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Transmission Factors for the Penetration of Neutron and Photon Fluence into Wood-Frame Dwellings, 1990 (TF90)

W. A. Rhoades
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M. B. Emmett

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ORNL/TM-12021

Engineering Physics and Mathematics Division

TRANSMISSION FACTORS FOR THE PENETRATION OF NEUTRON AND PHOTON FLUENCE INTO WOOD-FRAME DWELLINGS, 1990 (TF90)

W.A.Rhoades
R.A.Lillie
M.B.Emmett*

*Computing and Telecommunications Division

DATE PUBLISHED - May 1992

This work is sponsored by the Defense Nuclear Agency under DNA Order No 91-806, Work Unit No. 00440, and DOE Interagency Agreement No 0046-C083-A1

Prepared by
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

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ACKNOWLEDGEMENTS

The authors wish to recognize the contributions of M.L.Gritzner and S.D.Egbert of Science Applications International Corporation (SAIC), La Jolla, for providing the delayed gamma fluences and geometric models for the wood-frame house cluster used in the original DS86 study. J.V.Pace, III of Oak Ridge National Laboratory (ORNL) provided the data files from which the prompt fluences were recreated. J.O.Johnson of ORNL provided the MORSE and DRC components of VCS and advised us frequently concerning the modification and application of these codes. J.M.Barnes constructed the ORNL model of the Bren "A" house for comparison with the DS86 model. T.J.Burns provided several of the illustrations of the computer models. R.L.Stohler of Dikewood Division, Kaman Sciences, Albuquerque, worked with us extensively in ensuring that the results of this study would suit the data base to which they were to be applied. S. Shriner of ORNL prepared the final manuscript for publication.

Material, including text and illustrations, taken from the DS86 report [ro87] is the copyright property of the Radiation Effects Research Foundation, Hiroshima, Japan. Use of this material is conditional upon acknowledgement of the source, which we gladly do. Persons wishing to make further use of this material must take care to similarly acknowledge the source and the copyright.

1. INTRODUCTION

An earlier study at Oak Ridge calculated radiation doses to persons inside reinforced concrete buildings during the exposures at Nagasaki. [rh89, rh92] The heavy structure of the buildings resulted in a stable, documented environment for the radiation calculations and protected many of the occupants from burn and blast injuries. Medical histories available for such a study number in the hundreds, not the thousands desired from a statistical point of view, however.

The "DS86" study conducted at several laboratories in the United States and Japan concentrated on persons inside wood-frame dwellings at both Nagasaki and Hiroshima. [ro87] The medical histories available for such a study number in the tens of thousands. While it is not practical to determine an individual nuclear model for each case in such a large data base, the study found that the construction of dwellings in those cities was fairly standardized, and that the radiation environment could be adequately modeled by a small number of typical buildings.

The study was successful in applying its methodology to the data base maintained by the Radiation Effects Research Foundation (RERF) in Japan. The numerical results were embodied in a complex computer-based process that was tied to the specific structure of the RERF data base, however, and attempts to apply them to the data base maintained by the Dikewood Division, Kaman Sciences, in Albuquerque, NM have been deemed technically unsatisfactory. [wo87]

The present study is directed toward applying the general technical approach of the DS86 study in a way that is applicable to the Dikewood data base. Numerous simplifications were indicated as a result of the earlier research, and the numerical results are represented as "transmission factors" (TF's) relating radiation outside the dwellings to doses received by individuals within. An advantage of this method is that the transmission factors can be presented in tables that can be reviewed, inspected, and applied in a very tangible and straightforward manner. In a companion study, Stohler has reported preliminary results obtained from the Dikewood data base using the data reported here. [st91]

Briefly, the method began with the calculation of radiation fluence at several ground ranges spanning the locations of the dwelling sites. Different methods are necessarily used for prompt and delayed radiation. A nuclear model of a neighborhood cluster consisting of 6 typical houses was developed. Then, the effectiveness of fluence at the surface of a box enclosing the neighborhood in penetrating to an individual site within the cluster was calculated using an adjoint Monte Carlo method.

By folding this adjoint result with the fluence data exterior to the dwelling cluster, the radiation at an interior site was determined. By moving the cluster to different ranges and rotating it with respect to the source, various radiation environments were simulated. By using the proper Monte Carlo response spectrum, free-in-air kerma (FIA), average small intestine kerma (SI), or average bone marrow kerma (BM) could be calculated. The transmission factor was defined as the ratio of the kerma of a particular type at the interior site to the FIA kerma that would exist at 1 meter above the ground level if the dwellings were not present.

