, ft								
		5	10	15	20	30	40	50	60	70
10 x 10	0.5	.05	.11	.15	.19	.25	.29	.31	.34	.36
10 x 10	1.0	.05	.11	.17	.20	.26	.30	.33	.35	.37
10 x 10	4.0	.04	.10	.17	.22	.30	.35	.38	.40	.43
20 x 20	0.5	.05	.12	.18	.22	.28	.32	.35	.38	.40
20 x 20	1.0	.06	.12	.18	.22	.29	.33	.36	.39	.41
20 x 20	4.0	.03	.09	.16	.21	.29	.34	.37	.40	.42
40 x 40	0.5	.08	.15	.21	.26	.30	.37	.40	.43	.45
40 x 40	1.0	.07	.14	.21	.25	.30	.37	.41	.43	.45
40 x 40	4.0	.04	.10	.17	.23	.32	.37	.41	.44	.46
80 x 80	0.5	.09	.17	.24	.29	.36	.41	.45	.47	.49
80 x 80	1.0	.08	.16	.23	.29	.36	.41	.45	.47	.50
80 x 80	4.0	.04	.11	.18	.25	.35	.39	.43	.46	.48
10 x 20	0.5	.05	.11	.16	.20	.26	.29	.32	.35	.37
10 x 20	1.0	.05	.11	.16	.20	.26	.30	.33	.35	.37
10 x 20	4.0	.03	.08	.14	.19	.27	.31	.35	.38	.40
20 x 40	1.0	.06	.13	.19	.24	.30	.35	.38	.40	.42
20 x 40	4.0	.04	.10	.15	.22	.30	.35	.39	.42	.44
40 x 80	1.0	.09	.17	.24	.29	.36	.41	.44	.46	.48
40 x 80	4.0	.06	.12	.19	.26	.35	.40	.44	.47	.49
10 x 40	0.5	.07	.14	.19	.23	.28	.32	.35		
10 x 40	1.0	.06	.14	.19	.23	.29	.33	.36		
10 x 40	4.0	.05	.12	.19	.24	.32	.37	.41	.43	.45
20 x 80	0.5	.09	.17	.22	.26	.32	.36	.40	.42	.44
20 x 80	1.0	.08	.15	.21	.26	.32	.36	.40	.42	.44
20 x 80	4.0	.05	.12	.19	.25	.33	.38	.42	.45	.47

eccentricity effect for fields of contamination over 200 ft wide. For source fields smaller than 20 ft wide (close-in) there may be 10 to 20 percent change; however, there is not enough data to make a valid deduction. In general, the amount of wall scattered radiation received from the upper half of the building as compared to the lower half increases with increasing field width (Wc) and increases with building area.

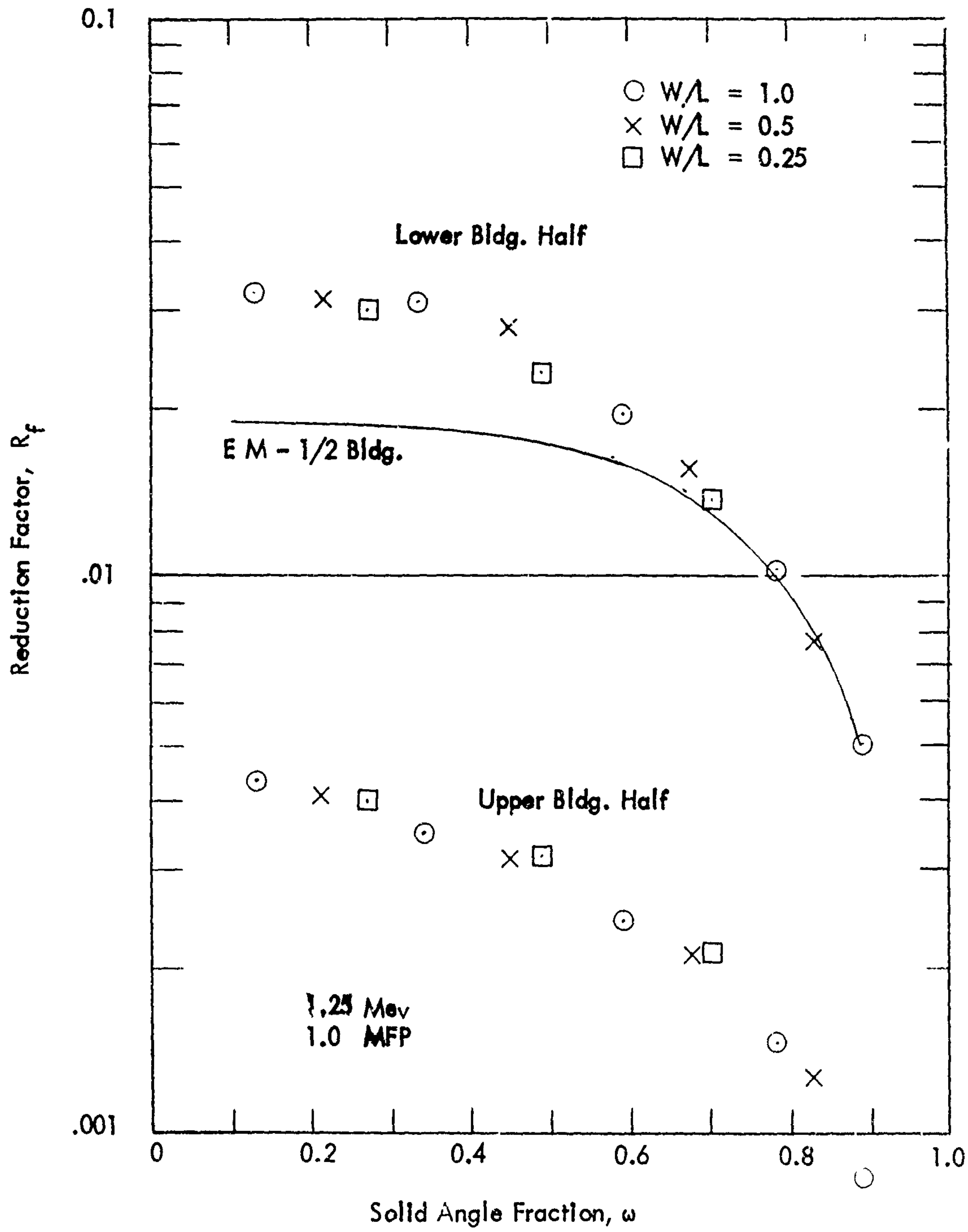
A more detailed view of the wall scatter contribution from the upper and lower halves of the walls is obtained from the data of Appendix A by plotting wall scatter data for each source field width (Wc). Typical plots are presented in Figs. 3.4, 3.5, 3.6, 3.7, and 3.8 for 1.0 mfp walls and source field widths of 5, 10, 20, 50, and 70 ft and in Figs. 3.9, and 3.10 for 4 mfp walls for 10 and 50 ft source field widths. Reduction factors are plotted against solid angle fraction of the upper and lower half walls as viewed from the mid-floor height detector. With the detector at mid-floor height the upper and lower solid angles (ω_u and ω_ℓ) are identical. Solid angle fractions for the square buildings are .13, .34, .59, .78 and .89. Solid angle fractions are .215, .445, .675, and .825 for the 5 x 10, 10 x 20, 20 x 40, and 40 x 80 ft buildings and .27, .49, and .70 for the 5 x 20, 10 x 40, and 20 x 80 ft buildings. Data is plotted with symbols to differentiate between buildings of different width to length ratios. Figure 3.4 shows the large (factor of 20) difference between the lower and upper half of the buildings for a source field width of 5 ft. Reduction factors shown in Fig. 3.4 for W_c=5 and in Figs. 3.5, 3.6, 3.7, and 3.8 for field widths of 10, 20, 50 and 70 ft show that reduction data essentially falls on a series of curves, one for the upper half of the wall and one for the lower half of the wall. Variation from the curves is small and is due to wall width to length changes. Engineering Method wall scatter contributions for the upper half and lower half of the walls of structures are equal and are also shown in the Figs. 3.4 through 3.10. Engineering Method wall scatter for the lower half of a building are fairly close to CONSTRIP values but are off by an order of magnitude in comparison with upper half values. For the very close-in field (W_c=5 ft) the Engineering Method calculated values are one half the CONSTRIP values for the lower building half at solid angles to 0.4 and were approximately equal to the CONSTRIP values for solid angles between 0.7 and 0.9. As field width increases the Engineering Method reduction factors approach the CONSTRIP values for the lower building half at small solid angles and become higher than the CONSTRIP values for solid angles greater than 0.5.

CONSTRIP and Engineering Method reduction factor values for thick walled (4.0 mfp) structures are illustrated in Figs. 3.9 and 3.10 for source field widths of 10 and 50 ft. Results are generally similar to the 1.0 mfp cases except there is a greater spread in the CONSTRIP data, particularly for the wall scatter from the lower half of the walls.



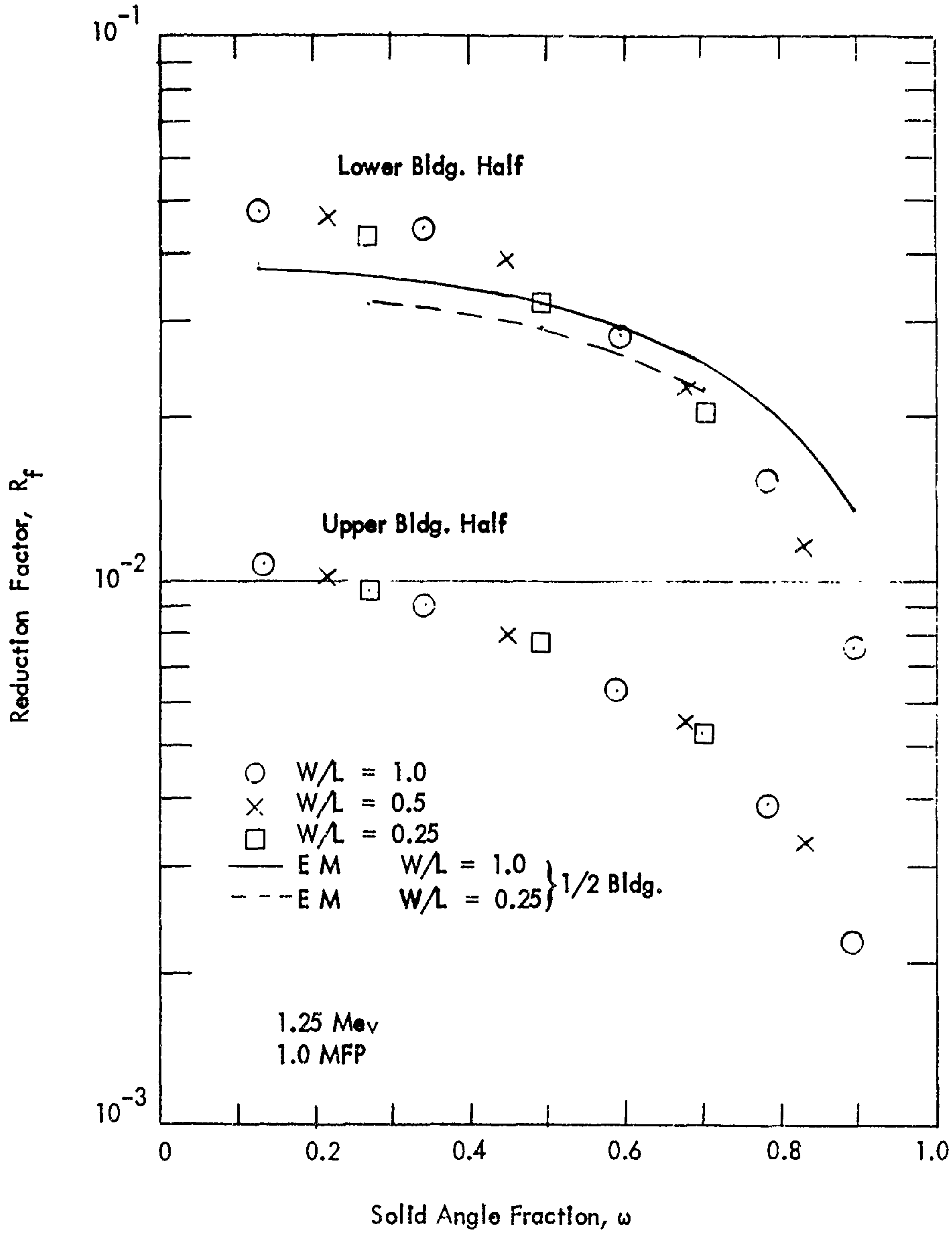
WALL SCATTER FROM FIVE FOOT WIDE SOURCE FIELD

Figure 3.4



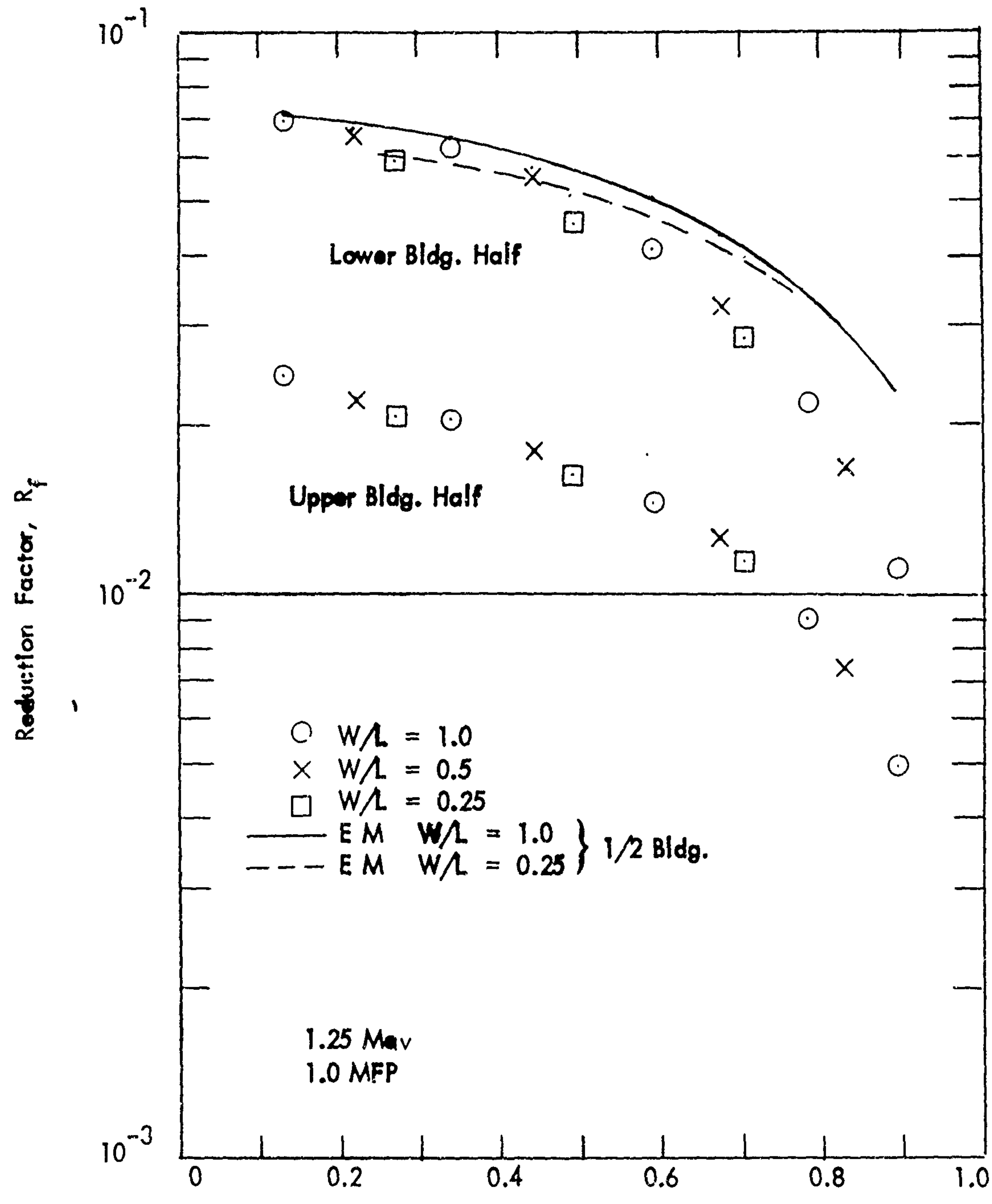
WALL SCATTER FROM TEN FOOT WIDE SOURCE FIELD

Figure 3.5



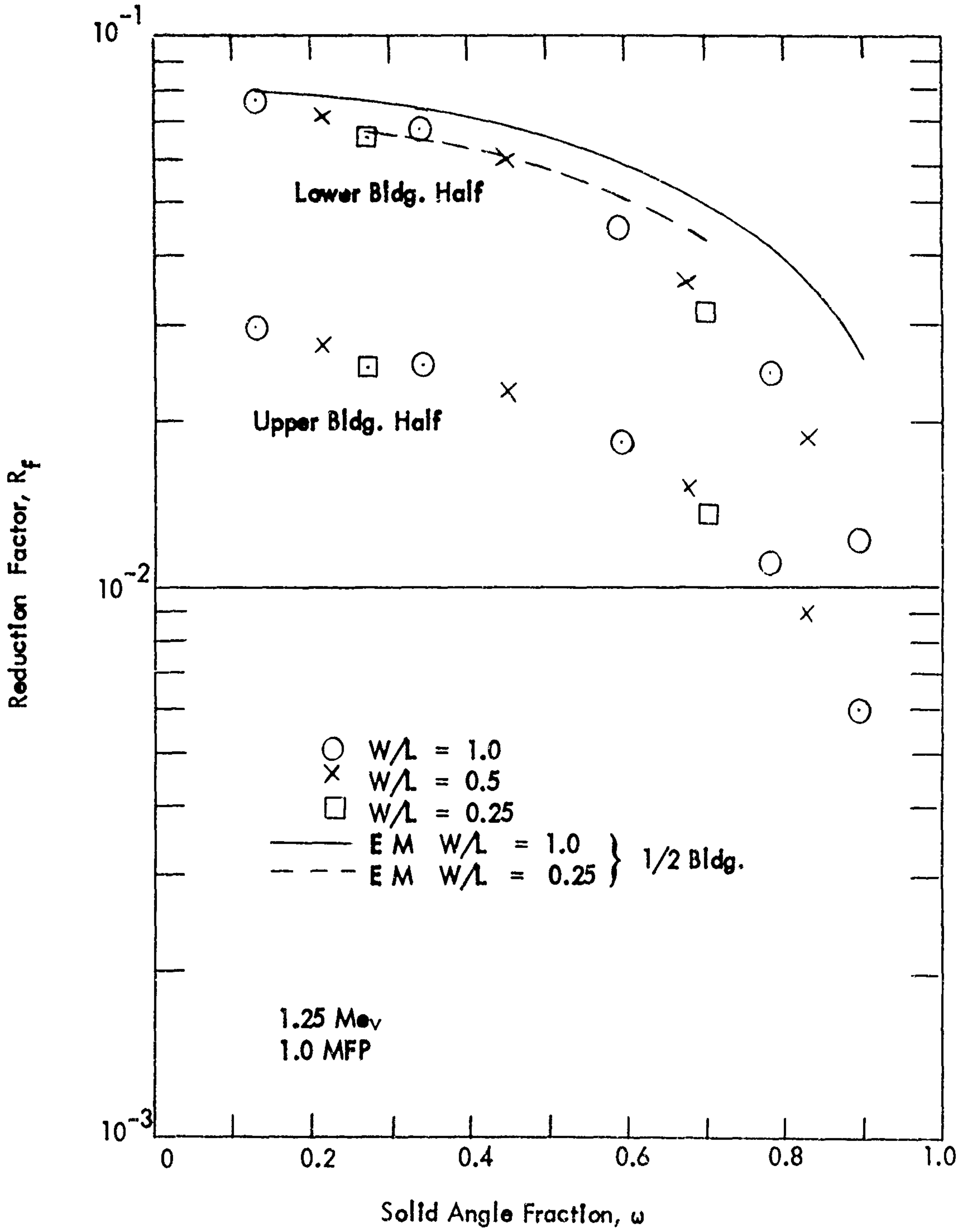
WALL SCATTER FROM TWENTY FOOT WIDE SOURCE FIELD

Figure 3.6



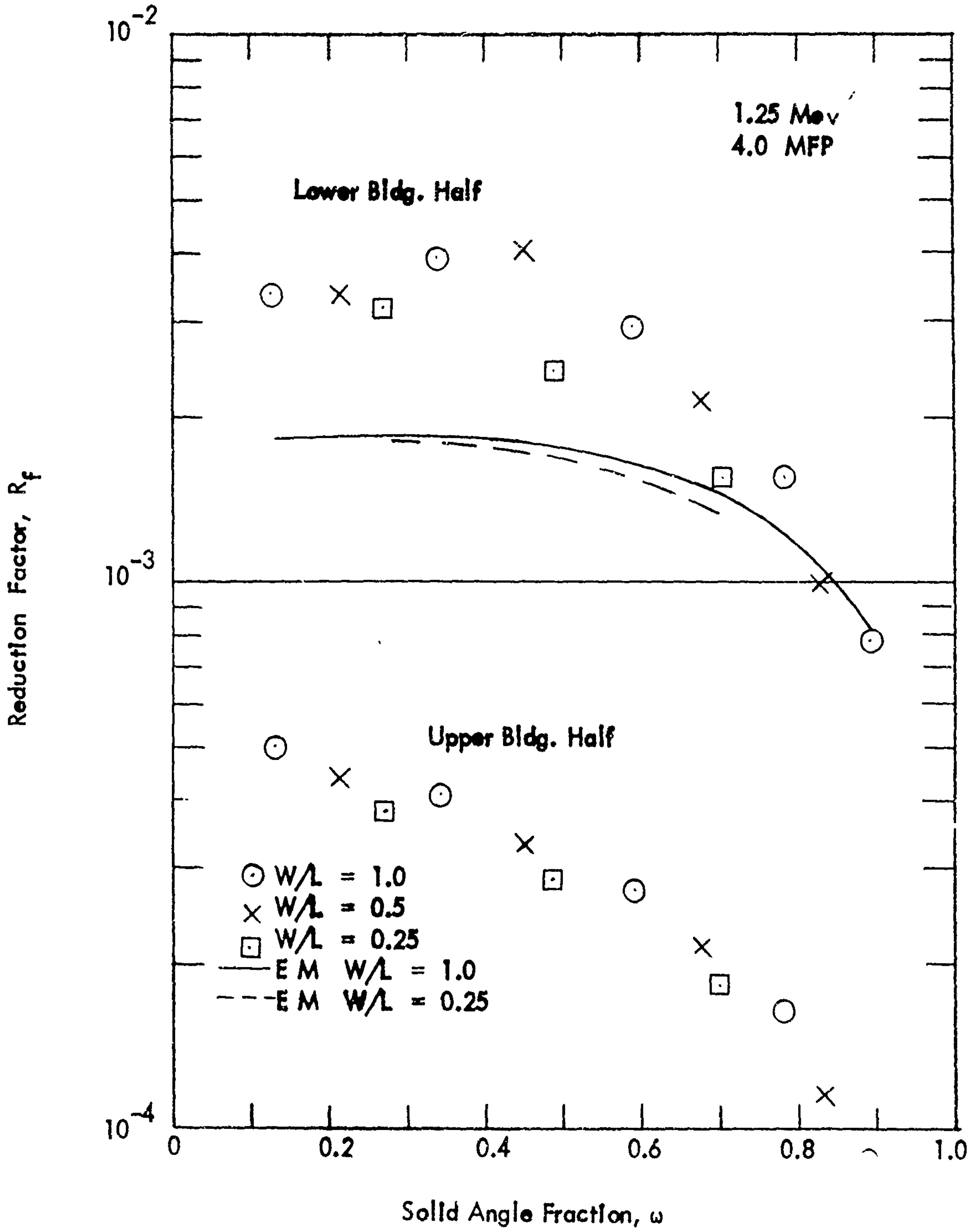
WALL SCATTER FROM FIFTY FOOT WIDE
SOURCE FIELD

Figure 3.7



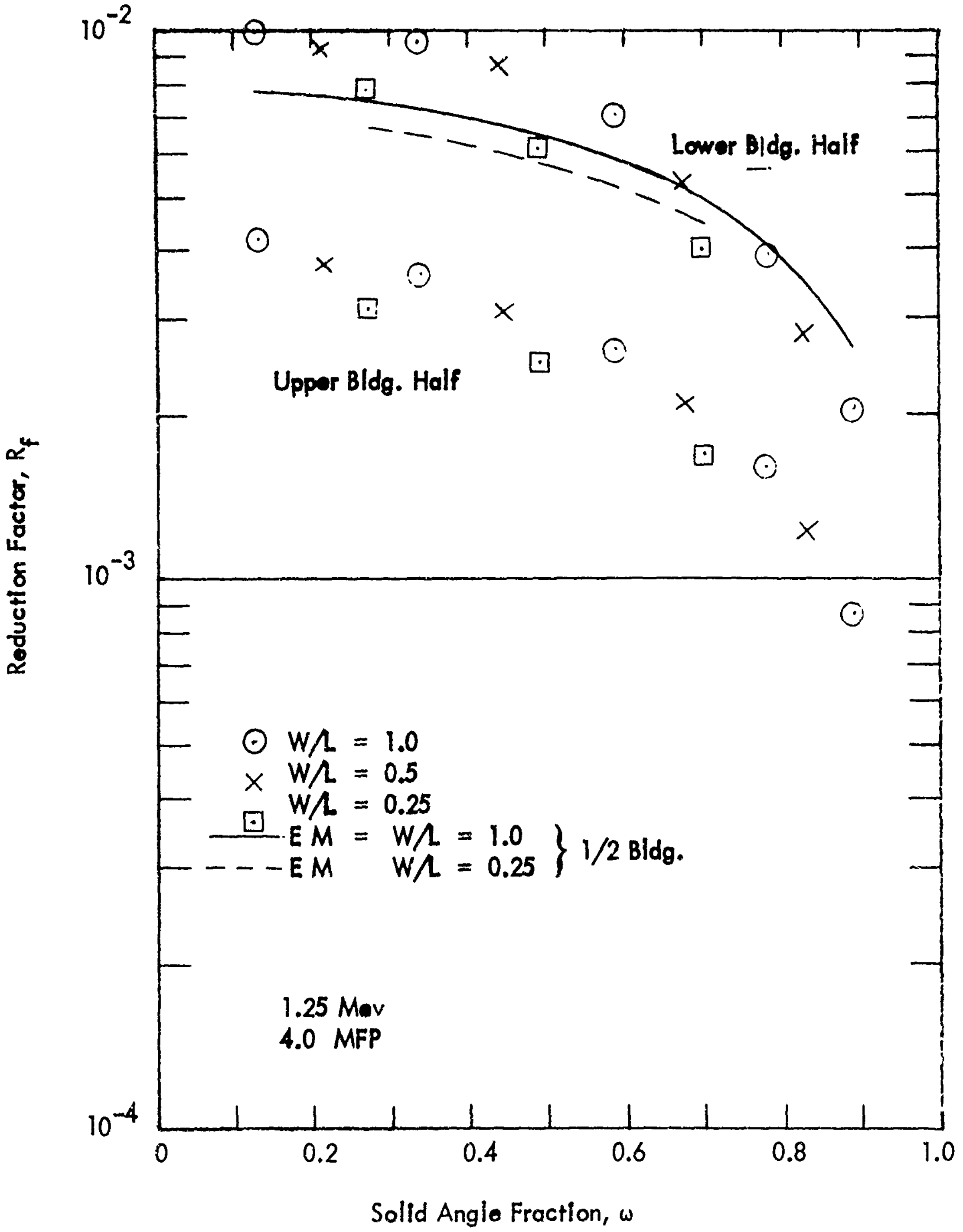
WALL SCATTER FROM SEVENTY FOOT WIDE
SOURCE FIELD

Figure 3.8



WALL SCATTER FROM TEN FOOT WIDE SOURCE FIELD

Figure 3.9



WALL SCATTER FROM FIFTY FOOT WIDE
SOURCE FIELD

Figure 3.10

Because the wall scatter reduction factors for buildings with 0.5 and 0.25 width to length ratios fell close to lines drawn through the square building data the square building data can be assumed representative of the wall scatter results for the rectangular structures. A series of plots of wall scatter reduction factors for the upper and lower building halves are shown in Figs. 3.11, 3.12, and 3.13 for field widths of 5, 10, 15, 20, 30, 50 and 70 ft. The curves shown in Fig. 3.11 are for 0.5 mfp walls, in Fig. 3.12 for 1.0 mfp walls and Fig. 3.13 for the 4.0 mfp square building cases. The reduction factor curves form a series of similar shaped curves for each wall thickness. Some deviation does occur for the 1.0 mfp lower wall half curves at solid angles less than 0.25 for close-in fields ($W_c < 10$). This deviation is more pronounced for the 4.0 mfp lower wall half curves of Fig. 3.13.

3.3 CUMULATIVE ANGULAR DISTRIBUTION OF WALL SCATTERED RADIATION

The wall scatter data for the upper and lower halves of the walls of the square building series summarized in the graphs in Figs. 3.11, 3.12, and 3.13 of the previous section can be extended to determine the finite field values for the cumulative angular distribution of wall scattered radiation, G_s. This is accomplished by extrapolating the CONSTRIP finite field curves in Figs. 3.11, 3.12, and 3.13 for 0.5, 1.0 and 4.0 mfp walls to a solid angle value of zero. The 5 x 5 building (ω= .13) was processed to permit accurate extrapolation to zero solid angle values.

In the Engineering Method the finite field wall scatter reduction factor is

$$D_{\omega s} = D_{\omega s \ell} + D_{\omega s u} = K(G_s(\omega_\ell) + G_s(\omega_u))\ E$$

where $D_{\omega s l}$ = wall scatter from below detector plane

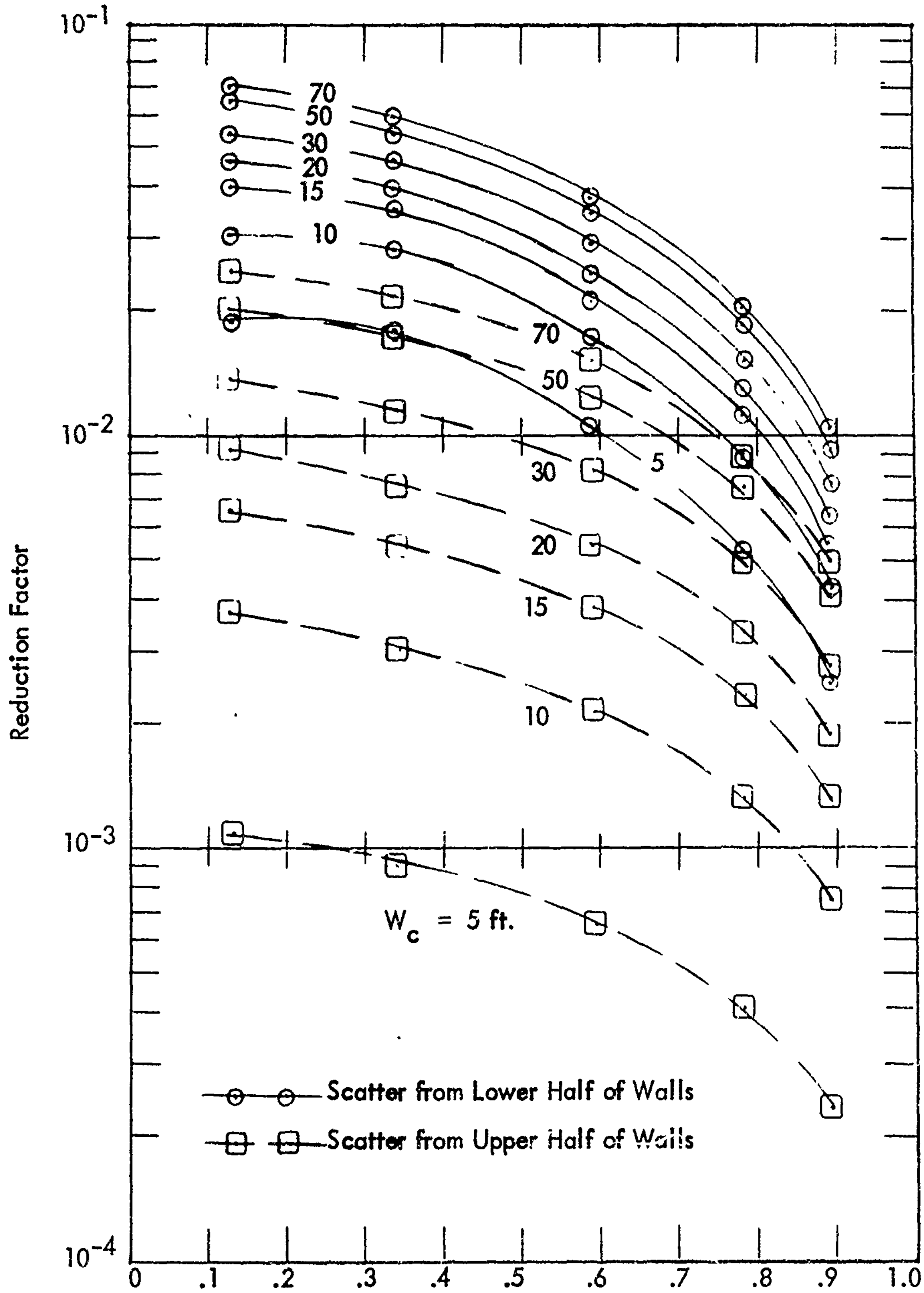
$D_{\omega s u}$ = wall scatter from above detector plane

K = wall barrier factor times S_W

$G_s(\omega)$ = cumulative angular distribution of wall scattered radiation

E = building shape factor

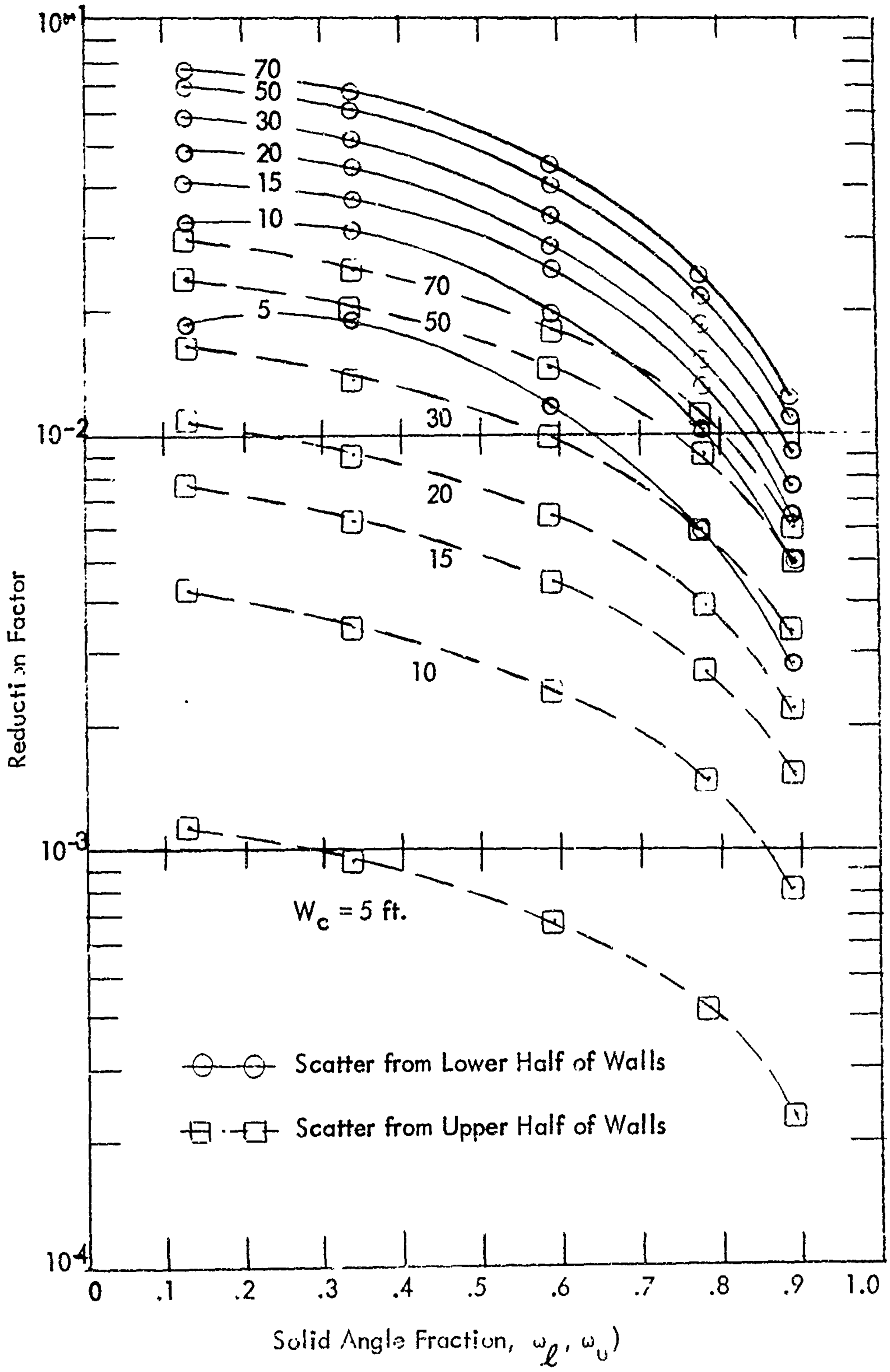
For the Engineering Method $G_s(\omega)$, radiation from below the detector plane, $G_s(\omega_\ell)$, is the same as $G_s(\omega)$, radiation from above the detector plane, $G_s(\omega_u)$, for equal solid angle fractions. Price and French [8], using a COHORT Monte Carlo procedure, showed that for infinite fields of contamination the directional response (cumulative angular distribution) from the lower half of a wall can be up to 50 percent higher than the directional response from the upper half of the wall at corresponding small solid angle fractions.