Since it would be impractical to perform individual calculations for each of the tens of thousands of medical histories, an indirect means was used in applying the transmission factors to the data base. The Dikewood data base includes computer data files containing numerous parameters that describe the environment of each individual at the time of the exposure. A subset of parameters of particular interest to radiation calculations, the "Dikewood parameters", was selected.

As the transmission factors for numerous interior sites, cluster rotations, and ranges from the weapon were calculated, it was possible to determine the corresponding set of Dikewood parameters and to group TF values of like parameters into "bins". For those bins having more than one TF value, an average bin TF and a fractional standard deviation (FSD) were determined. The FSD's, then, served as an indication of the validity of the parameters in describing the radiation environment -- the lower the FSD, the better the representation.

The doses corresponding to a specific medical case were then determined by interpolating the exterior FIA doses due to various sources from data tables, and then multiplying by the transmission factors from the table position having corresponding Dikewood parameters. The TF data were interpolated between the ground ranges in the table. The three response types, i.e. FIA, SI, or BM, were obtained from the corresponding data in the tables.

2. BASIC NUCLEAR DATA AND SOURCES

2.1 CROSS SECTION DATA

The nuclear cross sections used in calculating the transport of radiation away from the weapon and into the dwellings were taken from the DABL69 set. [ro85] Data for the 46 neutron energy groups and the 23 gamma groups of this set were obtained by spectrum weighing of the 174 neutron groups and 38 gamma groups of the VITAMIN-E set. [vi84] A later version of DABL69 differs only in details not of concern to this study. [in89] The energy group boundaries are listed in table 2.1.

2.2 DWELLING MATERIAL COMPOSITIONS

All dwelling material compositions were taken from the DS86 study. Table 2.2 shows the atomic densities in units of atoms/gram rather than the more familiar atoms/cm**3. Multiplying by the densities shown in the table converts to the latter units. Roof tile and mud have the same composition, but the densities are different. The material ID numbers refer to the 69-group DABL69 cross sections set. The "wall" material is a composite of mud with 25 volume percent organic reinforcing material, representative of wall construction at that time and place. The "roof wood" material was used in a wooden subroof layer, and it was also adopted for both first- and second-story floor compositions.

2.3 KERMA RESPONSE FUNCTIONS

Kerma is defined as: "...the total kinetic energy of all the charged particles liberated by neutrons and gamma rays in a small volume of a given material divided by the mass of the material in that volume element." [ro87] This definition is equivalent to the definition of dose in rad units given by Goldstein. [go57] This study, however, will use the SI unit centiGray (cGy). Dose measurements in centiGrays are numerically equal to doses in rads.

The "free-in-air" (FIA) soft tissue kerma, is defined as the kerma in an infinitesimal particle of soft tissue. Since this response is independent of direction, the kerma at a given site can be determined by folding an energy-dependent response function with the scalar flux at that site. The free-in-air kerma response function is listed in table 2.3.

This function was obtained by J.V.Pace, III at Oak Ridge by converting Kerr's kerma data [ke82] to the VITAMIN-E group structure using the VITAMIN-E weighting spectrum, performing a 1-D air-transport calculation with a point source representing the weapon leakage, and then further reducing the data to the final group structure using the energy spectrum from the 1-D calculation. The FIA data presented in the tables were determined using the leakage from the Nagasaki weapon at a ground range of about 500m. The 69-group