Solid Angle Fraction (ω_ℓ, ω_u)

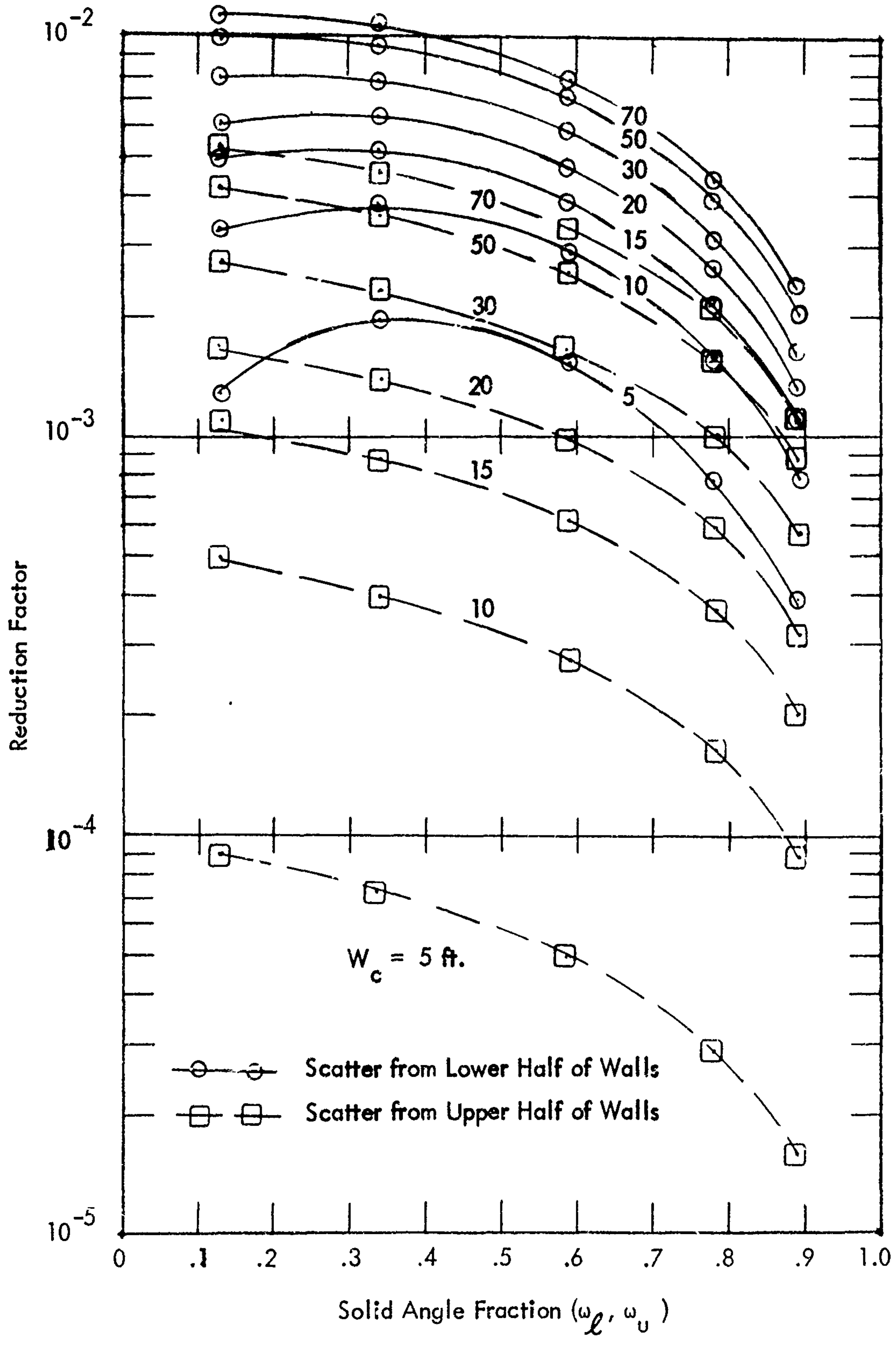
SCATTER COMPONENT FROM LOWER AND UPPER HALF OF SQUARE STRUCTURES FOR RECTANGULAR SOURCE FIELDS - 0.5 MFP, 1.25 MEV

Figure 3.11



SCATTER COMPONENT FROM LOWER AND UPPER HALF OF SQUARE STRUCTURES FOR RECTANGULAR SOURCE FIELDS - 1.0 MFP, 1.25 MEV

Figure 3.12



SCATTER COMPONENT FROM LOWER AND UPPER HALF OF SQUARE STRUCTURE FOR RECTANGULAR SOURCE FIELDS - 4.0 MFP, 1.25 MEV

Figure 3.13

The response function $G_s(\omega_u) + G_s(\omega_\ell) = 1.0$ at $\omega = 0$. For the square building series the shape factor is constant and the wall barrier effect is held constant by holding the wall mass thickness constant. The only variable in this case for a particular finite field and wall mass thickness is the cumulative angular distribution of wall scattered radiation. Curves for $G_s(\omega_\ell)$ and $G_s(\omega_u)$ then can be determined by extrapolating the wall scatter curves of Figs. 3.11, 3.12, and 3.13 to $\omega = 0$.

At $\omega = 0$

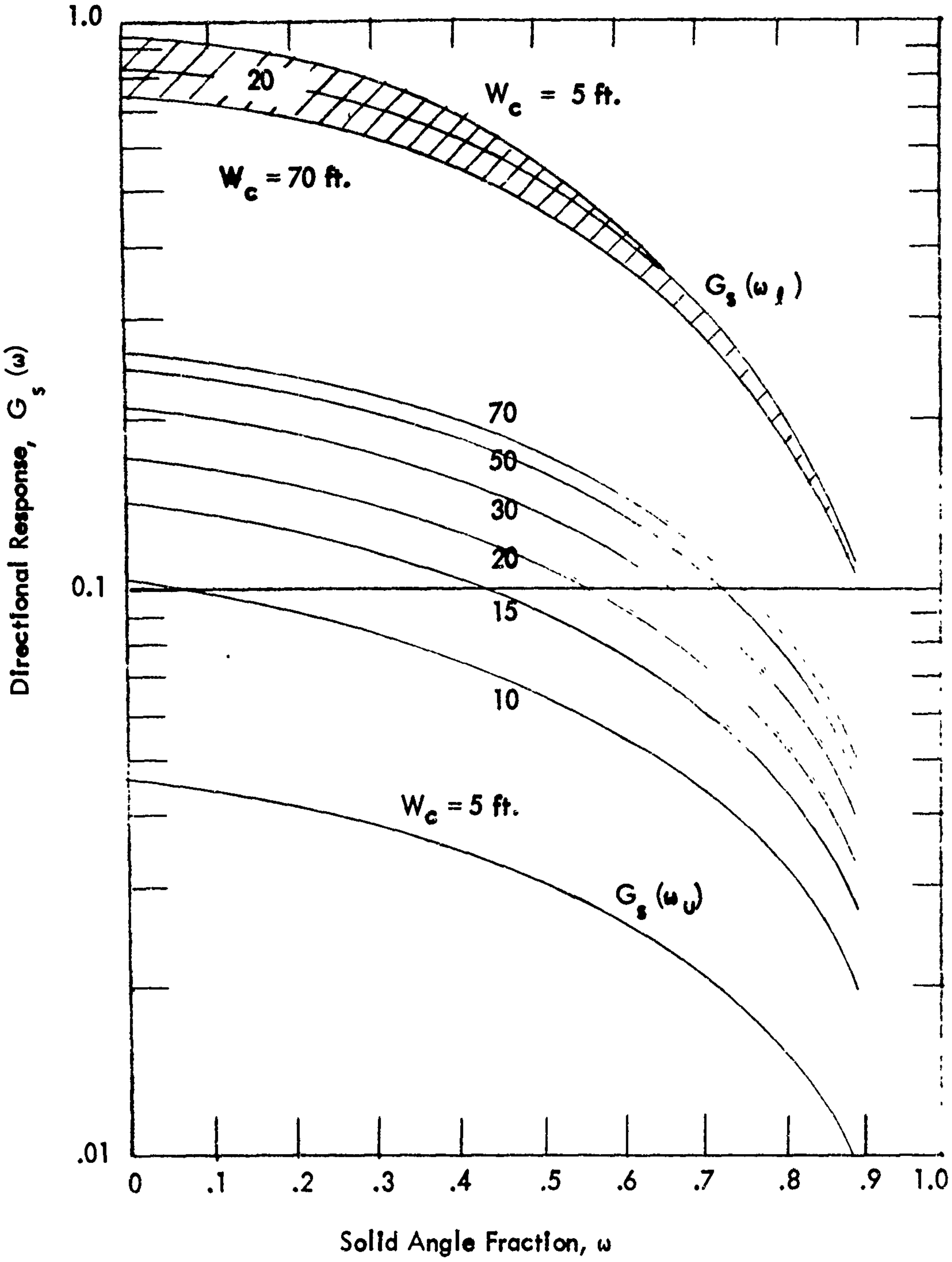
$$G_s(\omega_\ell) + G_s(\omega_u) = 1$$

and $K \cdot E = \text{Constant} = D_{\omega s \ell} + D_{\omega s u}$

With the constant, K·E, determined for a particular field width, $G_s(\omega_u)$ and $G_s(\omega_\ell)$ values for solid angles other than zero can be determined by dividing the wall scatter reduction factors by the constant for the respective source field widths. The directional response curves determined in this manner are shown in Figs. 3.14, 3.15, and 3.16 for wall mass thickness values of 0.5, 1.0 and 4.0 mfp. The directional response for wall scattered radiation from below the detector plane falls in a fairly narrow band as shown in the figures for W_c between 5 and 70 ft. The directional response at a field width of 20 ft gives a good average value for $G_s(\omega_\ell)$ for the shaded area representing field widths between 5 and 70 ft. For radiation from above the detector plane, the directional response varies strongly with field width. Incremental changes decrease as the source field width increases. There is little difference between the directional response curves obtained for $G_s(\omega_\ell)$ for the three mass thickness values of 0.5, 1.0 and 4.0 mfp. There is a small increase in the direction response values for radiation from above the detector plane as the wall mass thickness goes from 0.5, to 4.0 mfp. The direction response curve used in Engineering Method is shown in Fig. 3.15 and falls between that determined from CONSTRIP data for the supper and lower halves of the wall except for $\omega > 0.8$.

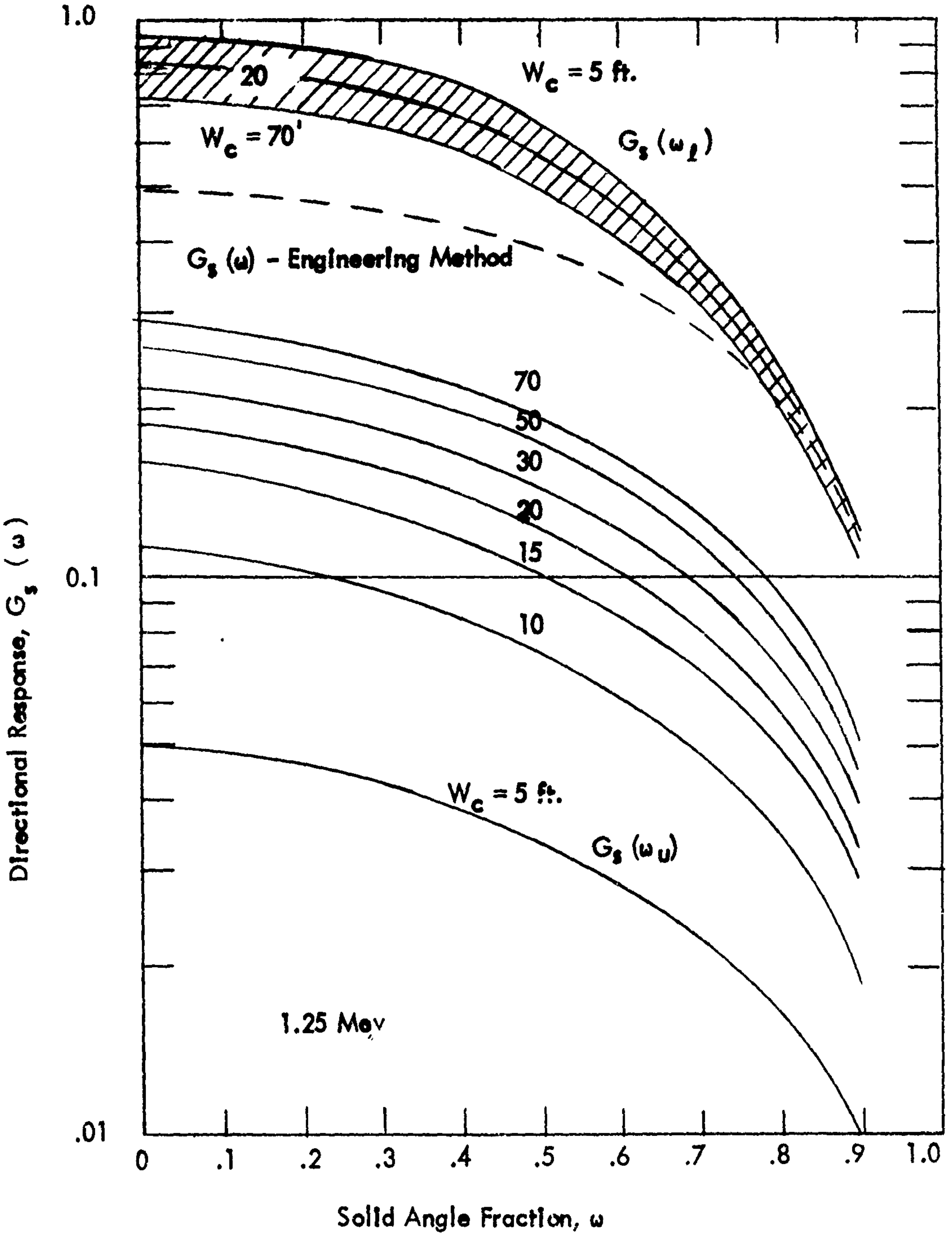
3.4 STRUCTURE ECCENTRICITY EFFECTS

Three building configurations were processed to try to obtain further insight into the effect of eccentricity on the wall scatter and non-wall scatter radiation components. The three buildings have the same solid angle fraction for the outside walls as viewed from a detector at the center of the structures. The buildings were 20 x 20 ft, 15.2 x 30.4 ft, and 13.75 x 55 ft , structures having width to length ratios of 1.0, 0.5 and 0.25 respectively. The solid angle of the exterior walls was 0.59 for the lower and upper half of the walls for all three structures. Wall mass thicknesses were 0.5, 1.0 and 4.0 mfp for the three buildings, and finite source field width varied from 5 to 70 ft.



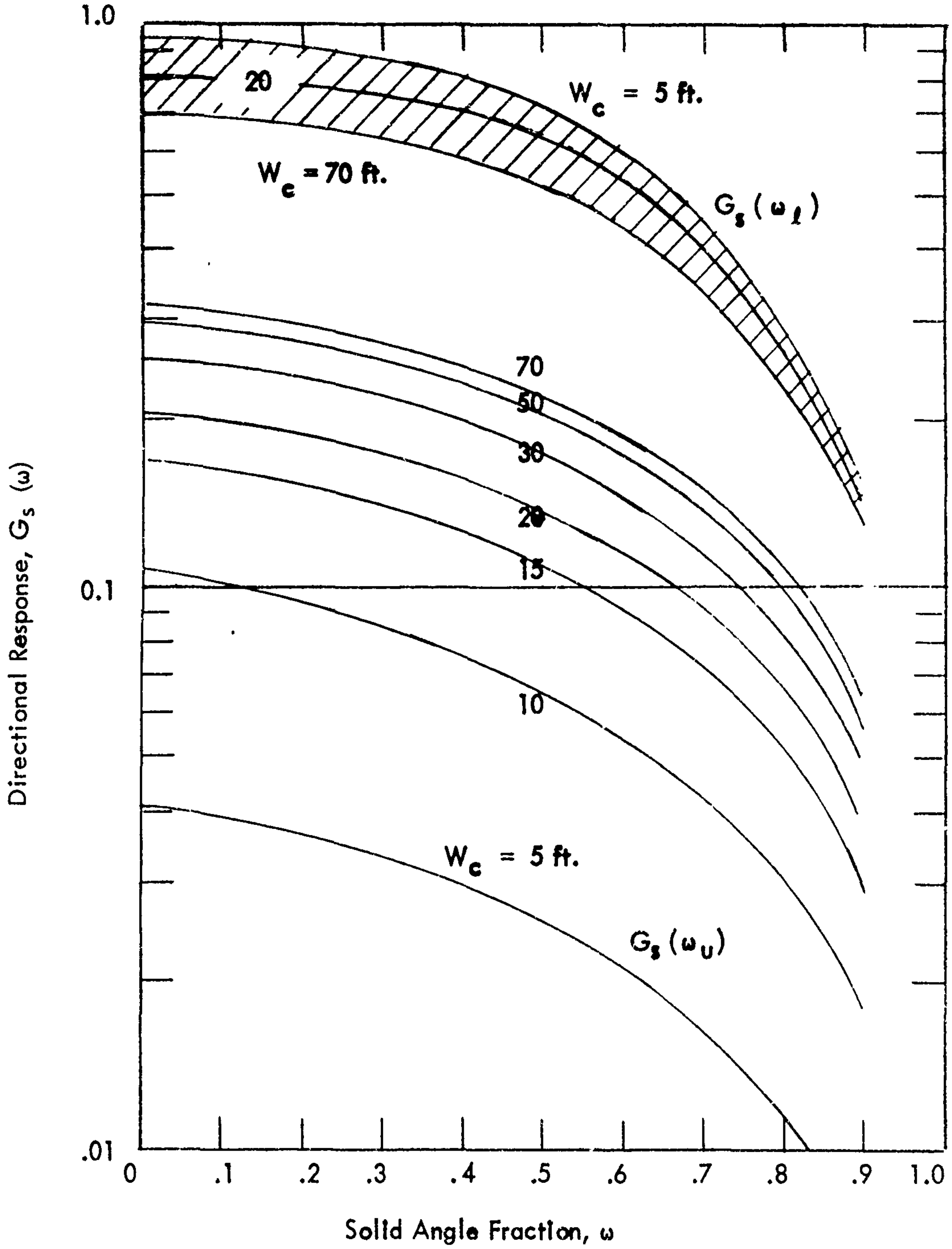
DIRECTIONAL RESPONSE FOR WALL SCATTERED RADIATION, 0.5 MFP WALLS

Figure 3.14



DIRECTIONAL RESPONSE FOR WALL SCATTERED RADIATION, 1.0 MFP WALLS

Figure 3.15



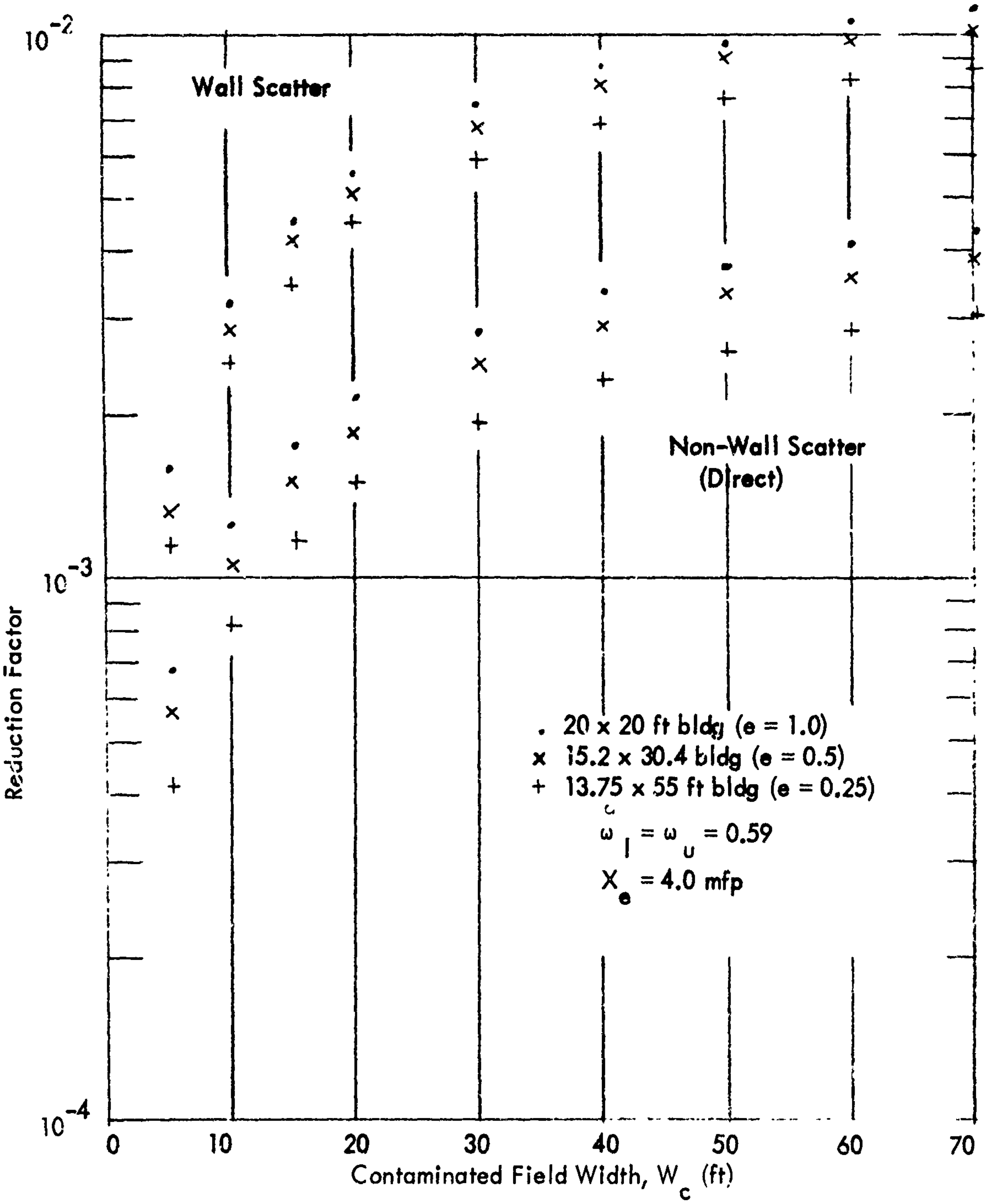
DIRECTIONAL RESPONSE FOR WALL SCATTERED
RADIATION, 4 MFP WALLS

Figure 3.16

The results of the CONSTRIP III processing for the heavy wall case (4 mfp) are shown in Fig. 3.17 for both the wall scattered and non-wall scattered components for the three buildings. Reduction factor components are highest for the square (20 x 20) building and lowest for the high eccentricity (13.75 x 55 ft) building. This general pattern held for all field widths processed (0–70 ft). For these same buildings, but with 1.0 mfp walls, the non-wall scattered component spread was similar but of smaller magnitude and the spread between the three structures was very small. For the 0.5 mfp wall cases there was a smaller spread for the non-wall scattered component and a very slight reversal for the wall scatter case with the square building giving the lowest values. These results are presented in greater detail in Table 3.5 for the non-wall scatter component and in Table 3.6 for the wall scatter component.

Table 3.5 summarizes the results obtained for the non-wall scatter or direct radiation component for building width to length ratios of 1.0, 0.5 and 0.25. The Engineering Method [6] assumes that there is no direct eccentricity factor, E_d. The results of the three cases here indicate that there should be a direct eccentricity factor and that it will vary with mass thickness. The eccentricity part of the CONSTRIP III runs was not in sufficient detail and scope to more than indicate that there should be direct eccentricity factors. The CONSTRIP non-wall scatter components for the 15.2 x 30.4 and the 13.75 x 55 ft buildings were compared in Table 3.5 to the square building case to illustrate the magnitude of the eccentricity effect. These ratios are summarized as the range of ratios for source field widths of 5 to 70 ft. For 0.5 and 1.0 mfp walls the eccentricity effect increases with both wall thickness and with increasing finite source field width. For 4.0 mfp walls the eccentricity effect is higher overall than for the 1.0 mfp wall, with the largest effect now occuring for the smallest source field widths. The ratio of the 1.0 (square) to the 0.25 building gives reduction factor components that were 18 percent higher for the square building at a wall mass thickness of 0.5 mfp, 28 percent for a 1.0 mfp value and 65 percent for a 4.0 mfp wall. Eccentricity effects from the Engineering Method calculations were nil at the 70 ft source field width, but indicated up to 15 percent for small finite fields.

Wall scattered eccentricity effects are summarized in Table 3.6. Eccentricity effects were small for the comparison based on the three buildings having width to length ratios of 1.0, 0.5, and 0.25. There are no obvious patterns between Engineering Method calculations using the Shape Factor Curve shown in Fig. 3.18 and the CONSTRIP values. The Engineering Method eccentricity effect for wall scattered radiation does not change with wall mass thickness, whereas the CONSTRIP results indicate that the effect does increase as wall mass increases.



CONSTRIP III Wall Scatter and Non-Wall Scatter Reduction Factor Components For Varying Eccentricity and Constant ω_l and ω_u

Figure 3.17

TABLE 3.5

SHAPE FACTORS FOR NON-WALL SCATTERED RADIATION COMPARISON OF NON-WALL SCATTER RATIOS FOR DIFFERENT SHAPED BUILDINGS HAVING IDENTICAL SOLID ANGLE FRACTIONS

$(\omega_l = \omega_u = 0.59)$

$$\text{Ratio A} = \frac{\text{20 x 20 bldg non-wall scatter } (e = 1.0)}{\text{15.2 x 30.4 bldg } (e = 0.50)}$$

$$\text{Ratio B} = \frac{\text{20 x 20 bldg non-wall scatter } (e = 1.0)}{\text{13.75 x 55 bldg } (e = 0.25)}$$

X_e (mfp)	CONSTRIP III*	Engineering Method*
	Ratio A	Ratio A
0.5	1.00 - 1.11	.94 - 1.00
1.0	1.05 - 1.13	.93 - 1.00
4.0	1.20 - 1.15	.93 - 1.00
	Ratio B	Ratio B
0.5	1.07 - 1.18	.84 - .99
1.0	1.17 - 1.28	.84 - .98
4.0	1.64 - 1.45	.84 - .98

*Range of values for finite field widths between five and 70 feet.

SHAPE FACTOR FOR WALL-SCATTERED RADIATION

Figure 3.18

Engineering Method Shape Factors

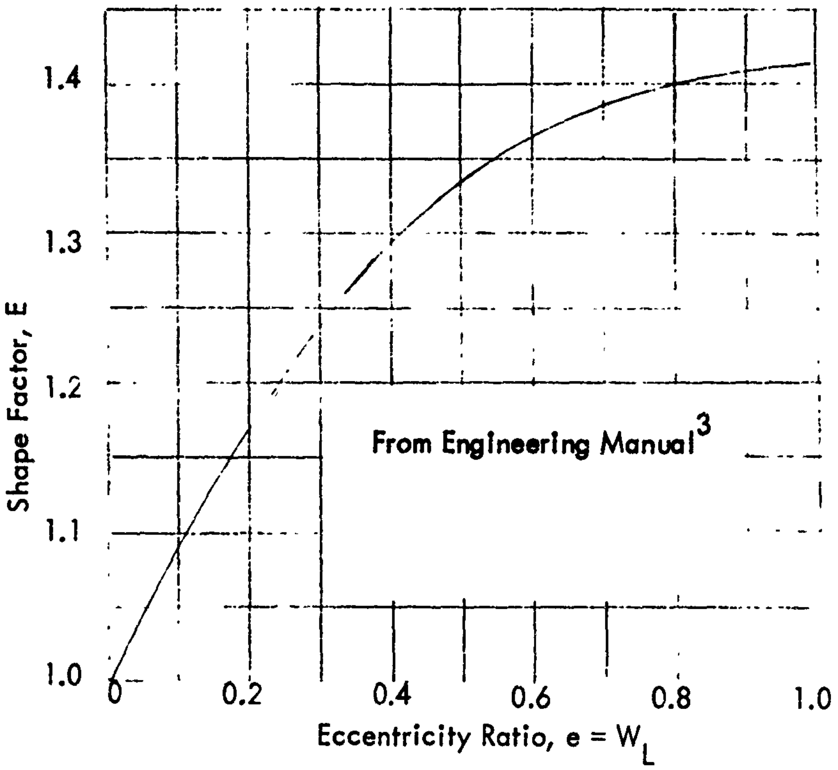


Table 3.6

Comparison of Wall Scatter Ratios For Different Shaped Buildings Having An Identical Solid Angle Fraction ($\omega_l = \omega'_u = 0.59$)

Ratio A = $\frac{20 \times 20 \text{ bldg wall scatter}}{15.2 \times 30.4 \text{ bldg } (e = 0.5)}$ Ratio B = $\frac{20 \times 20 \text{ bldg } (e = 1.0)}{13.75 \times 55 \text{ bldg } (e = 0.25)}$

X_e(mfp)	CONSTRIP III	Engineering Method
	Ratio A	Ratio A
0.5	.94-1.00	1.02-1.04
1.0	.96-1.02	1.01-1.04
4.0	1.20-1.08	1.00-1.04
	Ratio B	Ratio B
0.5	.85-.98	1.08-1.12
1.0	.98-1.07	1.08-1.14
4.0	1.40-1.27	1.02-1.12

3.5 COMPARISON BETWEEN CONSTRIP AND ENGINEERING METHOD REDUCTION FACTORS

The comparison between CONSTRIP and the Engineering Method total reduction factors values at the center of both square and rectangular structures are summarized in Table 3.7. Agreement in general is excellent. The greatest differences occur at the smallest field width (5 ft). For such a small field width, radiation from the contaminated area strikes the wall at nearly grazing angles and both CONSTRIP and Engineering Method errors would tend to be most severe. For the 0.5 mfp buildings the average ratio of CONSTRIP to Engineering Method reduction factors was .98 for source field widths between 5 to 70 ft. For source field widths between 10 and 70 ft the average was .97 with a ±13 percent spread of reduction factor values. Agreement is better for the square buildings than for the rectangular buildings. The ratios for 1.0 mfp walls were very similar for source field widths ranging from 10 to 70 ft; however, reduction factor ratios from .95 to 1.38 were obtained for 5 ft wide source strips. For 4.0 mfp walls considerably more spread occurs. The average ratio is .92 with a ±25 percent variation for field widths between 10 and 70 ft.

The total reduction factor values are in excellent general agreement. The wall scatter and direct components are in poor agreement with CONSTRIP. Direct contributions are generally higher than the Engineering Method predictions and the CONSTRIP wall scatter values are lower than the Engineering Method. The differences compensate to give excellent agreement for the combined wall scatter and direct values.

For the direct component with square buildings the CONSTRIP values are higher than the Engineering Method except for small field widths for the 5 x 5 building with 4.0 mfp walls. The ratio between CONSTRIP and the Engineering Method increases with increase in source field width. This ratio also increases with building size and in general with wall thickness. For example, a 10 x 10 ft building has CONSTRIP to Engineering Method ratios ranging from 1.22 to 1.28 at 0.5 mfp and 1.05 to 1.96 at 4 mfp walls compared to 80 x 80 ft building values at 1.46 to 1.68 at 0.5 mfp and 2.45 to 2.86 at 4.0 mfp. The direct contribution ratios are not so high for buildings with wall width to length values of 0.5 and 0.25. The 20 x 80 building has a CONSTRIP to Engineering Method ratio of .97 to 1.20 at 0.5 mfp and 1.05 to 1.61 at 4.0 mfp, indicating that there is a direct eccentricity factor effect. Shape effects as determined from the CONSTRIP data are covered in Section 3.4 of this report.

TABLE 3. 7

COMPARISON OF CONSTRIP AND ENGINEERING METHOD TOTAL REDUCTION FACTORS

Constrip R_f / Engineering Method R_f

Contaminated Field Width, W_c (ft)

Bldg (ft x ft)	5	10	15	20	30	40	50	60	70
0.5 mfp (18 psf)									
5 x 5	1.10	1.13	1.07	1.04	1.07	1.00	1.00	1.01	1.01
10 x 10	1.20	1.10	1.05	1.02	1.00	.96	.99	1.00	1.00
20 x 20	1.04	1.01	.99	.98	.97	.96	.97	1.00	1.00
40 x 40	1.00	.93	.95	.95	.95	.96	.99	1.00	1.03
80 x 80	.98	.94	.90	.91	.95	.97	1.02	1.04	1.07
5 x 10	1.16	1.05	1.04	1.02	.99	.97	.97	.99	.99
10 x 20	1.11	1.02	.99	.98	.97	.95	.97	.97	.98
5 x 20	1.04	.97	.97	.96	.93	.92	.94	.94	.95
10 x 40	.97	.91	.90	.90	.89	.89	.90		
20 x 80	.91	.88	.90	.87	.87	.88	.96	.91	.92
3 mfp (36 psf)									
5 x 5	1.28	1.14	1.10	1.08	1.02	1.00	1.00	1.01	1.01
10 x 10	1.35	1.15	1.09	1.06	1.02	1.00	1.00	1.01	1.02
20 x 20	1.38	1.05	1.01	1.02	.97	.97	.99	.99	1.01
40 x 40	1.05	.95	.94	.94	.91	.93	.96	.98	.99
80 x 80	.96	.86	.84	.86	.85	.90	.93	.97	.99
5 x 10	1.22	1.09	1.06	1.03	.99	.96	.98	.98	.99
10 x 20	1.25	1.08	1.04	1.02	.97	.95	.97	.98	.99
20 x 40	1.05	.96	.94	.94	.91	.91	.93	.94	.95
40 x 80	.96	.87	.85	.81	.83	.86	.89	.92	.92
5 x 20	.94	.98	.95	.96	.92	.90	.92	.92	.97
10 x 10	1.00	.93	.91	.87	.87	.87	.89	.89	
20 x 80	.95	.87	.86	.86	.83	.85	.86	.88	.89
4 mfp (144 psf)									
5 x 5	1.09	1.04	1.04	1.02	1.00	1.01	.98	.99	.99
10 x 10	1.54	1.20	1.13	1.10	1.06	1.05	1.02	1.03	1.03
20 x 20	1.48	1.13	1.06	1.03	1.00	1.00	1.00	1.00	1.00
40 x 40	1.17	.92	.89	.90	.88	.88	.89	.89	.91
80 x 80	1.00	.72	.75	.73	.76	.78	.79	.81	.83
5 x 10	1.16	1.03	1.01	1.00	.98	.98	.97	.96	.97
10 x 20	1.77	1.24	1.14	1.08	1.04	1.04	1.01	1.01	1.01
20 x 40	1.15	.94	.91	.89	.90	.90	.90	.90	.92
40 x 80	.84	.73	.72	.75	.76	.77	.80	.80	.80
5 x 20	1.09	.93	.92	.90	.90	.90	.89	.89	.90
10 x 40	.91	.82	.82	.78	.82	.83	.83	.84	.84
20 x 80	.82	.74	.74	.73	.76	.76	.78	.79	.86

The scattered radiation from the walls as determined from the CONSTRIP is, in general, less than that predicted by the Engineering Method. For the 10 x 10 ft building the CONSTRIP values are 1.25 - .60 of the Engineering Method predictions for source field from 5 to 70 ft with 0.5 mfp building walls. The ratios for the 10 x 10 ft building with 4.0 mfp walls range from 1.41 to .90. For the 80 x 80 ft building comparable ratios are .39 to .30 for 0.5 mfp walls and .75 to .56 for 4.0 mfp walls. For the wall scatter contributions the CONSTRIP to Engineering Method ratios decreases with source field widrh and building size, and increases with wall mass thickness. For the 20 x 80 ft case, the ratios are similar to the 20 x 20 ratios for 0.5 and 1.0 mfp walls and are close to the 80 x 80 ratios for a 4.0 mfp wall mass thickness. There are some shape factor effects in evidence for the wall scatter component, but they are not so pronounced as for the direct component. Wall scatter shape factor effects are covered in more detail in Section 3.4.

CHAPTER 4

DECONTAMINATION OF RECTANGULAR 0.66 MEV SOURCE AREAS

A portion of the CONSTRIP III runs for 1.25 Mev finite rectangular fields of contamination was repeated at a lower source energy of 0.66 Mev to determine the effect of lowering source energy on decontamination. The CONSTRIP III multiple scatter Monte Carlo data for 1.25 Mev was replaced with 0.66 Mev data. In the 0.66 Mev calculations a value of 330 ft was used as the mean free path of 0.66 Mev gamma rays in air. The normalization constant (CNORM) was changed to 0.03043. The air-ground buildup factor section of the program was not changed and therefore used 1.25 Mev values.

The error introduced by using the 1.25 Mev air-ground buildup for 0.66 Mev was not significant enough to warrant changing the code. According to the buildup measurements by Rexroad and Schmoke [7] for point sources on the ground and with detector 3 and 6 ft above the ground, buildup for source to detector horizontal distances up to 100 ft were almost the same for 1.25 and 0.66 Mev radiation. For source distances between 100 and 150 ft, the 0.66 Mev buildup becomes a maximum of 5 percent higher than for 1.25 Mev radiation. At a distance of 200 ft it becomes approximately seven and one half percent higher. Since two thirds of the infinite field exposure rate comes from the first 100 ft source field width and contains essentially no buildup error, cumulative exposure rate values from the CONSTRIP calculations for field widths between 100 and 200 ft will be less than about 2 percent. The outer 40 ft source band used in Appendix C to calculate the far field contribution will, however, be low by approximately 6 percent from use of the 1.25 Mev buildup. The influence on the infinite field estimate is only in the order of one percent by the far field component. The infinite field calculations are covered in Appendix C.

The values for the effect of decontaminating finite rectangular areas of 0.66 Mev source material surrounding nine square and rectangular structures are given in Table 4.1. Table 4.1 is similar to Table 3.1 for 1.25 Mev contamination. Only the 20 x 20 building was processed for 0.5 mfp walls. The nine structures were all processed for 1.0 and 4.0 mfp (26 and 108 psf) wall mass thickness. The values and patterns in Table 4.1 for 0.66 Mev contamination are very similar to those shown in Table 3.1 for 1.25 Mev contamination. The 0.66 Mev percentage of infinite field decontamination of a particular field width is a little higher than the comparable 1.25 Mev values given in Table 3.1. The 0.66 Mev percentages are 5 to 15 percent higher for field widths to 50 ft, and decrease to 5 to 10 percent for larger fields. The average increase in effectiveness for decontaminating 0.66 Mev rectangular strips is about eight percent over 1.25 Mev contamination.

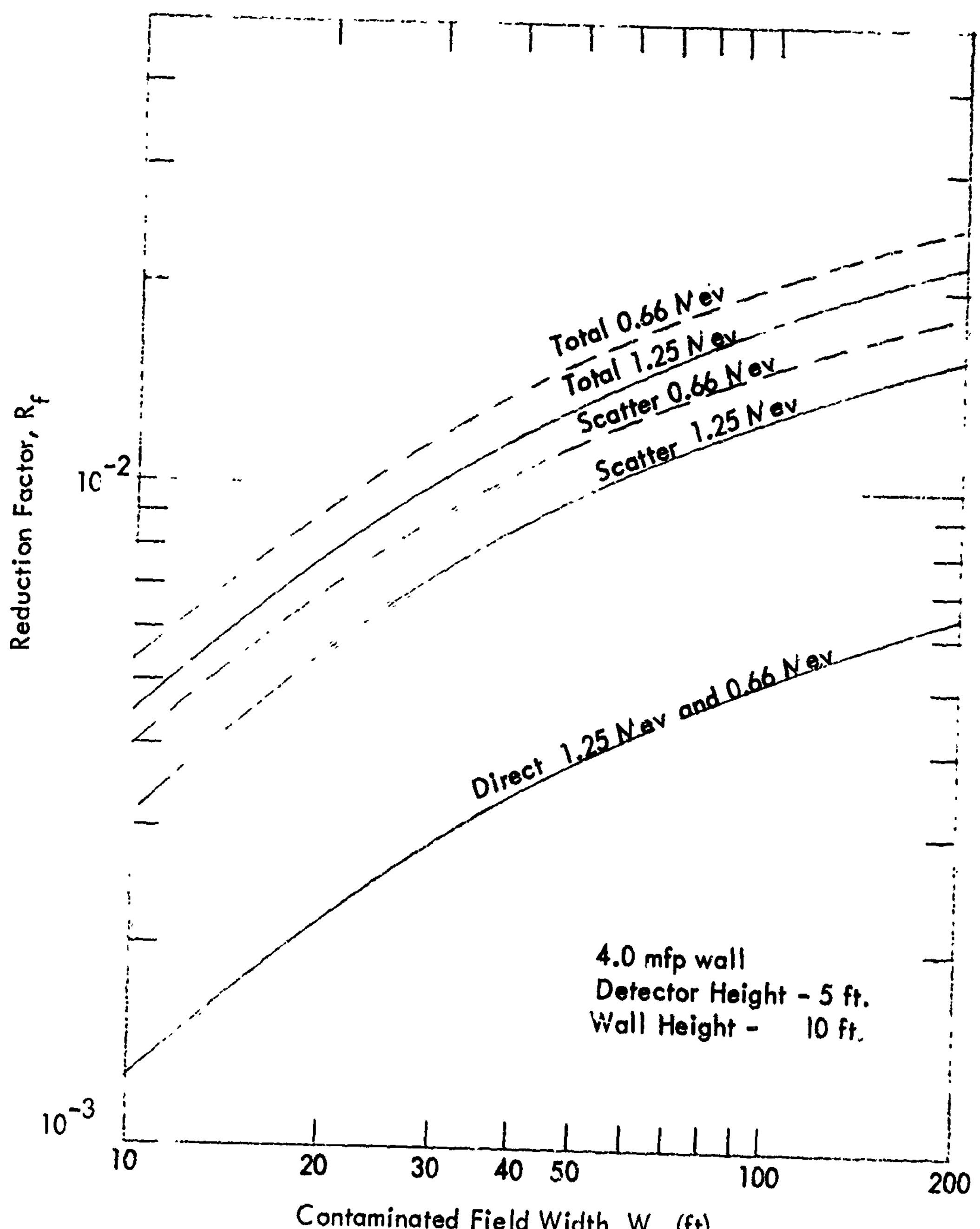
Table 4.1

Percent of Infinite Field of Contamination For Finite Rectangular Source Fields Surrounding Square and Rectangular Structures – 0.66 Mev