Table 2.1 DABL69 Energy-Group Boundaries

Group	Neutron energy range (eV)	Group	Gamma energy range (eV)
1	1.964030E+07—1.690461E+07	47	2.000000E+07—1.400000E+07
2	1.690461E+07—1.491830E+07	48	1.400000E+07—1.200000E+07
3	1.491830E+07—1.419070E+07	49	1.200000E+07—1.000000E+07
4	1.419070E+07—1.384030E+07	50	1.000000E+07—8.000000E+06
5	1.384030E+07—1.252320E+07	51	8.000000E+06—7.000000E+06
6	1.252320E+07—1.221400E+07	52	7.000000E+06—6.000000E+06
7	1.221400E+07—1.105170E+07	53	6.000000E+06—5.000000E+06
8	1.105170E+07—1.000000E+07	54	5.000000E+06—4.000000E+06
9	1.000000E+07—9.048370E+06	55	4.000000E+06—3.000000E+06
10	9.048370E+06—8.187310E+06	56	3.000000E+06—2.500000E+06
11	8.187310E+06—7.408180E+06	57	2.500000E+06—2.000000E+06
12	7.408180E+06—6.376280E+06	58	2.000000E+06—1.500000E+06
13	6.376280E+06—4.965850E+06	59	1.500000E+06—1.000000E+06
14	4.965850E+06—4.723670E+06	60	1.000000E+06—7.000000E+05
15	4.723670E+06—4.065700E+06	61	7.000000E+05—4.500000E+05
16	4.065700E+06—3.011940E+06	62	4.500000E+05—3.000000E+05
17	3.011940E+06—2.385210E+06	63	3.000000E+05—1.500000E+05
18	2.385210E+06—2.306860E+06	64	1.500000E+05—1.000000E+05
19	2.306860E+06—1.826840E+06	65	1.000000E+05—7.000000E+04
20	1.826840E+06—1.422740E+06	66	7.000000E+04—4.500000E+04
21	1.422740E+06—1.108030E+06	67	4.500000E+04—3.000000E+04
22	1.108030E+06—9.616400E+05	68	3.000000E+04—2.000000E+04
23	9.616400E+05—8.208500E+05	69	2.000000E+04—1.000000E+04
24	8.208500E+05—7.427360E+05		
25	7.427360E+05—6.392790E+05		
26	6.392790E+05—5.502320E+05		
27	5.502320E+05—3.688320E+05		
28	3.688320E+05—2.472350E+05		
29	2.472350E+05—1.576440E+05		
30	1.576440E+05—1.110900E+05		
31	1.110900E+05—5.247520E+04		
32	5.247520E+04—3.430670E+04		
33	3.430670E+04—2.478750E+04		
34	2.478750E+04—2.187490E+04		
35	2.187490E+04—1.059460E+04		
36	1.059460E+04—3.354630E+03		
37	3.354630E+03—1.234100E+03		
38	1.234100E+03—5.829470E+02		
39	5.829470E+02—2.753640E+02		
40	2.753640E+02—1.013010E+02		
41	1.013010E+02—2.902319E+01		
42	2.902319E+01—1.067700E+01		
43	1.067700E+01—3.059020E+00		
44	3.059020E+00—1.125350E+00		
45	1.125350E+00—4.139940E−01		
46	4.139940E−01—1.000010E−05		

Table 2.2. Wood-Frame Dwelling Material Compositions

DABL69 ID	Element	Elemental Composition (atoms/g material x 10^{24})				
		Air	Ground	Roof Wood	Roof Tile & Mud	Wall
1	H	1.137(-3)	1.826(-2)[a]	4.050(-2)	4.956(-3)	8.301(-3)
55	C		4.356(-4)	2.131(-2)	2.533(-4)	2.215(-3)
61	N	3.230(-2)	0	3.655(-4)	0	3.406(-5)
67	O	9.260(-3)	2.227(-2)	1.878(-2)	1.868(-2)	1.871(-2)
79	Na		3.130(-4)		3.597(-4)	3.264(-4)
85	Mg		5.380(-5)		2.765(-4)	2.509(-4)
91	Al		1.212(-3)		4.373(-3)	3.968(-3)
97	Si		5.426(-3)		3.714(-3)	3.365(-3)
121	Ar	1.950(-4)	0		0	0
127	K		4.182(-4)		7.101(-4)	6.443(-4)
133	Ca		9.791(-5)		1.988(-4)	1.804(-4)
139	Ti		1.385(-5)		1.359)-4)	1.266(-4)
163	Fe		1.405(-4)		2.792(-4)	2.534(-4)
	Density (g/cm^3)	1.176(-3)	1.5	0.5	1.7/1.5 Tile/Mud	1.5