(Wall Height 10 ft, Detector Height 5 ft)

Bldg. (ft x ft)	X_e (mfp)	Field Width, W_c (ft)													
		5	10	15	20	30	40	50	60	70	80	100	120	160	200
10 x 10	1.0	12	21	28	34	42	48	53	57	60	63	68	72	78	82
10 x 10	4.0	8	17	24	30	39	45	51	55	58	62	66	71	77	81
20 x 20	0.5	11	19	25	30	38	44	49	53	57	60	65	69	74	79
20 x 20	1.0	11	19	26	31	39	45	50	54	58	61	66	70	76	80
20 x 20	4.0	9	17	24	30	38	45	50	54	57	60	65	69	75	80
40 x 40	1.0	9	16	21	26	34	39	44	49	52	56	61	65	72	77
40 x 40	4.0	8	16	22	27	35	42	47	51	55	58	63	68	74	78
80 x 80	1.0	6	12	17	21	28	34	39	43	47	50	56	61	68	74
80 x 80	4.0	7	14	19	24	32	38	43	48	51	55	60	65	72	77
10 x 20	1.0	12	22	28	33	41	47	52	56	59	62	67	71	77	81
10 x 20	4.0	10	18	25	31	39	46	51	54	58	61	66	70	75	80
20 x 40	1.0	11	19	25	30	38	44	49	53	56	60	65	69	75	80
20 x 40	4.0	8	17	23	29	37	44	49	53	56	60	65	69	75	80
40 x 80	1.0	8	15	20	25	33	39	44	48	52	55	61	65	73	78
40 x 80	4.0	6	14	20	25	34	40	45	49	53	56	61	65	72	77
10 x 40	1.0	12	22	29	35	43	50	54	58	62	64	69	73	78	82
10 x 40	4.0	8	18	26	33	43	50	56	61	65	66	71	74	80	84
20 x 80	1.0	11	20	26	32	40	46	51	56	59	62	67	70	77	81
20 x 80	4.0	8	17	25	31	41	48	54	59	62	64	69	72	78	82

A comparison is shown in Fig. 4.1 of the reduction factor graphs between 0.66 and 1.25 Mev finite contaminated rectangular fields. The figure shows the wall scatter and non-wall scatter or direct components, as well as the total reduction factors for a 20 x 20 ft building having a 4 mfp wall. The direct component is identical for 0.66 and 1.25 Mev on a mfp basis. This was also the case in similar plots for the other eight structures. The direct component for 1.0 mfp walls with 0.66 and 1.25 Mev contamination was also identical. The wall scatter reduction factor component in all cases was higher for 0.66 Mev contamination. For the 20 x 20 ft building shown in Fig. 4.1, the 0.66 Mev wall scatter reduction factors are approximately 17 percent higher than the 1.25 Mev values. For the other 4 mfp structures the differences between 0.66 and 1.25 Mev reduction factor curves followed the same pattern; both wall scatter and total 0.66 Mev values being higher than the 1.25 Mev reduction factors. For the 1.0 mfp cases the 0.66 Mev reduction factors were higher than the 1.25 Mev wall scatter and total reduction factors by only one to five percent.



Reduction Factor Comparison For A 20 X 20 Foot Building Subjected To 1.25 Mev and to 0.66 Mev Contamination.

Figure 4.1

CHAPTER 5

CONCLUSIONS

1. Decontamination of finite rectangular fields of 1.25 Mev source material reduced the exposure rates in single story, 100 ft square buildings by 12, 20, 50 and 80 percent for decontaminated strips surrounding the structures of 5, 10, 50, and 200 ft widths, respectively. The percentages decrease with increases in building floor plan area.

2. Removal of 0.66 Mev contamination is more effective in reducing exposure rates with structures by 8 percent than removal of 1.25 Mev contamination.

3. Separate directional response curves for wall scattered radiation should be used for wall scatter from above and from below the detector plane. Directional response for wall scattered radiation from above the detector plane is strongly influenced by finite field width.

4. There should be a building shape factor for non-wall scattered (direct) radiation that is a function of wall mass thickness.

5. CONSTRIP total reduction factor values are in excellent general agreement with Engineering Method calculated values.

6. CONSTRIP wall scatter reduction factor components are generally lower than Engineering Method values. The difference becomes smaller as the source field width and building floor plan area increases. The difference becomes larger as wall mass thickness increases.

7. CONSTRIP non-wall scattered (direct) reduction factor components are higher than Engineering Method values. For the buildings studied in this report CONSTRIP direct components were up to three times higher than Engineering Method values. The difference increases with increase in wall mass thickness and source field width and decreases as the length to width ratios of the buildings become larger.

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APPENDIX A

CONSTRIP III AND ENGINEERING METHOD DATA FOR 1.25 MEV CONTAMINATION

Appendix A contains both CONSTRIP III and Engineering Method [1] data for finite rectangular source fields of 1.25 Mev contamination. CONSTRIP III data is given for rectangular source strips having widths (Wc) to 200 ft from the walls of the structure. Engineering Method finite field data was computed to a maximum source field width of 70 ft. Both CONSTRIP and Engineering Method values are given for the wall scattered component, the non-wall scattered (direct) component, and the combined or total values. Both CONSTRIP and Engineering reduction factors for source field widths ranging from 5 to 70 ft are given in Table A-1 through A-14 for 5 x 5, 10 x 10, 20 x 20, 40 x 40, 80 x 80, 5 x 10, 10 x 20, 20 x 40, 40 x 80, 5 x 20, 10 x 40, 20 x 80, 15.2 x 30.4 and 13.75 x 55 ft buildings. All buildings were 10 ft high with the detector positioned in the center of the structure at a height of 5 ft. Wall mass thickness values were 0.5, 1.0 and 4.0 mean free paths. CONSTRIP wall scatter values are given for both the upper and lower half of the structures. The Engineering Method wall scatter contribution is the same from the upper and lower half. Ratios are included in the tables to give a comparison between reduction factor values using the CONSTRIP III code and Engineering Method values for wall scatter and direct components and for the total or combined reduction factor values. During CONSTRIP III calculation for 0.66 Mev contamination source field input cards were added to the data deck to extend rectangular source fields for the 10 x 10, 20 x 20, 40 x 40, 80 x 80, 10 x 20, 20 x 40, 40 x 80, 10 x 40, and 20 x 80 ft buildings from 70 to 200 ft. At that time runs were repeated at 1.25 Mev to also extend the 1.25 Mev CONSTRIP results to 200 ft. CONSTRIP III reduction factors for the wall scatter, the direct, and the combined wall scatter and direct components are given in Tables A-15, A-16, and A-17 for wall mass thickness values of 1.0, 4.0 and 0.5 mfp, respectively. The wall scatter components for source field widths greater than 70 ft do not include a breakdown between contributions between the upper and lower half of the walls and do not include comparisons with the Engineering Method.

TABLE A.1

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

5x5 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft.	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg Method	CON-STRIP	C. / E. M.	Engrg Method	CON-STRIP	C. / E. M.
						X_e = 18 psf						
5	.00812	.00110	.0191	.14	2.36	1.25	.0411	.0508	1.24	.0484	.0530	1.10
10	.0191	.00378	.0323	.20	1.67	0.89	.0808	.0975	1.21	.119	.134	1.13
15	.0285	.00670	.0408	.24	1.43	0.83	.110	.133	1.21	.168	.180	1.07
20	.0381	.00943	.0468	.25	1.23	0.74	.131	.160	1.22	.207	.216	1.04
30	.0518	.0141	.0550	.27	1.06	0.66	.160	.212	1.33	.263	.281	1.07
40	.0641	.0177	.0605	.28	.94	0.60	.180	.230	1.28	.309	.309	1.00
50	.0709	.0208	.0646	.29	.91	0.61	.196	.252	1.29	.337	.338	1.00
60	.0758	.0233	.0679	.31	.90	0.61	.207	.271	1.31	.360	.362	1.01
70	.0806	.0255	.0706	.32	.88	0.60	.216	.286	1.32	.377	.382	1.01
						X_e = 36 psf						
5	.00728	.00114	.0181	.17	2.490	1.31	.0193	.0234	1.21	.0334	.0426	1.28
10	.0193	.00423	.0326	.22	1.689	.954	.0364	.0418	1.34	.0750	.0856	1.14
15	.0283	.00771	.0423	.27	1.495	.884	.0495	.0674	1.36	.107	.117	1.10
20	.0375	.0109	.0492	.29	1.312	.802	.0589	.0846	1.42	.134	.144	1.08
30	.0541	.0164	.0586	.30	1.083	.693	.0722	.106	1.47	.177	.181	1.02
40	.0643	.0207	.0650	.32	1.011	.667	.0816	.123	1.51	.210	.209	1.00
50	.0716	.0242	.0698	.34	.975	.657	.0884	.136	1.54	.230	.230	1.00
60	.0756	.0272	.0736	.36	.974	.667	.0938	.146	1.56	.245	.247	1.01
70	.0801	.0298	.0767	.37	.958	.665	.0978	.155	1.58	.258	.261	1.01
						X_e = 144 psf						
5	.00050	.000090	.00128	.180	2.560	1.370	.00052	.000285	.55	.00151	.00165	1.09
10	.00180	.000499	.00333	.277	1.850	1.064	.00100	.000946	.95	.00460	.00478	1.04
15	.00305	.00110	.00498	.361	1.633	.997	.00136	.00158	1.16	.00745	.00766	1.04
20	.00407	.00170	.00621	.418	1.526	.987	.00162	.00210	1.30	.00977	.0100	1.02
30	.00580	.00275	.00793	.474	1.367	.971	.00198	.00292	1.48	.0136	.0136	1.00
40	.00692	.00356	.00910	.514	1.315	.915	.00224	.00353	1.58	.0160	.0162	1.01
50	.00783	.00423	.00998	.540	1.275	.908	.00243	.00401	1.65	.0184	.0182	.98
60	.00878	.00479	.0107	.546	1.220	.884	.00258	.00441	1.71	.0201	.0199	.99
70	.00935	.00527	.0113	.564	1.209	.886	.00269	.00474	1.76	.0214	.0213	.99

TABLE A.2

Reduction Factors from Ground Sources of Contamination by CONSTRIP II' Code and Engineering Method
10 x 10 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c-ft.	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Eng Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00845	.000919	.0186	.11	2.20	1.16	.0427	.0522	1.22	.0596	.0717	1.20
10	.0190	.00309	.0290	.16	1.52	.84	.0764	.0925	1.21	.114	.125	1.10
15	.0280	.00551	.0357	.20	1.27	.74	.100	.123	1.23	.156	.164	1.05
20	.0360	.00780	.0405	.22	1.12	.67	.119	.147	1.24	.191	.195	1.02
30	.0484	.0117	.0472	.25	.98	.62	.146	.184	1.26	.242	.243	1.00
40	.0595	.0149	.0517	.25	.87	.56	.165	.211	1.28	.283	.278	.96
50	.0650	.0174	.0552	.27	.85	.56	.179	.232	1.30	.309	.305	.99
60	.0696	.0196	.0579	.28	.83	.56	.200	.250	1.25	.329	.328	1.00
70	.0739	.0215	.0602	.29	.81	.55	.198	.265	1.28	.346	.347	1.00
X_e = 36 psf												
5	.00790	.000945	.0195	.12	2.46	1.28	.0192	.0269	1.40	.0350	.0473	1.35
10	.0190	.00347	.0314	.18	1.65	.92	.0345	.0490	1.42	.0726	.0839	1.15
15	.0278	.00637	.0373	.23	1.34	.77	.0453	.0661	1.46	.101	.110	1.09
20	.0356	.00911	.0449	.26	1.26	.76	.0539	.0791	1.47	.125	.133	1.06
30	.0490	.0138	.0527	.28	1.07	.67	.0669	.101	1.51	.165	.168	1.02
40	.0594	.0175	.0581	.29	.98	.57	.0744	.116	1.56	.193	.192	1.00
50	.0648	.0206	.0622	.32	.96	.64	.0810	.129	1.59	.211	.21[illegible]	1.00
60	.0694	.0232	.0654	.33	.94	.64	.0859	.139	1.62	.225	.228	1.01
70	.0734	.0254	.0681	.35	.93	.64	.0897	.148	1.65	.237	.242	1.02
X_e = 144 psf												
5	.00059	.000073	.00198	.12	2.69	1.41	.00052	.000546	1.05	.00169	.00260	1.54
10	.00183	.000403	.00391	.22	2.14	1.18	.00094	.00123	1.31	.00460	.00554	1.20
15	.00293	.000877	.00532	.30	1.82	1.06	.00124	.00182	1.47	.00710	.00802	1.13
20	.00389	.00141	.00638	.36	1.64	1.00	.00147	.00230	1.55	.00925	.0101	1.10
30	.00540	.00233	.00786	.43	1.46	.95	.00180	.00308	1.71	.0126	.0133	1.06
40	.00641	.00306	.00888	.48	1.38	.93	.00204	.00365	1.79	.0149	.0156	1.05
50	.00737	.00366	.00965	.50	1.31	.91	.00222	.00411	1.85	.0170	.0174	1.02
60	.00807	.00416	.0103	.52	1.27	.90	.00235	.00450	1.91	.0184	.0190	1.03
70	.00857	.00460	.0108	.54	1.26	.90	.00246	.00482	1.96	.0196	.0202	1.03

TABLE A.3

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

20 x 20 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 125 Mev Radiation

Field Width W_c-ft.	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00758	.000660	.0106	.09	1.40	.74	.0342	.0404	1.18	.0495	.0517	1.04
10	.0161	.00216	.0173	.13	1.07	.61	.0583	.0713	1.22	.0397	.0908	1.01
15	.0234	.00386	.0217	.16	.93	.55	.0773	.0960	1.24	.124	.122	.99
20	.0294	.00548	.0250	.19	.85	.54	.0917	.117	1.28	.151	.148	.98
30	.0393	.00828	.0294	.21	.75	.48	.115	.150	1.30	.194	.188	.97
40	.0477	.0105	.0326	.22	.68	.45	.130	.175	1.35	.227	.218	.96
50	.0511	.0124	.0349	.24	.68	.46	.142	.195	1.37	.244	.242	.99
60	.0550	.0139	.0368	.25	.67	.46	.154	.212	1.38	.264	.263	1.00
70	.0582	.0153	.0384	.26	.66	.46	.162	.226	1.39	.279	.280	1.00
X_e = 36 psf												
5	.00717	.000666	.0118	.09	1.64	.88	.0152	.0283	1.86	.0296	.0408	1.38
10	.0162	.00241	.0196	.15	1.21	.68	.0262	.0400	1.53	.0588	.0620	1.05
15	.0237	.00445	.0249	.19	1.05	.62	.0348	.0540	1.55	.0824	.0833	1.01
20	.0289	.00640	.0287	.22	.99	.61	.0413	.0660	1.60	.0994	.101	1.02
30	.0399	.00976	.0341	.24	.86	.55	.0516	.0846	1.64	.132	.128	.97
40	.0474	.0125	.0378	.26	.80	.53	.0588	.0986	1.68	.154	.149	.97
50	.0511	.0147	.0406	.29	.79	.52	.0649	.110	1.70	.168	.165	.99
60	.0548	.0166	.0429	.30	.78	.54	.0692	.119	1.72	.179	.178	.99
70	.0578	.0182	.0448	.31	.78	.54	.0728	.128	1.76	.189	.191	1.01
X_e = 144 psf												
5	.00055	.000050	.00153	.09	2.78	1.44	.00042	.000672	1.60	.00152	.00225	1.48
10	.00161	.000275	.00293	.17	1.81	1.00	.00072	.00126	1.75	.00395	.0044[illegible]	1.13
15	.00248	.000617	.00393	.25	1.58	.92	.00095	.00174	1.84	.00591	.00629	1.06
20	.00324	.000984	.00469	.30	1.45	.87	.00113	.00214	1.89	.00764	.00781	1.03
30	.00434	.00165	.00575	.38	1.32	.85	.00141	.00282	2.00	.0101	.0102	1.00
40	.00513	.00219	.00649	.43	1.26	.89	.00161	.00333	2.06	.0119	.0120	1.00
50	.00586	.00263	.00705	.45	1.20	.83	.00177	.00375	2.12	.0135	.0134	1.00
60	.00638	.00301	.00749	.47	1.17	.82	.00189	.00410	2.17	.0147	.0146	[illegible]
70	.00675	.00333	.00787	.49	1.16	.83	.00200	.00440	2.20	.0155	.0156	[illegible]

TABLE A.4

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

40 x 40 Ft. Bldg. 10 Ft. High, Detector at 5 ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18												
5	.00565	.00042	.0053	.07	.94	.51	.0194	.0250	1.29	.0307	.0308	1.00
10	.0118	.00135	.0089	.11	.77	.44	.0336	.0455	1.35	.0572	.0557	.98
15	.0174	.00239	.0113	.14	.65	.40	.0458	.0627	1.37	.0805	.0764	.95
20	.0214	.00339	.0131	.16	.61	.39	.0562	.0774	1.38	.0990	.0939	.95
30	.0284	.00510	.0156	.18	.55	.37	.0720	.102	1.42	.129	.123	.95
40	.0337	.00646	.0174	.19	.52	.36	.0850	.122	1.43	.152	.146	.96
50	.0359	.00758	.0188	.21	.53	.37	.0944	.138	1.46	.166	.165	.99
60	.0386	.00852	.0198	.22	.52	.37	.102	.153	1.50	.180	.181	1.00
70	.0407	.00932	.0207	.23	.51	.37	.109	.165	1.51	.190	.195	1.03
X_e = 36 psf												
5	.00535	.00041	.0059	1.10	.08	.59	.00870	.0141	1.75	.0194	.0204	1.05
10	.0120	.00147	.0102	.85	.12	.49	.0152	.0257	1.70	.0392	.0374	.95
15	.0171	.00272	.0131	.77	.16	.47	.0207	.0355	1.72	.0547	.0513	.94
20	.0210	.00392	.0152	.72	.19	.46	.0254	.0439	1.73	.0673	.0631	.94
30	.0289	.00597	.0183	.63	.21	.42	.0326	.0579	1.78	.0904	.0822	.91
40	.0335	.00762	.0204	.61	.22	.41	.0384	.0692	1.80	.105	.0972	.93
50	.0359	.00896	.0220	.61	.27	.44	.0427	.0787	1.84	.114	.110	.96
60	.0384	.0101	.0233	.61	.26	.44	.0463	.0869	1.80	.123	.120	.98
70	.0405	.0111	.0244	.59	.27	.43	.0492	.0941	1.91	.130	.129	.99
X_e = 144 psf												
5	.00043	.000029	.00077	.07	1.79	.93	.00024	.00049	2.04	.00110	.00129	1.17
10	.00123	.000163	.00157	.13	1.33	.73	.00041	.00090	2.19	.00286	.00264	.92
15	.00183	.000368	.00215	.20	1.17	.69	.00057	.00126	2.21	.00423	.00377	.89
20	.00240	.000591	.00258	.25	1.07	.66	.00069	.00156	2.26	.00549	.00493	.90
30	.00310	.000997	.00310	.32	1.00	.66	.00089	.00208	2.34	.00710	.00627	.88
40	.00369	.00133	.00363	.36	.98	.67	.00105	.00249	2.37	.00842	.00745	.88
50	.00416	.00160	.00395	.38	.95	.67	.00117	.00284	2.42	.00948	.00840	.89
60	.00448	.00183	.00422	.41	.94	.68	.00127	.00314	2.47	.0102	.00919	.89
70	.00474	.00203	.00443	.43	.94	.69	.00135	.00341	2.52	.0108	.00987	.91

TABLE A.5

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

80 x 80 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00361	.00024	.00255	.07	.71	.39	.00884	.0129	1.46	.0161	.0157	.98
10	.00761	.00076	.00436	.10	.57	.34	.0161	.0243	1.51	.0313	.0294	.94
15	.0113	.00135	.00560	.12	.50	.31	.0233	.0345	1.48	.0460	.0415	.90
20	.0140	.00191	.00651	.14	.47	.31	.0291	.0438	1.50	.0571	.0522	.91
30	.0187	.00285	.00781	.15	.42	.29	.0386	.0604	1.56	.0759	.0710	.92
40	.0214	.00360	.00872	.17	.40	.29	.0464	.0746	1.61	.0893	.0869	.97
50	.0231	.00421	.00941	.18	.41	.30	.0529	.0871	1.65	.0991	.101	1.02
60	.0247	.00471	.00997	.20	.40	.30	.0592	.0983	1.66	.109	.113	1.04
70	.0259	.00514	.0104	.20	.39	.30	.0644	.108	1.68	.116	.124	1.07
X_e = 36 psf												
5	.00345	.00023	.00285	.07	.83	.45	.00395	.00735	1.86	.0108	.0104	.96
10	.00776	.00082	.00500	.11	.64	.38	.00725	.0139	1.92	.0228	.0197	.86
15	.0112	.00152	.00649	.14	.58	.36	.0105	.0197	1.88	.0329	.0277	.84
20	.0137	.00219	.00759	.16	.55	.36	.0131	.0250	1.91	.0405	.0348	.86
30	.0189	.00333	.00916	.18	.49	.34	.0174	.0345	1.98	.0552	.0470	.85
40	.0214	.00423	.0103	.20	.48	.34	.0210	.0426	2.03	.0637	.0571	.90
50	.0230	.00496	.0111	.22	.48	.35	.0239	.0499	2.09	.0700	.0660	.93
60	.0245	.00557	.0118	.23	.48	.36	.0268	.0561	2.10	.0758	.0734	.97
70	.0259	.00609	.0123	.24	.48	.36	.0292	.0620	2.12	.0809	.0804	.99
X_e = 144 psf												
5	.00028	.000016	.00039	.06	1.39	.73	.00011	.000270	2.45	.00067	.00067	1.00
10	.00080	.000088	.00079	.11	.99	.55	.00020	.000511	2.55	.00180	.00139	.77
15	.00120	.000201	.00109	.17	.91	.54	.00029	.000728	2.51	.00270	.00202	.75
20	.00158	.000324	.00131	.21	.83	.52	.00036	.000925	2.57	.00351	.00256	.73
30	.00202	.000574	.00163	.28	.81	.55	.00048	.00128	2.61	.00453	.00346	.76
40	.00241	.000730	.00186	.30	.77	.54	.00058	.00158	2.70	.00539	.00417	.78
50	.00268	.000878	.00203	.33	.76	.55	.00066	.00184	2.78	.00601	.00475	.79
60	.00286	.00100	.00217	.35	.76	.56	.00073	.00208	2.81	.00646	.00525	.81
70	.00304	.00111	.00229	.37	.75	.56	.00080	.00229	2.86	.00687	.00568	.83

TABLE A.6

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

5 x 10 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00825	.00117	.0190	.14	2.30	1.22	.0443	.0504	1.14	.0608	.0705	1.16
10	.0188	.00376	.0310	.20	1.65	.93	.0810	.0922	1.14	.119	.125	1.05
15	.0289	.00655	.0388	.23	1.34	.79	.108	.124	1.15	.164	.170	1.04
20	.0360	.00914	.0444	.25	1.23	.74	.128	.149	1.16	.200	.203	1.02
30	.0461	.0135	.0524	.29	1.14	.72	.156	.186	1.19	.253	.251	.99
40	.0599	.0171	.0572	.29	.96	.63	.176	.213	1.21	.296	.287	.97
50	.0657	.0199	.0611	.30	.93	.62	.191	.234	1.23	.322	.315	.97
60	.0704	.0224	.0642	.32	.91	.62	.202	.251	1.25	.342	.337	.99
70	.0747	.0244	.0668	.33	.89	.61	.210	.265	1.26	.360	.356	.99
X_e = 36 psf												
5	.00762	.00112	.0182	.15	2.34	1.25	.0199	.0235	1.13	.0351	.0429	1.22
10	.0188	.00402	.0314	.21	1.67	.94	.0365	.0457	1.25	.0742	.0811	1.09
15	.0277	.00723	.0400	.26	1.44	.85	.0488	.0629	1.29	.104	.110	1.06
20	.0356	.0102	.0463	.29	1.27	.78	.0579	.0766	1.32	.129	.133	1.03
30	.0491	.0153	.0549	.31	1.12	.72	.0705	.0972	1.38	.169	.167	.99
40	.0599	.0193	.0607	.32	1.01	.67	.0795	.112	1.41	.199	.192	.96
50	.0655	.0226	.0650	.34	.99	.67	.0863	.124	1.44	.217	.212	.98
60	.0701	.0253	.0686	.36	.98	.67	.0913	.134	1.47	.232	.227	.98
70	.0742	.0277	.0714	.37	.96	.67	.0953	.142	1.49	.244	.241	.99
X_e = 144 psf												
5	.00056	.00008	.00148	.14	2.64	1.39	.00054	.00035	.65	.00165	.00191	1.16
10	.00180	.00044	.00335	.22	1.86	1.04	.00100	.00095	.95	.00460	.00474	1.03
15	.00292	.00097	.00480	.33	1.64	.99	.00134	.00149	1.11	.00718	.00727	1.01
20	.00389	.00150	.00589	.39	1.51	.95	.00159	.00195	1.23	.00936	.00934	1.00
30	.0544	.00244	.00740	.45	1.36	.91	.00194	.00267	1.32	.0128	.0125	.98
40	.0646	.00318	.00845	.49	1.31	.90	.00218	.00321	1.47	.0151	.0148	.98
50	.0743	.00379	.00923	.51	1.23	.87	.00237	.00363	1.53	.0172	.0166	.97
60	.0815	.00429	.00985	.53	1.21	.87	.00251	.00398	1.59	.0188	.0181	.96
70	.0867	.00472	.0104	.54	1.20	.87	.00262	.00418	1.60	.0200	.0193	.97

TABLE A.7

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

10 x 20 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00817	.00094	.0172	.16	2.10	1.13	.0427	.0472	1.11	.0590	.0653	1.11
10	.0176	.00295	.0261	.17	1.51	.88	.0736	.0823	1.12	.109	.111	1.02
15	.0257	.00515	.0319	.20	1.24	.72	.0952	.109	1.15	.147	.146	.99
20	.0325	.00720	.0361	.22	1.11	.67	.112	.131	1.17	.177	.174	.98
30	.0435	.0107	.0419	.25	.96	.61	.137	.164	1.20	.224	.216	.97
40	.0530	.0135	.0459	.25	.87	.56	.154	.188	2.22	.260	.248	.95
50	.0571	.0158	.0489	.28	.87	.58	.168	.208	2.24	.282	.273	.97
60	.0614	.0178	.0514	.29	.84	.57	.178	.224	2.26	.301	.293	.97
70	.0650	.0195	.0534	.30	.82	.56	.186	.238	2.28	.316	.311	.98
X_e = 36 psf												
5	.00770	.00089	.0182	.12	2.36	1.24	.0191	.0239	1.25	.0345	.0431	1.25
10	.0177	.00316	.0283	.18	1.60	.89	.0332	.0429	1.29	.0686	.0743	1.08
15	.0259	.00570	.0349	.22	1.35	.79	.0430	.0576	1.34	.0947	.0983	1.04
20	.0320	.00808	.0397	.25	1.24	.75	.0508	.0695	1.37	.115	.117	1.02
30	.0441	.0122	.0468	.28	1.06	.67	.0618	.0879	1.42	.150	.146	.97
40	.0528	.0154	.0510	.29	.97	.63	.0698	.102	1.46	.176	.168	.95
50	.0570	.0181	.0544	.32	.95	.64	.0761	.112	1.47	.190	.185	.97
60	.0612	.0203	.0572	.33	.93	.63	.0806	.122	1.51	.203	.199	.98
70	.0645	.0222	.0599	.34	.93	.64	.0844	.129	1.53	.213	.211	.99
X_e = 144 psf												
5	.00059	.000063	.00239	.11	4.04	2.08	.00052	.00054	1.04	.00169	.00299	1.77
10	.00175	.000336	.00399	.19	2.28	1.24	.00091	.00111	1.22	.00439	.00543	1.24
15	.00271	.000744	.00516	.27	1.90	1.09	.00117	.00159	1.36	.00659	.00750	1.14
20	.00356	.00117	.00603	.33	1.69	1.01	.00139	.00200	1.44	.00852	.00920	1.08
30	.00483	.00193	.00725	.40	1.50	.95	.00169	.00265	1.57	.0113	.0118	1.04
40	.00570	.00255	.00810	.45	1.42	.94	.00191	.00314	1.64	.0133	.0138	1.04
50	.00653	.00305	.00873	.47	1.34	.96	.00209	.00353	1.69	.0151	.0153	1.01
60	.00711	.00347	.00924	.49	1.30	.90	.00221	.00387	1.75	.0164	.0166	1.01
70	.00754	.00384	.00964	.51	1.28	.90	.00231	.00414	1.79	.0174	.0176	1.01

TABLE A.8

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

20 x 40 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c-ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R.F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+ C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 36 psf												
5	.00638	.000601	.00930	.09	1.46	.78	.0138	.0181	1.31	.0266	.0280	1.05
10	.0143	.00212	.0157	.15	1.10	.62	.0235	.0323	1.37	.0522	.0500	.96
15	.0206	.00385	.0198	.19	.96	.58	.0308	.0436	1.41	.0720	.0673	.94
20	.0252	.00547	.0229	.22	.91	.56	.0366	.0531	1.45	.0869	.0814	.94
30	.0347	.00824	.0272	.24	.78	.51	.0457	.0682	1.49	.115	.104	.91
40	.0405	.0105	.0301	.26	.74	.50	.0524	.0799	1.52	.133	.121	.91
50	.0435	.0123	.0324	.28	.74	.51	.0574	.0895	1.56	.144	.134	.93
60	.0466	.0138	.0342	.30	.73	.52	.0614	.0976	1.58	.155	.146	.94
70	.0491	.0151	.0357	.31	.73	.52	.0647	.105	1.62	.163	.156	.95
X_e = 144 psf												
5	.000505	.000040	.00104	.08	2.06	1.01	.000380	.000533	1.40	.00139	.00162	1.15
10	.00145	.000218	.00212	.15	1.46	.81	.000640	.000990	1.55	.00354	.00333	.94
15	.00218	.000488	.00290	.22	1.33	.77	.000840	.00138	1.64	.00521	.00476	.91
20	.00286	.000777	.00347	.30	1.21	.74	.00100	.00170	1.70	.00673	.00595	.89
30	.00374	.00130	.00429	.35	1.14	.74	.00125	.00224	1.79	.00874	.00783	.90
40	.00443	.00172	.00486	.39	1.10	.74	.00144	.00266	1.84	.0103	.00924	.90
50	.00502	.00207	.00528	.41	1.05	.74	.00158	.00300	1.89	.0116	.0104	.90
60	.00542	.00236	.00563	.44	1.04	.74	.00168	.00331	1.97	.0125	.0113	.90
70	.00574	.00262	.00592	.46	1.03	.74	.00178	.00356	2.00	.0132	.0121	.92

TABLE A9

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

40 x 80 Ft. Bldg. 10 Ft. High, Detector of 5 ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Eng. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L / E.M.	Eng. Meth.	CON-STRIP	C. / E.M.	Eng. Meth.	CON-STRIP	C. / E.M.
X_e = 36 psf												
5	.00445	.000366	.00425	.08	.95	.52	.00699	.0106	1.52	.0159	.0152	.96
10	.0100	.00128	.00758	.13	.76	.44	.0128	.0196	1.53	.0328	.0285	.87
15	.0144	.00232	.00985	.16	.68	.42	.0176	.0272	1.54	.0464	.0394	.85
20	.0176	.00330	.0115	.19	.65	.42	.0214	.0338	1.58	.0566	.0487	.86
30	.0243	.00495	.0139	.20	.57	.39	.0280	.0450	1.60	.0766	.0638	.83
40	.0277	.00626	.0155	.23	.56	.39	.0326	.0541	1.66	.0880	.0759	.86
50	.0298	.00732	.0168	.25	.56	.40	.0364	.0618	1.70	.0960	.0859	.89
60	.0318	.00820	.0178	.26	.56	.40	.0395	.0681	1.73	.103	.0946	.92
70	.0335	.00896	.0186	.27	.56	.41	.0425	.0746	1.75	.110	.102	.92
X_e = 144 psf												
5	.000365	.00009	.000392	.06	1.07	.56	.000180	.000352	1.95	.00091	.000763	.84
10	.00103	.000118	.000989	.11	.96	.54	.000340	.000659	1.94	.00240	.00177	.74
15	.00155	.000277	.00142	.18	.92	.55	.000480	.000921	1.92	.00358	.00262	.73
20	.00202	.000447	.00174	.22	.86	.54	.000580	.00116	2.00	.00463	.00334	.72
30	.00261	.000756	.00219	.29	.84	.56	.000760	.00155	2.04	.00598	.00450	.75
40	.00310	.00101	.00251	.33	.81	.56	.000890	.00188	2.11	.00709	.00541	.76
50	.00346	.00121	.00276	.35	.80	.57	.000990	.00216	2.18	.00791	.00613	.77
60	.00370	.00138	.00295	.37	.80	.59	.00108	.00241	2.23	.00849	.00684	.80
70	.00393	.00153	.00312	.39	.79	.59	.00116	.00262	2.26	.00902	.00727	.80

TABLE A.10

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

5 x 20 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev' Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00836	.00135	.0199	.16	2.37	1.27	.0482	.0461	.97	.0650	.0674	1.04
10	.0180	.00400	.0312	.22	1.73	.98	.0845	.0841	1.00	.120	.119	.99
15	.0263	.00671	.0384	.26	1.46	.86	.109	.112	1.03	.162	.157	.97
20	.0333	.00920	.0434	.28	1.30	.79	.128	.133	1.04	.194	.186	.96
30	.0450	.0134	.0504	.30	1.22	.76	.155	.165	1.06	.244	.229	.93
40	.0542	.0167	.0552	.31	1.02	.67	.173	.189	1.09	.282	.261	.92
50	.0584	.0193	.0588	.33	1.01	.67	.188	.207	1.10	.304	.286	.94
60	.0628	.0216	.0616	.34	.98	.66	.198	.222	1.12	.324	.306	.94
70	.0664	.0236	.0640	.26	.97	.62	.206	.236	1.15	.340	.323	.95
X_e = 36 psf												
5	.00785	.00119	.0180	.15	2.19	1.17	.0217	.0159	.73	.0374	.0351	.94
10	.0181	.00397	.0299	.22	1.65	.94	.0382	.0393	1.03	.0744	.0731	.98
15	.0266	.00694	.0375	.26	1.41	.84	.0495	.0536	1.08	.103	.0980	.95
20	.0327	.00961	.0429	.29	1.31	.80	.0581	.0652	1.12	.123	.118	.96
30	.0451	.0141	.0503	.31	1.11	.71	.0700	.0820	1.17	.160	.147	.92
40	.0540	.0176	.0554	.32	1.03	.68	.0785	.0950	1.21	.186	.168	.90
50	.0583	.0206	.0593	.35	1.02	.69	.0850	.105	1.24	.202	.185	.92
60	.0625	.0230	.0623	.37	1.00	.69	.0898	.113	1.26	.215	.198	.92
70	.0659	.0251	.0649	.38	.98	.68	.0936	.120	1.28	.216	.210	.97
X_e = 144 psf												
5	.000595	.00007	.00160	.09	3.72	1.91	.00059	.00026	.44	.00177	.00193	1.09
10	.00179	.00038	.00313	.21	1.75	.98	.00104	.00077	.74	.00461	.00428	.93
15	.00278	.00083	.00431	.30	1.55	.93	.00135	.00119	.88	.00691	.00632	.92
20	.00365	.00126	.00518	.34	1.42	.88	.00159	.00150	.99	.00889	.00801	.90
30	.00494	.00204	.00641	.41	1.30	.86	.00192	.00212	1.10	.0118	.0106	.90
40	.00583	.00265	.00726	.46	1.25	.86	.00215	.00256	1.18	.0138	.0125	.90
50	.00658	.00315	.00789	.51	1.23	.87	.00233	.00289	1.24	.0157	.0139	.89
60	.00727	.00357	.00839	.49	1.16	.83	.00246	.00316	1.28	.0170	.0151	.89
70	.00771	.00393	.00881	.51	1.14	.83	.00256	.00341	1.33	.0180	.0162	.90

TABLE A.11

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

10 x 40 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION: Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height: Upper	CONSTRIP 1/2 Wall Height: Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	DIRECT: Engrg. Method	DIRECT: CON-STRIP	DIRECT: C. / E. M.	TOTAL R.F.: Engrg. Method	TOTAL R.F.: CON-STRIP	TOTAL R.F.: C. / E. M.
X_e = 18 psf												
5	.00780	.00108	.0146	.14	1.87	1.01	.0452	.0430	.95	.0608	.0587	.97
10	.0165	.00319	.0230	.19	1.39	.79	.0756	.0733	.97	.109	.0995	.91
15	.0242	.00535	.0283	.22	1.17	.70	.0971	.0980	1.01	.146	.132	.90
20	.0300	.00730	.0321	.24	1.07	.66	.113	.117	1.04	.173	.156	.90
30	.0399	.0106	.0373	.29	.93	.61	.136	.145	1.07	.216	.193	.89
40	.0476	0132	.0409	.28	.88	.58	.152	.167	1.10	.247	.221	.89
50	.0510	.0153	.0436	.30	.85	.58	.165	.184	1.11	.267	.241	.90
60	.0548					.57	.174	.197		.284	.260	.92
70	.0578					.57	.182	.210		.298	.276	.93
X_e = 36 psf												
5	.00738	.00093	.0138	.13	1.87	1.00	.0204	.0203	1.00	.0351	.0351	1.00
10	.0167	.00312	.0228	.19	1.37	.78	.0342	.0367	1.07	.0676	.0626	.93
15	.0232	.00550	.0286	.23	1.20	.72	.0440	.0490	1.11	.0917	.0832	.91
20	.0295	.00766	.0328	.26	1.11	.69	.0509	.0591	1.16	.110	.0995	.90
30	.0406	.0113	.0385	.28	.95	.62	.0616	.0741	1.20	.143	.124	.87
40	.0479	.0141	.0424	.29	.89	.59	.0690	.0858	1.24	.164	.142	.87
50	.0509	.0162	.0454	.32	.89	.61	.0747	.0948	1.22	.177	.157	.89
60	.0545					.61	.0790	.102	1.29	.188	.168	.89
70	.0575					.61	.0825	.107	1.29	.198	.178	.90
X_e = 144 psf												
5	.00059	.000055	.00112	.09	1.90	1.00	.00055	.000389	.71	.00173	.00157	.91
10	.00169	.000287	.00240	.17	1.42	.80	.00093	.000840	.90	.00431	.00353	.82
15	.00256	.000626	.00333	.24	1.30	.77	.00120	.00122	1.02	.00631	.00518	.82
20	.00335	.000978	.00402	.29	1.20	.75	.00139	.00154	1.11	.00839	.00654	.78
30	.00438	.00160	.00499	.37	1.14	.76	.00169	.00204	1.21	.0105	.00862	.82
40	.00520	.00210	.00556	.40	1.09	.75	.00189	.00244	1.29	.0123	.0102	.83
50	.00588	.00250	.00616	.43	1.05	.74	.00205	.00275	1.34	.0138	.0114	.83
60	.00635	.00283	.00656	.45	1.03	.74	.00217	.00300	1.38	.0148	.0124	.84
70	.00672	.00312	.00689	.47	1.02	.75	.00226	.00320	1.41	.0157	.0132	.84