[a]Read as 1.826×10^{-2}

Table 2.3 69-group kerma response functions

Group	Free-in-air $\frac{cGy \cdot cm^2}{particle}$	Small intestine $\frac{Gy \cdot cm^2}{particle}$	Bone marrow $\frac{Gy \cdot cm^2}{particle}$
1	0.0	0.0	0.0
2	7.077370E−09	4.426527E−11	4.772557E−11
3	6.854930E−09	4.242363E−11	4.686905E−11
4	6.744980E−09	4.272550E−11	4.597830E−11
5	6.488640E−09	3.950927E−11	4.206632E−11
6	6.381350E−09	3.866144E−11	4.051942E−11
7	6.333820E−09	3.560847E−11	3.937926E−11
8	5.989160E−09	3.566422E−11	3.937441E−11
9	5.771130E−09	3.296186E−11	3.660641E−11
10	5.515770E−09	2.931333E−11	3.409208E−11
11	5.471970E−09	2.685140E−11	3.202864E−11
12	5.118050E−09	2.489206E−11	3.053506E−11
13	4.718830E−09	2.278859E−11	2.757607E−11
14	4.578040E−09	1.854872E−11	2.487749E−11
15	4.436460E−09	1.630944E−11	2.352912E−11
16	4.203620E−09	1.317658E−11	1.959037E−11
17	3.554380E−09	1.026234E−11	1.669800E−11
18	3.325070E−09	9.639425E−12	1.501879E−11
19	3.216030E−09	7.465329E−12	1.307756E−11
20	2.916400E−09	5.736491E−12	1.060127E−11
21	2.638570E−09	4.031827E−12	8.443888E−12
22	2.525510E−09	2.993088E−12	6.835394E−12
23	2.227480E−09	2.899945E−12	6.105845E−12
24	2.060070E−09	2.809753E−12	6.000444E−12
25	1.938130E−09	2.372944E−12	5.247199E−12
26	1.792150E−09	2.233542E−12	4.719108E−12
27	1.649400E−09	1.723456E−12	3.962127E−12
28	1.297760E−09	1.573431E−12	2.972716E−12
29	1.021680E−09	1.380759E−12	2.380207E−12
30	8.114740E−10	1.334669E−12	1.910536E−12
31	5.690210E−10	1.238254E−12	1.577307E−12
32	3.630200E−10	1.175168E−12	1.357668E−12
33	2.610050E−10	1.160076E−12	1.235696E−12
34	2.132010E−10	1.162470E−12	1.229365E−12
35	1.541070E−10	1.109893E−12	1.183093E−12
36	6.520750E−11	1.135166E−12	1.131684E−12
37	2.295970E−11	1.121648E−12	1.105471E−12
38	9.602990E−12	1.121044E−12	1.163116E−12
39	4.134630E−12	1.159321E−12	1.146539E−12
40	2.106530E−12	1.097105E−12	1.187130E−12
41	1.079640E−12	1.148725E−12	1.143656E−12
42	9.180880E−13	1.131138E−12	1.221251E−12
43	1.265990E−12	1.124283E−12	1.272104E−12
44	2.198230E−12	1.145612E−12	1.281946E−12
45	3.585080E−12	1.142234E−12	1.237433E−12
46	8.100940E−12	1.106108E−12	1.220370E−12

Table 2.3 Cont'd

Group	Free-in-air (FIA)	Small intestine (SI)	Bone marrow (BM)
47	0.0	0.0	0.0
48	3.175600E−09	2.544366E−11	2.769750E−11
49	2.761200E−09	2.178194E−11	2.403630E−11
50	2.351700E−09	1.806358E−11	2.000330E−11
51	2.052500E−09	1.564311E−11	1.739900E−11
52	1.852210E−09	1.380293E−11	1.563240E−11
53	1.645670E−09	1.248159E−11	1.339117E−11
54	1.436400E−09	1.061882E−11	1.165841E−11
55	1.216860E−09	1.704023E−12	9.403036E−12
56	1.036000E−09	7.084599E−12	8.113812E−12
57	9.026680E−10	6.171013E−12	6.816419E−12
58	7.580870E−10	4.883398E−12	5.514999E−12
59	5.893170E−10	3.671165E−12	4.077272E−12
60	4.266030E−10	2.523286E−12	2.837419E−12
61	2.957870E−10	1.683161E−12	1.937082E−12
62	1.951130E−10	1.068689E−12	1.263538E−12
63	1.083820E−10	5.968414E−13	7.139559E−13
64	5.296280E−11	3.327378E−13	3.743490E−13
65	3.494150E−11	2.118065E−13	2.453518E−13
66	3.110080E−11	1.469365E−13	1.601847E−13
67	4.846280E−11	7.815564E−14	1.019230E−13
68	1.049700E−10	1.238341E−14	5.347652E−14
69	3.395990E−10	0.0	1.055788E−14

energy structure was found to be sufficiently fine, however, that this response could be used for the entire study.