TABLE A. 12

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

20 x 80 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R.F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height		C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
		Upper	Lower									
X_e = 18 psf												
5	.00598	.00078	.00824	.13	1.37	.75	.0317	.0306	.97	.0437	.0396	.91
10	.0126	.00224	.0134	.18	1.06	.62	.0535	.0538	1.02	.0787	.0694	.88
15	.0187	.00373	.0168	.20	.90	.55	.0691	.0762	1.10	.107	.0967	.90
20	.0232	.00507	.0192	.22	.83	.53	.0819	.0872	1.07	.129	.112	.87
30	.0309	.00730	.0225	.24	.73	.49	.101	.111	1.10	.162	.141	.87
40	.0358	.00904	.0248	.25	.69	.47	.115	.129	1.12	.186	.163	.88
50	.0386	.0105	.0265	.27	.69	.48	.125	.144	1.15	.202	.181	.90
60	.0412	.0117	.0279	.28	.68	.48	.133	.156	1.17	.215	.196	.91
70	.0434	.0127	.0291	.29	.67	.48	.140	.168	1.20	.226	.209	.92
X_e = 36 psf												
5	.00570	.00062	.00811	.11	1.42	.77	.0142	.0156	1.10	.0256	.0243	.95
10	.0128	.00212	.0138	.17	1.08	.63	.0241	.0275	1.13	.0498	.0433	.87
15	.0185	.00375	.0175	.20	.95	.58	.0312	.0372	1.20	.0682	.0584	.86
20	.0227	.00524	.0202	.23	.89	.56	.0370	.0452	1.22	.0824	.0706	.86
30	.0313	.00773	.0239	.25	.76	.51	.0455	.0578	1.27	.108	.0894	.83
40	.0357	.00968	.0265	.27	.74	.51	.0519	.0677	1.30	.123	.104	.85
50	.0385	.0113	.0284	.29	.74	.52	.0564	.0757	1.34	.133	.115	.86
60	.0410	.0126	.0300	.31	.73	.52	.0601	.0823	1.37	.142	.125	.88
70	.0433	.0137	.0313	.32	.72	.52	.0632	.0882	1.40	.150	.133	.89
X_e = 144 psf												
5	.00047	.000029	.00063	.06	1.34	.70	.00039	.00041	1.05	.00131	.00107	.82
10	.00132	.000182	.00151	.14	1.14	.64	.00066	.00076	1.15	.00330	.00245	.74
15	.00199	.000409	.00213	.21	1.07	.64	.00085	.00107	1.26	.00484	.00360	.74
20	.00260	.000647	.00259	.25	1.00	.63	.00101	.00132	1.31	.00622	.00456	.73
30	.00337	.00107	.00324	.32	.96	.64	.00125	.00174	1.39	.00798	.00605	.76
40	.00399	.00142	.00369	.36	.92	.64	.00142	.00208	1.46	.00941	.00719	.76
50	.00446	.00170	.00404	.38	.91	.65	.00155	.00238	1.54	.0104	.00808	.78
60	.00478	.00193	.00431	.40	.90	.65	.00165	.00258	1.56	.0112	.00883	.79
70	.00507	.00213	.00454	.42	.89	.66	.00173	.00278	1.61	.0119	.00946	.80

TABLE A.13

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

15.2 x 30.4 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R. F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00747	.000835	.0112	.11	1.50	.81	.0365	.0415	1.14	.0514	.0535	1.04
10	.0158	.00238	.0183	.15	1.16	.66	.0612	.0695	1.14	.0927	.0902	.97
15	.0230	.00405	.0228	.18	.99	.59	.0800	.0925	1.16	.126	.119	.94
20	.0287	.00535	.0259	.19	.90	.55	.0942	.111	1.18	.151	.142	.94
30	.0383	.00860	.0303	.22	.79	.51	.117	.141	1.19	.193	.180	.93
40	.0461	.0106	.0333	.23	.72	.48	.132	.164	1.24	.224	.208	.93
50	.0492	.0127	.0357	.26	.73	.50	.145	.182	1.25	.243	.230	.95
60	.0530	.0141	.0372	.27	.71	.49	.154	.196	1.27	.260	.247	.95
70	.0560	.0152	.0384	.27	.69	.48	.162	.205	1.27	.274	.259	.95
X_e = 36 psf												
5	.00705	.000750	.0123	.10	1.74	.92	.0164	.0213	1.30	.0305	.0344	1.13
10	.0159	.00253	.0197	.16	1.24	.70	.0276	.0375	1.36	.0594	.0597	1.01
15	.0230	.00455	.0242	.20	1.07	.64	.0361	.0500	1.38	.0821	.0793	.97
20	.0281	.00645	.0285	.23	1.01	.62	.0425	.0600	1.41	.0988	.0949	.96
30	.0389	.00965	.0338	.25	.87	.56	.0527	.0765	1.45	.130	.120	.92
40	.0458	.0123	.0373	.27	.82	.55	.0598	.0890	1.49	.151	.139	.92
50	.0492	.0145	.0400	.29	.81	.55	.0655	.0998	1.50	.163	.154	.94
60	.0528	.0164	.0421	.31	.80	.56	.0697	.107	1.53	.175	.169	.97
70	.0557	.0180	.0438	.32	.79	.56	.0732	.113	1.54	.184	.175	.95
X_e = 144 psf												
5	.00055	.000044	.00128	.08	2.32	1.20	.00045	.000560	1.24	.00155	.00188	1.21
10	.00160	.000256	.00256	.16	1.60	.88	.00076	.00106	1.39	.00395	.00388	.98
15	.00243	.000561	.00356	.23	1.47	.85	.00099	.00148	1.49	.00585	.00561	.96
20	.00318	.000928	.00420	.29	1.32	.81	.00117	.00184	1.57	.00753	.00695	.92
30	.00422	.00152	.00520	.36	1.23	.80	.00145	.00244	1.68	.00988	.00976	.95
40	.00499	.00204	.00596	.41	1.20	.81	.00164	.00288	1.76	.0116	.0107	.94
50	.00567	.00248	.00646	.44	1.14	.79	.00180	.00324	1.80	.0131	.0122	.93
60	.00615	.00280	.00688	.46	1.12	.79	.00192	.00356	1.85	.0142	.0132	.93
70	.00651	.00308	.00720	.43	1.11	.77	.00201	.00384	1.91	.0150	.0141	.94

TABLE A.14

Reduction Factors from Ground Sources of Contamination by CONSTRIP III Code and Engineering Method

13.75 x 55 Ft. Bldg. 10 Ft. High, Detector at 5 Ft., 1.25 Mev Radiation

Field Width W_c - ft	SCATTER CONTRIBUTION						DIRECT			TOTAL R.F.		
	Engrg. Method 1/2 wall	CONSTRIP 1/2 Wall Height Upper	CONSTRIP 1/2 Wall Height Lower	C. U. / E. M.	C. L. / E. M.	C.U.+C.L. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.	Engrg. Method	CON-STRIP	C. / E. M.
X_e = 18 psf												
5	.00703	.000910	.0125	.13	1.78	.96	.0406	.0378	.93	.0547	.0512	.94
10	.0148	.00275	.0192	.19	1.30	.75	.0665	.0657	.99	.0962	.0877	.91
15	.0219	.00450	.0236	.19	1.07	.63	.0858	.0875	1.02	.130	.115	.88
20	.0271	.00622	.0268	.23	.99	.61	.0997	.104	1.04	.154	.142	.92
30	.0360	.00903	.0308	.25	.86	.56	.121	.131	1.08	.193	.171	.89
40	.0424	.0112	.0339	.24	.80	.52	.137	.150	1.09	.221	.194	.88
50	.0455	.0129	.0362	.28	.80	.54	.148	.165	1.11	.239	.214	.90
60	.0488	.0144	.0380	.29	.78	.54	.157	.179	1.14	.254	.231	.91
70	.0514	.0158	.0392	.31	.76	.54	.164	.192	1.17	.267	247	.93
X_e = 36 psf												
5	.00663	.00076	.0119	.11	1.79	.95	.0182	.0190	1.04	.00316	.0317	1.00
10	.0151	.00265	.0196	.14	1.30	.72	.0300	.0331	1.10	.0601	.0554	.92
15	.0216	.0046	.0240	.21	1.11	.66	.0387	.0439	1.13	.0819	.0725	.89
20	.0266	.0065	.0276	.24	1.04	.64	.0450	.0525	1.17	.0982	.0866	.88
30	.0366	.0096	.0326	.26	.89	.58	.0548	.0680	1.23	.128	.110	.86
40	.0422	.0120	.0361	.27	.86	.57	.0618	.0782	1.27	.146	.126	.86
50	.0454	.0140	.0389	.31	.86	.59	.0670	.0870	1.30	.158	.140	.89
60	.0485	.0157	.0404	.32	.83	.58	.0709	.0945	1.33	.167	.151	.90
70	.0512	.0170	.0420	.33	.82	.58	.0743	.100	1.35	.177	.159	.90
X_e = 144 psf												
5	.00054	.000043	.00109	.08	2.02	1.05	.00050	.00041	.82	.00158	.00154	.97
10	.00154	.00025	.00221	.16	1.44	.80	.00082	.00082	1.00	.00390	.00328	.84
15	.00231	.00052	.00300	.23	1.30	.77	.00107	.00118	1.10	.00570	.00470	.82
20	.00304	.00081	.00363	.27	1.20	.74	.00124	.00148	1.19	.00731	.00592	.81
30	.00394	.00147	.00443	.37	1.12	.75	.00151	.00193	1.28	.00938	.00783	.83
40	.00468	.00180	.00502	.38	1.07	.73	.00170	.00229	1.35	.0111	.00911	.82
50	.00525	.00212	.00545	.40	1.04	.72	.00184	.00259	1.41	.0124	.0102	.82
60	.00566	.00241	.00580	.43	1.02	.73	.00195	.00283	1.45	.0133	.0110	.83
70	.00598	.00269	.00608	.45	1.02	.74	.00204	.00303	1.49	.0140	.0118	.84

TABLE A-15

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS FOR BUILDINGS WITH 1 MFP WALL MASS THICKNESS

(10 ft. High Bldgs., Detector at 5 ft., 1.25 Mev Source)

	Field Width, Wc, (ft.)						
	80	100	120	140	160	180	200
10 x 10 ft. Bldg.							
Total Scatter	.0978	.105	.111	.115	.119	.123	.126
Direct	.160	.173	.184	.192	.200	.206	.211
TOTAL	.258	.278	.294	.308	.319	.329	.337
20 x 20 ft.							
Total Scatter	.0660	.0712	.0753	.0787	.0816	.0842	.0863
Direct	.135	.147	.157	.165	.172	.178	.184
TOTAL	.201	.218	.232	.244	.254	.263	.270
40 x 40 ft.							
Total Scatter	.0372	.0402	.0426	.0446	.0462	.0478	.0490
Direct	.100	.111	.120	.128	.134	.140	.145
TOTAL	.138	.152	.163	.173	.181	.188	.194
80 x 80 ft.							
Total Scatter	.0194	.0209	.0222	.0235	.0241	.0249	.0256
Direct	.0669	.0760	.0836	.0900	.0957	.101	.105
TOTAL	.0863	.0969	.106	.114	.120	.126	.131
10 x 20 ft.							
Total Scatter	.0854	.0916	.0965	.101	.104	.107	.110
Direct	.136	.147	.156	.164	.170	.176	.181
TOTAL	.222	.239	.252	.264	.274	.283	.291
20 x 40 ft.							
Total Scatter	.0533	.0574	.0607	.0635	.0658	.0678	.0696
Direct	.111	.121	.130	.137	.143	.149	.154
TOTAL	.164	.179	.191	.201	.209	.216	.223
40 x 80 ft.							
Total Scatter	.0290	.0312	.0331	.0346	.0360	.0371	.0380
Direct	.0801	.0891	.0968	.103	.109	.114	.118
TOTAL	.109	.120	.130	.138	.145	.151	.156
10 x 40 Ft.							
Total Scatter	.0729	.0782	.0825	.0860	.0891	.0917	.0940
Direct	.114	.124	.131	.138	.143	.148	.152
TOTAL	.187	.202	.214	.224	.232	.240	.246
20 x 80 ft.							
Total Scatter	.0463	.0492	.0515	.0534	.0551	.0565	.0577
Direct	.0934	.102	.109	.115	.120	.125	.129
TOTAL	.140	.151	.160	.169	.176	.181	.186

TABLE A-16

CONSTRIP III GROUND CONSTRIBUTION REDUCTION FACTORS FOR BUILDINGS WITH 4 MFP WALL MASS THICKNESS

(10 ft. High Bldgs., Detector at 5 ft., 1.25 Mev Source)

	Field Width, Wc, (ft.)						
	80	100	120	140	160	180	200
10 x 10 ft. Bldg.							
Total Scatter	.0162	.0175	.0186	.0195	.0203	.0210	.0215
Direct	.00510	.00558	.00596	.00628	.00656	.00679	.00700
TOTAL	.0213	.0231	.0246	.0258	.0268	.0278	.0285
20 x 20 ft.							
Total Scatter	.0118	.0128	.0136	.0143	.0149	.0154	.0158
Direct	.00467	.00512	.00548	.00579	.00605	.00628	.00648
TOTAL	.0165	.0179	.0191	.0201	.0209	.0216	.0222
40 x 40 ft.							
Total Scatter	.00683	.00742	.00790	.00830	.00864	.00894	.00918
Direct	.00365	.00405	.00438	.00467	.00491	.00512	.00531
TOTAL	.0105	.0115	.0123	.0130	.0136	.0141	.0145
80 x 80 ft.							
Total Scatter	.00358	.00390	.00416	.00437	.00455	.00471	.00484
Direct	.00248	.00282	.00310	.00334	.00355	.00374	.00391
TOTAL	.00607	.00672	.00726	.00771	.00810	.00845	.00875
10 x 20 ft.							
Total Scatter	.0142	.0153	.0162	.0169	.0176	.0181	.0186
Direct	.00442	.00482	.00517	.00545	.00569	.00590	.00608
TOTAL	.0186	.0201	.00214	.0224	.0233	.0240	.0247
20 x 40 ft.							
Total Scatter	.00896	.00971	.0103	.0108	.0113	.0116	.0120
Direct	.00380	.00418	.00450	.00476	.00498	.00518	.00536
TOTAL	.0127	.0139	.0148	.0156	.0162	.0168	.0173
40 x 80 ft.							
Total Scatter	.00490	.00532	.00567	.00596	.00620	.00642	.00660
Direct	.00282	.00315	.00344	.00367	.00388	.00406	.00422
TOTAL	.00772	.00848	.00911	.00963	.0101	.0105	.0108
10 x 40 ft.							
Total Scatter	.0102	.108	.0113	.0117	.0121	.0123	.0126
Direct	.00342	.00374	.00400	.00424	.00443	.00460	.00474
TOTAL	.0136	.0146	.0153	.0160	.0165	.0170	.0174
20 x 80 ft.							
Total Scatter	.00693	.00732	.00763	.00789	.00811	.00830	.00847
Direct	.00297	.00327	.00351	.00373	.00391	.00407	.00421
TOTAL	.00990	.0106	.0111	.0116	.0120	.0124	.0127

TABLE A-17

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR BUILDINGS WITH 0.5 MFP WALL MASS THICKNESS

(10 ft. High Buildings, Detector at 5 ft, 1.25 Mev Source)

	Field Width, Wc, (ft)						
	80	100	120	140	160	180	200
10 X 10 ft bldg							
Scatter	.0853	.0914	.0962	.100	.104	.107	.109
Direct	.276	.298	.315	.330	.342	.353	.362
TOTAL	.361	.389	.411	.430	.446	.459	.471
20 X 20 ft bldg							
Scatter	.0563	.0606	.0640	.0669	.0693	.0714	.0733
Direct	.234	.255	.272	.287	.299	.309	.318
TOTAL	.290	316	.336	.354	.368	.380	.391
40 X 40 ft bldg							
Scatter	.0316	.0340	.0360	.0377	.0391	.0403	.0414
Direct	.176	.196	.212	.225	.236	.246	.255
TOTAL	.208	.230	.248	.263	.280	.287	.296
80 X 80 ft bldg							
Scatter	.0164	.0177	.0187	.0196	.0203	.0210	.0215
Direct	.117	.133	.146	.158	.168	.176	.184
TOTAL	.134	.151	.165	.177	.188	.197	.206
10 X 20 ft bldg							
Scatter	.0754	.0807	.0850	.0886	.0916	.0942	.0965
Direct	.250	.270	.287	.300	.312	.322	.331
TOTAL	.326	.351	.372	.389	.404	.416	.428
10 X 40 ft bldg							
Scatter	.0684	.0727	.0763	.0792	.0817	.0838	.0858
Direct	.220	.238	.257	.273	.287	.298	.308
TOTAL	.288	.311	.333	.352	.368	.382	.394

APPENDIX A

REFERENCE

OCD PM 100-1, "The Design and Review of Structures for Protection From Fallout Gamma Radiation", February 1965.

APPENDIX B

CONSTRIP III DATA FOR 0.66 MEV CONTAMINATION

Appendix B contains Tables of the CONSTRIP reduction factors for buildings subjected to 0.66 Mev ground contamination. The tables contain data for finite rectangular source fields from 5 to 200 ft wide. The structures processed were 10 x 10, 20 x 20, 40 x 40, and 80 x 80 ft square buildings and 10 x 20, 20 x 40, 40 x 80, 10 x 40, and 20 x 80 ft rectangular buildings having a wall height of 10 ft. Calculations were made for 1 and 4 mfp walls. Calculations were also made for a 20 x 20 ft building with 0.5 mfp walls.