Table 2.3 also shows two additional response functions determined by Ryman at Oak Ridge for kerma in the small intestine and in bone marrow. The details of how these were derived are given in appendix C of the concrete building study. [rh89]

Since the stated definition of kerma applies rigorously only to a "small volume," the concept of a kerma response function for an extended organ or system requires some elaboration. The simplest extension is to define the response function as the average kerma in the given organ that would result from a uniform external fluence of unit magnitude in a particular energy group. Organs located on the front of the body and shielded from rear exposure by the bulk of the body would require treatment of directional dependence, but that effect is not important to small intestine and bone marrow kerma. In addition, much of the delayed radiation arrived after the shock wave, when both the locations of the occupants and the structural integrity of the dwellings had been disrupted.

An approximation is also implied by the use of a single height above the floor for the dose determination. In this study, 30cm was used to represent persons on the floor and 90cm was used for standing persons. Sitting persons were assigned TF values midway between those extremes. In general, fluence was found to be a slowly-varying function of height, and so great accuracy in vertical positioning was not needed.

2.4 PROMPT EXTERIOR FLUENCE CALCULATIONS

The general procedure described in the DS86 document for calculating the fluence external to the buildings due to prompt sources was as follows:

. the sources of prompt neutrons and gammas in the weapon were determined from a coupled neutronics-hydrodynamics calculation,

. the leakage from the weapon was determined by a Monte Carlo process,

. an analytical first-collision source calculation throughout the surrounding air and ground was performed,

. the first-collision sources were transported from the first-collision sites to the sites of the dwellings by a 2-D discrete ordinates calculation, and

. the directional fluences at specific sites were selected, normalized, and reordered for subsequent folding with the adjoint functions generated by the Monte Carlo calculations described later.

A full description of the calculation of weapon leakage and transport to the site of the buildings is given in the DS86 report. The weapon leakage calculation was performed under the direction of Whalen at Los Alamos. First, a coupled neutronic-hydrodynamic code calculated the source of neutrons and gammas within the weapon. Then, a special version of the MCNP Monte Carlo code [br86] calculated the escape of particles from the weapon mass.

In the air/ground fluence calculation, the Nagasaki weapon was represented as an isotropic point source at a height of 503m above sea level. The Hiroshima weapon was also represented as a point source at a height of 580m, but the polar distribution of the emission, i.e. the distribution with respect to the axis of the weapon, was included.

The GRTUNCL code [ch91] performed an analytical calculation of the first-collision source, i.e. the distribution of particles after their first flight from the point source, in cylindrical (RZ) geometry. Since the new source was distributed in space over a large volume, it provided a better starting condition for the subsequent discrete ordinates calculation. Given the output of GRTUNCL, the DORT 2-D discrete ordinates code [rh88] then calculated the fluence of particles in the air and ground out to a distance of about 2,000m. The DORT output was produced in a very fine 240-direction mesh.

The cross sections used in the GRTUNCL and DORT calculations were represented in the 69-group structure described earlier, and they derived from the same sources as the standard DABL69 set. To obtain accurate results at large distances, however, a special weighing was used. The fine-group VITAMIN-E data in a selected number of radial zones were weighted over the fine-group spectra obtained from a 1-D ANISN [en67] calculation. This gave, in effect, several cross section sets, each appropriate to a specific distance from the weapon.

DORT produced an output file of directional fluence information over a selected band of heights. The VISA component of the Vehicle Code System (VCS) [rh74, rh74a] then selected a subset of positions in the vicinity of the sites being studied, normalized the data correctly, and reordered them for use in the forward-adjoint folding process performed by the DRC component of VCS. The original air transport calculations were performed by Pace at Oak Ridge on an IBM 370/3033 computer, but it was possible to move the cross sections and source data to Los Alamos and to reproduce the fluences on a Cray X-MP.

2.5 DELAYED EXTERIOR FLUENCE CALCULATIONS

The calculation of the fluences due to delayed sources is also described in the DS86 report. The sources referred to as "delayed" include radiation due to the decay of short-term activation products, fission products, and delayed-neutron precursors in the time domain following 0.2s. The nuclides from which these emissions occur were contained in the bomb debris and were carried upward from the detonation point in the fireball, propelled by buoyancy and shock effects. Although several sources of delayed radiation exist, only the delayed gammas contributed enough to the total dose to merit inclusion in this study.