TABLE B-1

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS FOR STRUCTURES SUBJECTED TO 0.66 MEV RADIATION
(10 Foot High Buildings, Detector at 5 feet)

	Field Width W_c, ft.	1 mfp wall Scatter	1 mfp wall Direct	1 mfp wall Total	4 mfp wall Scatter	4 mfp wall Direct	4 mfp wall Total
10 x 10 ft. Bldg.	5	.0230	.0279	.0510	.00273	.000568	.00329
	10	.0394	.0504	.0898	.00562	.00125	.00686
	15	.0514	.0679	.119	.00800	.00184	.00984
	20	.0608	.0817	.142	.00992	.00233	.0122
	30	.0745	.103	.177	.0128	.00310	.0159
	40	.0843	.118	.202	.0149	.00367	.0186
	50	.0920	.130	.222	.0166	.00412	.0207
	60	.0983	.140	.239	.0179	.00452	.0224
	70	.104	.149	.253	.0191	.00483	.0239
	80	.108	.156	.265	.0200	.00512	.0252
	100	.116	.169	.285	.0217	.00558	.0272
	120	.122	.179	.301	.0230	.00596	.0289
	140	.127	.187	.314	.0240	.00627	.0303
	160	.131	.194	.325	.0249	.00653	.0314
	180	.135	.199	.334	.0257	.00675	.0324
	200	.138	.204	.342	.0263	.00695	.0333
20 x 20 ft. Bldg.	5	.0143	.0236	.0378	.00208	.000694	.00278
	10	.0249	.0416	.0665	.00411	.00129	.00540
	15	.0328	.0561	.0889	.00574	.00179	.00754
	20	.0390	.0679	.107	.00707	.00221	.00928
	30	.0481	.0866	.135	.00908	.00289	.0120
	40	.0548	.101	.155	.0106	.00340	.0140
	50	.0600	.112	.172	.0117	.00386	.0156
	60	.0642	.122	.186	.0126	.00419	.0168
	70	.0678	.130	.198	.0134	.00450	.0180
	80	.0710	.138	.209	.0141	.00476	.0189
	100	.0761	.150	.226	.0153	.00522	.0205
	120	.0802	.160	.240	.0162	.00558	.0218
	140	.0836	.168	.251	.0170	.00588	.0228
	160	.0865	.175	.261	.0176	.00613	.0237
	180	.0889	.180	.269	.0181	.00635	.0245
	200	.0909	.185	.276	.0185	.00654	.0251

TABLE B-1 (Continued)

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR STRUCTURES SUBJECTED TO 0.66 MEV RADIATION

	Field Width W_c, ft.	1 mfp wall			4 mfp wall		
		Scatter	Direct	Total	Scatter	Direct	Total
40 x 40 ft. bldg.	5	.00740	.0145	.0219	.00108	.000501	.00156
	10	.0133	.0263	.0396	.00223	.000922	.00315
	15	.0177	.0362	.0539	.00316	.00128	.00444
	20	.0212	.0447	.0659	.00392	.00159	.00551
	30	.0264	.0588	.0852	.00507	.00211	.00718
	40	.0301	.0703	.100	.00592	.00253	.00845
	50	.0331	.0800	.113	.00658	.00289	.00945
	60	.0355	.0883	.124	.00713	.00320	.0103
	70	.0373	.0956	.133	.00759	.00347	.0111
	80	.0393	.102	.141	.00799	.00370	.0117
	100	.0421	.113	.155	.00864	.00411	.0127
	120	.0444	.122	.166	.00917	.00444	.0136
	140	.0463	.129	.176	.00959	.00472	.0143
	160	.0479	.135	.183	.00995	.00495	.0149
	180	.0493	.141	.190	.0103	.00515	.0154
	200	.0504	.145	.196	.0105	.00533	.0158
80 X 80 ft. Bldg.	5	.00368	.00740	.0111	.000550	.000272	.000822
	10	.00673	.0140	.0207	.00114	.000515	.00165
	15	.00905	.0199	.0290	.00162	.000733	.00235
	20	.0109	.0253	.0362	.00202	.000935	.00296
	30	.0136	.0350	.0486	.00263	.00129	.00393
	40	.0156	.0433	.0588	.00308	.00160	.00468
	50	.0171	.0505	.0676	.00343	.00187	.00530
	60	.0183	.0569	.0756	.00371	.00211	.00582
	70	.0194	.0626	.0820	.00395	.00232	.00627
	80	.0203	.0677	.0880	.00416	.00251	.00667
	100	.0218	.0766	.0984	.00450	.00284	.00735
	120	.0230	.0840	.107	.00478	.00312	.00790
	140	.0240	.0902	.114	.00500	.00335	.00835
	160	.0248	.0956	.120	.00519	.00355	.00874
	180	.0254	.100	.126	.00535	.00373	.00908
	200	.0261	.104	.130	.00549	.00388	.00937

TABLE B-1 (Continued)

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR STRUCTURES SUBJECTED TO 0.66 MEV RADIATION

	Field, Width Wc ft	1 mfp Wall			4 mfp Wall		
		Scatter	Direct	Total	Scatter	Direct	Total
10 X 20 ft Bldg	5	.0214	.0249	.0463	.00302	.000560	.00358
	10	.0379	.0444	.0823	.00543	.00114	.00657
	15	.0456	.0595	.105	.00739	.00164	.00903
	20	.0535	.0717	.125	.00896	.00206	.0110
	30	.0652	.0903	.155	.0114	.00272	.0141
	40	.0736	.104	.178	.0131	.00321	.0163
	50	.0802	.115	.195	.0144	.00361	.0181
	60	.0855	.124	.210	.0156	.00395	.0195
	70	.0905	.132	.223	.0165	.00423	.0207
	80	.0940	.140	.234	.0173	.00450	.0218
	100	.100	.151	.251	.0186	.00491	.0235
	120	.106	.160	.266	.0197	.00525	.0249
	140	.110	.167	.277	.0206	.00552	.0261
	160	.113	.174	.287	.0213	.00576	.0270
	180	.117	.179	.296	.0219	.00595	.0278
	200	.119	.184	.303	.0224	.00612	.0286
20 X 40 ft Bldg	5	.0115	.0186	.0301	.00147	.000548	.00202
	10	.0202	.0330	.0532	.00304	.00102	.00406
	15	.0266	.0446	.0712	.00431	.00141	.00572
	20	.0316	.0542	.0858	.00534	.00174	.00708
	30	.0390	.0694	.108	.00689	.00229	.00918
	40	.0443	.0812	.126	.00804	.00271	.0108
	50	.0485	.0910	.140	.00892	.00307	.0120
	60	.0519	.0994	.151	.00965	.00337	.0130
	70	.0548	.106	.161	.0102	.00363	.0138
	80	.572	.113	.170	.0108	.00387	.0146
	100	.0613	.123	.185	.0116	.00425	.0159
	120	.0646	.132	.197	.0123	.00456	.0169
	140	.0672	.139	.206	.0129	.00482	.0177
	160	.0695	.145	.214	.0134	.00504	.0184
	180	.0714	.150	.221	.0138	.00523	.0190
	200	.0730	.154	.227	.0141	.00540	.0195

TABLE B-1 (Continued)

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR STRUCTURES SUBJECTED TO 0.66 MEV RADIATION

	Field Width Wc, ft	1 mfp Wall			4 mfp Wall		
		Scatter	Direct	Total	Scatter	Direct	Total
40 X 80 ft Bldg	5	.00554	.0108	.0164	.000637	.000358	.000995
	10	.0102	.0199	.0302	.00150	.000670	.00217
	15	.0138	.0276	.0414	.00220	.000935	.00313
	20	.0166	.0344	.0509	.00277	.00117	.00394
	30	.0206	.0456	.0663	.00364	.00158	.00522
	40	.0236	.0550	.0786	.00428	.00191	.00619
	50	.0259	.0628	.0887	.00478	.00219	.00697
	60	.0278	.0697	.0975	.00518	.00245	.00763
	70	.0294	.0757	.105	.00553	.00266	.00819
	80	.0307	.0812	.112	.00581	.00287	.00868
	100	.0329	.0901	.123	.00628	.00319	.00948
	120	.0347	.0977	.132	.00666	.00347	.0101
	140	.0361	.104	.140	.00698	.00370	.0107
	160	.0373	.109	.147	.00723	.00390	.0111
	180	.0384	.114	.152	.00746	.00407	.0115
	200	.0392	.118	.157	.00764	.00422	.0119
10 X 40 ft Bldg	5	.0174	.0211	.0385	.00169	.00405	.00209
	10	.0302	.0379	.0682	.00366	.000867	.00453
	15	.0394	.0506	.0900	.00527	.00125	.00652
	20	.0465	.0608	.107	.00656	.00158	.00815
	30	.0567	.0761	.133	.00851	.00209	.0106
	40	.0641	.0878	.152	.00992	.00249	.0124
	50	.0698	.0970	.167	.0110	.00281	.0138
	60	.0745	.104	.139	.0119	.00306	.0150
	70	.0785	.111	.189	.0127	.00330	.0160
	80	.0808	.117	.198	.0129	.00351	.0164
	100	.0856	.126	.212	.0137	.00383	.0175
	120	.0894	.134	.223	.0143	.00409	.0184
	140	.0926	.140	.233	.0148	.00432	.0191
	160	.0952	.146	.241	.0152	.00451	.0198
	180	.0974	.150	.247	.0156	.00467	.0203
	200	.0994	.154	.253	.0159	.00481	.0207

TABLE B-1 (Continued)

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR STRUCTURES SUBJECTED TO 0.66 MEV RADIATION

Field Width Wc, ft		1 mfp Wall			4 mfp Wall		
		Scatter	Direct	Total	Scatter	Direct	Total
20 X 80 ft	5	.0102	.0160	.0262	.00100	.000421	.00142
Bldg	10	.0182	.0282	.0464	.00229	.000779	.00307
	15	.0240	.0381	.0622	.00334	.00109	.00443
	20	.0285	.0463	.0748	.00418	.00136	.00554
	30	.0351	.0590	.0941	.00546	.00178	.00724
	40	.0398	.0693	.109	.00639	.00212	.00851
	50	.0435	.0774	.121	.00712	.00239	.00951
	60	.0465	.0841	.131	.00771	.00262	.0103
	70	.0490	.0902	.139	.00821	.00283	.0110
	80	.0503	.0954	.146	.00833	.00302	.0113
	100	.0532	.104	.157	.00880	.00332	.0121
	120	.0555	.111	.166	.00918	.00355	.0127
	140	.0575	.117	.174	.00948	.00377	.0132
	160	.0590	.122	.181	.00974	.00394	.0137
	180	.0604	.126	.186	.00996	.00410	.0141
	200	.0616	.130	.191	.0102	.00422	.0144

TABLE B-2

CONSTRIP III GROUND CONTRIBUTION REDUCTION FACTORS
FOR 20 X 20 FOOT BUILDING HAVING 0.5 mfp WALLS SUBJECTED
TO 0.66 MEV RADIATION:

	Scatter	Direct	Total
5	.0124	.0428	.0553
10	.0211	.0750	.0961
15	.0274	.101	.128
20	.0323	.121	.154
30	.0396	.154	.194
40	.0449	.179	.224
50	.0491	.199	.248
60	.0525	.216	.[illegible]69
70	.0554	.231	.287
80	.0580	.244	.302
100	.0621	.265	.328
120	.0654	.283	.348
140	.0681	.297	.365
160	.0704	.309	.379
180	.0723	.319	.391
200	.0740	.328	.402

APPENDIX C

INFINITE FIELD REDUCTION FACTOR ESTIMATES

For the series of structures covered in this report CONSTRIP III reduction factor values were determined for source fields extending to a maximum of 200 ft. from the structure walls for both 1.25 and 0.66 Mev contamination. Reduction factor values from the source fields extending to 200 ft are approximately 80 percent of the infinite field values that would have been obtained if the structures had been located on an infinite plane of contamination. In order to relate the CONSTRIP reduction factors obtained for finite rectangular source fields, estimates had to be made for the far field contribution from the source area between the finite source area and infinity.

Far field reduction factor estimates were based on the CONSTRIP reduction factors for the outer 40 ft (Wc between 160 and 200 ft) of the rectangular source fields. The relationship between 40 ft. outer rectangular annuli and the far field contribution was estimated from equivalent circular annuli using the measurements of Rexroad and Schmoke [1] for exposure rates above uniform plane areas of Co-60 (1.25 Mev) and Cs-137 (0.66 Mev) radiation. The rectangular annuli were converted to equivalent circular annuli having equal areas. The far field contribution for the source field between the outer radius of the circular annuli and the infinite field was determined by taking the difference between the infinite field values and the measured exposure rate for the limited field extending to the outer edge of the circular annulus. The far field values were divided by the contribution from the circular annulus. that approximated the 40 ft wide CONSTRIP rectangular annuli. This gave the factors for multiplying the CONSTRIP 40 ft outer annuli to obtain a far field estimate for each structure. For Co-60 the far field contribution averaged a factor of 5.4 times greater than the contribution from the outer annulus. For Cs-137 the far field averaged 4.5 times the annulus contribution. Variation was less than 10 percent for all structures. Far field contribution estimates for the 9 structures subjected to 1.25 and 0.66 Mev are given in Table C-1 are combined with the finite rectangular source field values to give infinite field reduction factors.

Initially, infinite field reduction factors were calculated by the Engineering Method [2] using 1.25 Mev and 0.66 Mev charts developed mainly from data in NBS-42 [3]. Relating the CONSTRIP finite field reduction factors to the infinite field, reduction factors calculated by a different procedure (the Engineering Method) was not satisfactory. The infinite field estimates for the CONSTRIP results should be based on finite field CONSTRIP data already obtained. A comparison is given in Table C-2 between the CONSTRIP and Engineering Method infinite field values for the 1.25 Mev energy cases. For one mfp structures the CONSTRIP based infinite field estimates range from 10 percent higher to 5 percent lower than the Engineering Method predictions. At 4 mfp the CONSTRIP predictions are from 15 percent higher for small square buildings to 15 percent lower for the 20 x 80 ft structure.

TABLE C-1

INFINITE FIELD REDUCTION FACTORS USED IN DETERMINING DECONTAMINATION EFFECTS

(Far field Rf estimated using 160 ft ID by 200' OD Source Annulus)

Building (ft x ft)	1.25 Mev Contamination			0.66 Mev Contamination		
	0-200 ft*	Far Field	Infinite	0-200 ft*	Far Field	Infinite
0.5 mfp	(18 psf)			(13 psf)		
10 X 10	.471	.135	.606			
20 X 20	.391	.124	.515	.402	.104	.506
40 X 40	.296	.086	.382			
80 X 80	.206	.097	.303			
10 X 20	.428	.130	.558			
10 X 40	.394	.140	.534			
1.0 mfp	(36 psf)			(27 psf)		
10 X 10	.337	.097	.434	.342	.077	.419
20 X 20	.270	.086	.356	.276	.068	.344
40 X 40	.194	.070	.264	.196	.058	.254
80 X 80	.131	.059	.190	.130	.045	.175
10 X 20	.291	.092	.383	.303	.072	.375
20 X 40	.223	.076	.299	.227	.058	.285
40 X 80	.156	.059	.215	.157	.045	.202
10 X 40	.246	.076	.322	.253	.054.	.307
20 X 80	.187	.054	.241	.191	.045	.236
4.0 mfp	(144 psf)			(106 psf)		
10 X 10	.0285	.0092	.0377	.0333	.0086	.0419
20 X 20	.0222	.0070	.0292	.0251	.0063	.0314
40 X 40	.0145	.0049	.0194	.0158	.0041	.0199
80 X 80	.00875	.00351	.0123	.00937	.00284	.0122
10 X 20	.0247	.0070	.0317	.0286	.0072	.0358
20 X 40	.0173	.0059	.0232	.0195	.0050	.0245
40 X 80	.0108	.0038	.0146	.0119	.0036	.0155
10 X 40	.0174	.0049	.0223	.0207	.0040	.0247
20 X 80	.0125	.0038	.0163	.0144	.0032	.0176

*0-200 feet from building wall

TABLE C-2

COMPARISON OF 1.25 MEV CONSTRIP AND ENGINEERING METHOD REDUCTION FACTORS

Building (ft x ft)	1 mfp			4 mfp		
	Constrip*	Engrg. Method	Δ Percent	Constrip	Engrg Method	ΔPercent
10 X 10	.434	.384	11.5	.0377	.0317	16
20 X 20	.356	.319	10	.0292	.0255	12
40 X 40	.264	.235	11	.0192	.0181	7
80 X 80	.190	.164	13	.0123	.0118	4
10 X 20	.383	.351	8	.0317	.0281	11
20 X 40	.299	.277	7	.0232	.0213	8
40 X 80	.215	.205	5	.0146	.0151	(3)
10 X 40	.322	.324	(1)	.0223	.0250	(12)
20 X 80	.241	.254	(5)	.0163	.0188	(15)

*CONSTRIP far field estimated from 160 ft ID by 200 ft. OD source annulus

APPENDIX C

REFERENCE

1. Rexroad, R. E., and Schmoke, M. A., "Scattered Radiation and Free Field Dose Rates from Distributed Cobalt 60 and Cesium 137 Sources", Nuclear Defense Laboratory, Report No. NDL-TR-2, September 1960.

2. OCD PM 100-1, "Design and Review of Structures for Protection From Fallout Gamma Radiation," February 1965.

3. Spencer, L. V., "Structure Shielding Against Fallout Radiation From Nuclear Weapons," National Bureau of Standards Monograph 42, June 1, 1962.

APPENDIX D

CONSTRIP III CODE MODIFICATIONS

Section 2.1 of the main body of this report discusses the changes made in the basic CONSTRIP III code to permit machine summations to be carried out for rectangular source strips. In this Appendix only the changes made to the CONSTRIP III program are shown. The complete program listing is long and does not warrant reproducing here. The CONSTRIP code before inclusion of these changes is both listed and described in detail in Reference 1.

APPENDIX D

SUMMATION MODIFICATIONS TO THE CONSTRIP III CODE

Asterisk in front of changed or added line

```
         DIMENSION CTHSB(11),CTHDB(11),PHIB(7),ZMAX(10),SMESH(10),DELS(10)      0001
         DIMENSION C(16),C1(16,16,16),C2(16,16),C3(16),D(16)                    0002
         DIMENSION WZS(17),C4(10),WZS1(11),CSS(16),CMS(16),CTSD(16)             0003
         DIMENSION C7(16)                                                       0004
         DIMENSION STRPLST(16,16,10),TSUM(10),ZSUM(16,10),BSUM(16,10),
*       1DLIST(10),UHALF(10),BHALF(10)
*        INTEGER HL,VL,W,STAR,BLANK,DASH,DOT,Z                                  0005
*        INTEGER Q
   C     *** START

      12 C1(J,K,L)=0.                                                           0109
*        DO 1897 Q=1,10
*        UHALF(Q)=0.0
*         BHALF(Q)=0.
*        TSUM(Q)=0.0
*        DLIST(Q)=0.0
*        DO 1897 J=1,16
*        BSUM(J,Q)=0.
*        ZSUM(J,Q)=0.
*        DO 1897 L=1,16
    1897 STRPLST(J,L,Q)=0.
         IF (T) 1415,415,1415                                                   0110
    1415 IF (ZD) 1414,2000,1414                                                 0111

     575 C(I)=C(I)*RUFACT                                                       0202
*         LIMIT=(-EPSW/2-XMIN)/DELS(1)+1
          IF (I+K.GE.LIMIT) 1850,1851
*   1850 Q=K
*         GO TO 1860
*   1851 Q=LIMIT-I
*   1860 STRPLST(J,L,Q)=STRPLST(J,L,Q)+C(I)                                     0203
          IF (ZD) 1424,1425,1424                                                0204
    1425 RUSS=RSS
```

APPENDIX D

SUMMATION MODIFICATIONS TO THE CONSTRIP III CODE

Asterisk in front of changed or added line

```
     515 D(I)=D(I)*RUFACT                                                0230
*        DLIST(Q)=DLIST(Q)+P(I)
         GO TO 395                                                       0231


      60 YW=YW+DELWY                                                     0262
         IF(YW-1.) 15,70,70                                              0263
*     70 DO 1891 NQ=1,KMAX
*        DO 1891 NJ=1,JMAX
*        DO 1891 NL=1,LMAX
*        TSUM(NQ)=TSUM(NQ)+STRPLST(NJ,NL,NQ)
*        ZSUM(NL,NQ)=ZSUM(NL,NQ)+STRPLST(NJ,NL,NQ)
*   1891 BSUM(NJ,NQ)=BSUM(NJ,NQ)+STRPLST(NJ,NL,NQ)
*        PRINT 1892,((ZSUM(NL,NQ),NQ=1,10),NL=1,LMAX)
*        PRINT 1893,((BSUM(NJ,NQ),NQ=1,10),NJ=1,JMAX)
*        PRINT 1894,(TSUM(NQ),NQ=1,10)
*        PRINT 1895,(DLIST(NQ),NQ=1,10)
*        IF (LMAX-LMAX/2*2) 1888,1899,1888
*   1899 NLMAX=LMAX/2
*        DO 1898 NQ=1,KMAX
*        DO 1898 NL=1,NLMAX

*        BHALF(NQ)=BHALF(NQ)+ZSUM(NL,NQ)
*   1898 UHALF(NQ)=UHALF(NQ)+ZSUM(NL+NLMAX,NQ)
*        PRINT 1883,(BHALF(NQ),NQ=1,KMAX)
*        PRINT 1884,(UHALF(NQ),NQ=1,KMAX)
*   1892 FORMAT (/*SCATTER THROUGH ZONES FROM STRIPS*,(2(/5E20.5)))
*   1893 FORMAT (/*SCATTER THROUGH RAYS FROM STRIPS*,(2(/5E20.5)))
*   1894 FORMAT (/*TOTAL SCATTER FROM STRIPS*,(/5E20.5))
*   1895 FORMAT (/*TOTAL DIRECT FROM STRIPS*,(/5E20.5))
*   1883 FORMAT (/*SCATTER THROUGH LOWER HALF OF WALL BY STRIPS*,(/5E20.5))
*   1884 FORMAT (/*SCATTER THROUGH UPPER HALF OF WALL BY STRIPS*,(/5E20.5))
*   1888 C5 = 0.
    3113 MPRUR=2                                                         0265
```

APPENDIX D

REFERENCE

1. Doggett, W. D., and Bryan, F. A., "Radiological Recovery Requirements, Structures and Operations Research", Volume 1, "Calculational Technique for Determining Importance of Limited Strip Decontamination Procedure", Research Triangle Institute, Report R-OU-266, May 1967.

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13 ABSTRACT

The CONSTRIP III computer code was used to calculate the reduction factors within single story rectangular buildings due to finite rectangular areas of contamination surrounding the buildings. The CONSTRIP code permitted breaking the reduction factors into wall scattered and non-wall scattered components from finite source strips up to 200 ft wide. Decontamination importance factors were determined for finite areas subjected to both 1.25 Mev and 0.66 Mev contamination. The directional responses for wall scattered radiation coming from above and below the detector plane were determined separately for finite source fields.

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