The calculation of fluence at ground level due to the delayed gammas was especially difficult because the sources were constantly in motion, and because the thermal and pressure effects perturbed the atmosphere between the sources and the ground area of interest. The procedure described in the reference was as follows:

. the emissions were determined as a function of time from previous experimental data,

. the flux as a function of distance for a constant point emission in a uniform air environment was determined by a 1-D ANISN calculation,

. the source location and perturbed air density at a set of discrete times were determined from the STLAMB hydrodynamics code, a variant of LAMB [ne75],

. the flux corresponding to each time was selected from the ANISN results at a radius providing an amount of air between the source and each observation point equivalent to the STLAMB result at that time and was then normalized to the appropriate source at that time,

. the effects of ground scattering and absorption were included by a separate correction derived from the VCS code system, and

. the resulting time-dependent flux at each point was integrated to provide fluence.

The ANISN calculations were performed using the 38 gamma groups of the VITAMIN-E group structure, and these were then condensed to the 23 gamma groups of the 69-group library. The correction due to ground scattering and absorption proved to be on the order of 6%, so an approximate treatment was satisfactory.

Fluences from this calculation and from a somewhat similar delayed-neutron calculation were supplied by Gritzner. [gr87] The data were in a format different from that of the prompt data, but a code called FIRE, developed for this study, was able to make the translation. From that point, the data were processed in the same manner as prompt data, resulting in a file of delayed fluence at the building surface. A bias of 5% was implied in the error estimates of the DS86 study. It was of no concern to this work, however, since it did not affect the transmission factor values.

2.6 FLUENCE RESULTS

The results of the fluence calculations were two files containing prompt and delayed fluence as a function of energy, direction, elevation, and range. Values of FIA kerma at selected ranges are shown in table 2.4. These values agree quite closely with the data used in the original DS86 study. In both studies, prompt gammas leaking directly from the weapon and gammas resulting from neutron interaction with the air and ground have been lumped together as prompt gammas. (It may be noted that certain discussions in the DS86 document use the term "early gammas" rather than "prompt gammas".)

Table 2.4 FIA KERMA 1 Meter Above Ground Level at Selected Ground Ranges (cGy units)

HIROSHIMA

Ground Range	Prompt Neutron	Prompt Gamma	Delayed Gamma
700m	162	538	950
1000m	21.6	152	248
1600m	.438	15.3	18.0
2500m	.00221	.690	.505

NAGASAKI

Ground Range	Prompt Neutron	Prompt Gamma	Delayed Gamma
700m	80.1	1,310	1,880
1000m	12.7	360	435
1500m	.606	48.0	42.8
2000m	.0329	7.79	5.09

3. DWELLING SENSITIVITY TO EXTERNAL FLUENCE

3.1 GENERAL APPROACH

Since the exposed persons were located in thousands of dwellings, it was not practical to model the site of each radiation exposure in detail, as was done in the concrete building study. Instead, the DS86 study relied on the use of a few models typical of construction at the time and place of the exposures. These models were grouped into model "neighborhood clusters", and the adjoint sensitivity of the clusters was calculated. (For this purpose, adjoint sensitivity is taken to be the amount of kerma caused by fluence in a given direction and at a given energy crossing an arbitrary surface enclosing the dwellings.) This approach allowed the cluster to be moved mathematically to different ranges and orientations, simulating a diverse set of radiation environments. This same general procedure was used in the present study.

3.2 INDIVIDUAL DWELLING MODELS AND THE RESIDENTIAL CLUSTER

The residential dwelling models were patterned after the structures used in the BREN experiments. [ch65] BREN was a test program conducted in Nevada to give integral experimental data from which doses inside the houses at Hiroshima and Nagasaki were to be deduced. Structures typical of Japanese construction were exposed to radiation from a nuclear reactor and from a cobalt gamma source, each mounted in turn on a 1500-foot tower. There were problems with the interpretation of the data, as discussed in detail in the DS86 report. The house prototypes were apparently well chosen, however, and their dimensions were used in the DS86 study as well as in the present effort. Figures 3.1-3.5 show photographs and floor plans of type "A" and "B" houses. A third house type, type "C", was used at BREN, but it was not included in this study. Type C was a one story house somewhat like A, but it included the annexes shown in the foreground of the photograph of B, a relatively minor difference.

A computer model of the "BREN A" house was constructed directly from a floor plan and a photograph by the use of projective geometry techniques. The model matches the photograph in the figure closely, as shown in figure 3.6. The BREN houses used Japanese-style wood framing, but a cement-asbestos board was used for wall and roof construction. The computer models, however, used the split-bamboo-reinforced clay walls and wood-clay-tile roofs typical of the Japanese construction, as will be discussed later.

The DS86 study included a residential cluster built from four "A" houses and two "B" houses turned to various orientations and, in some cases, inverted to mirror images of the originals. We were able to obtain the computer description of these houses through the courtesy of Egbert. [eg90] A model of the A house was prepared for this study by extracting one of the models from the cluster and examining it in detail. A catalog of each geometric zone, its use, key dimension details, and material assignments was made, as noted in table 3.1. (The materials corresponding to the material numbers will be defined later.) Minor construction problems were repaired, and the result was a sound and well-documented model illustrated in figure 3.6 as the "DS86 model".

Figure 3.1 Photograph of BREN Type A House

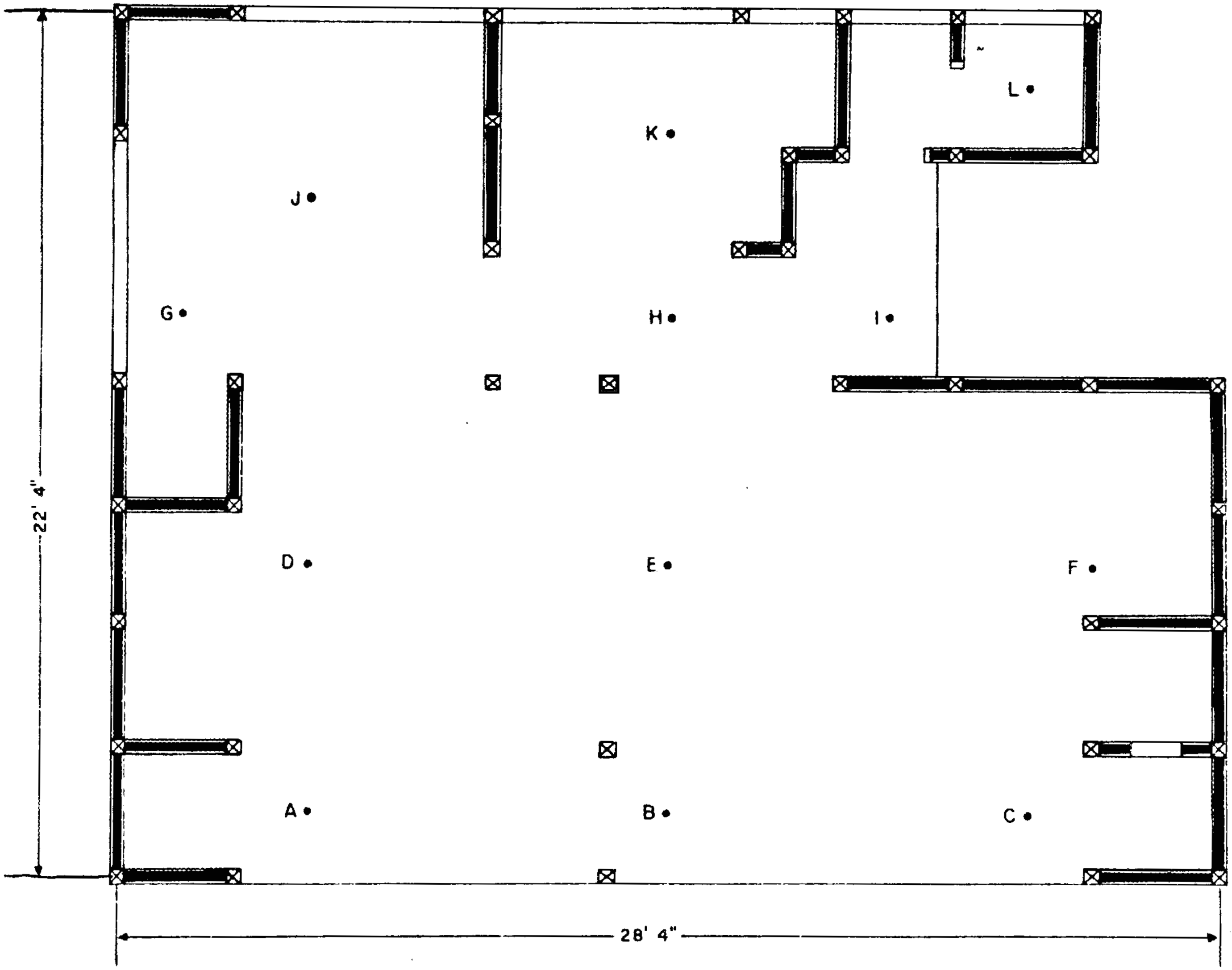


Figure 3.2 Floor Plan of BREN Type A House

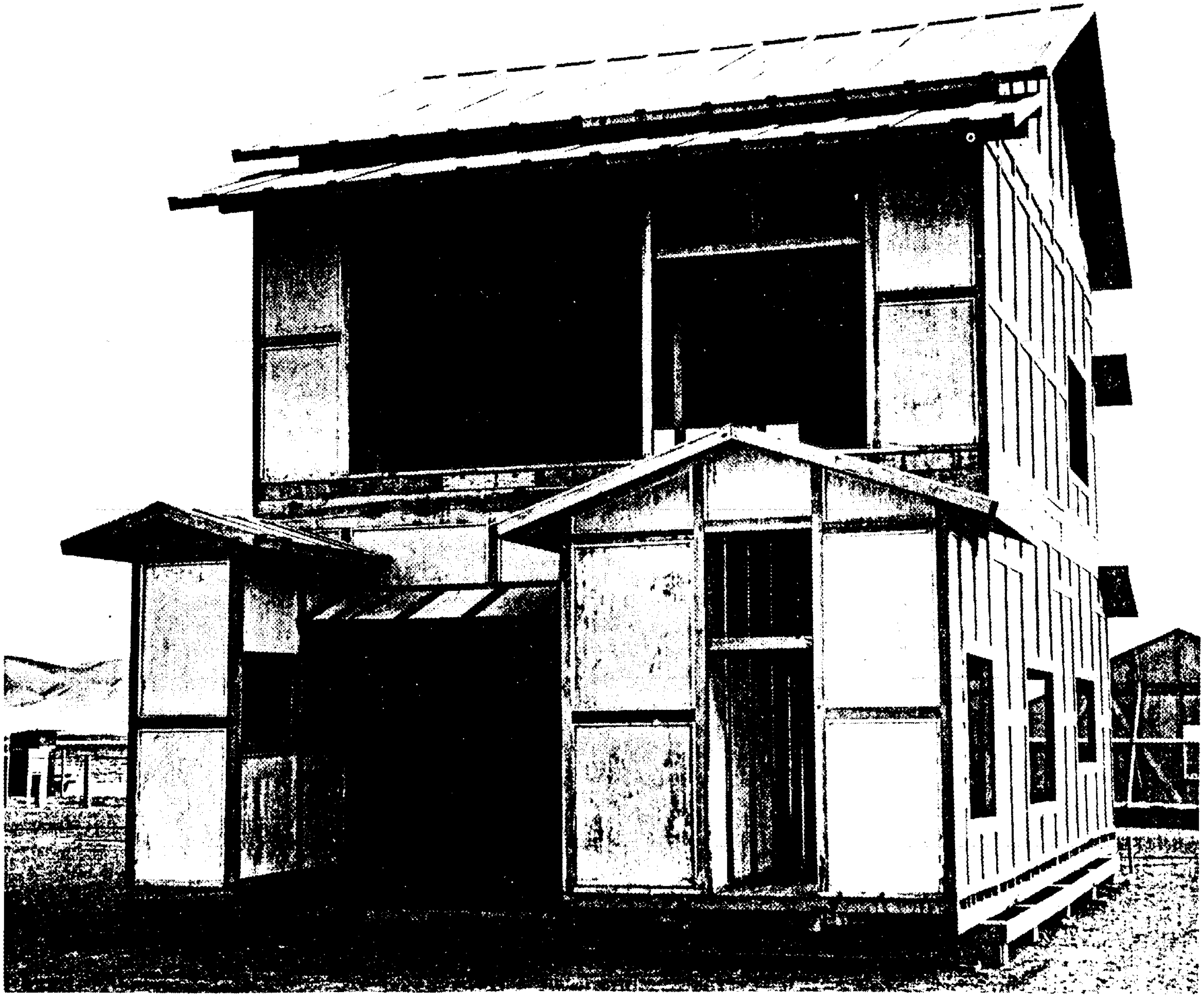


Figure 3.3 Photograph of BREN Type B House

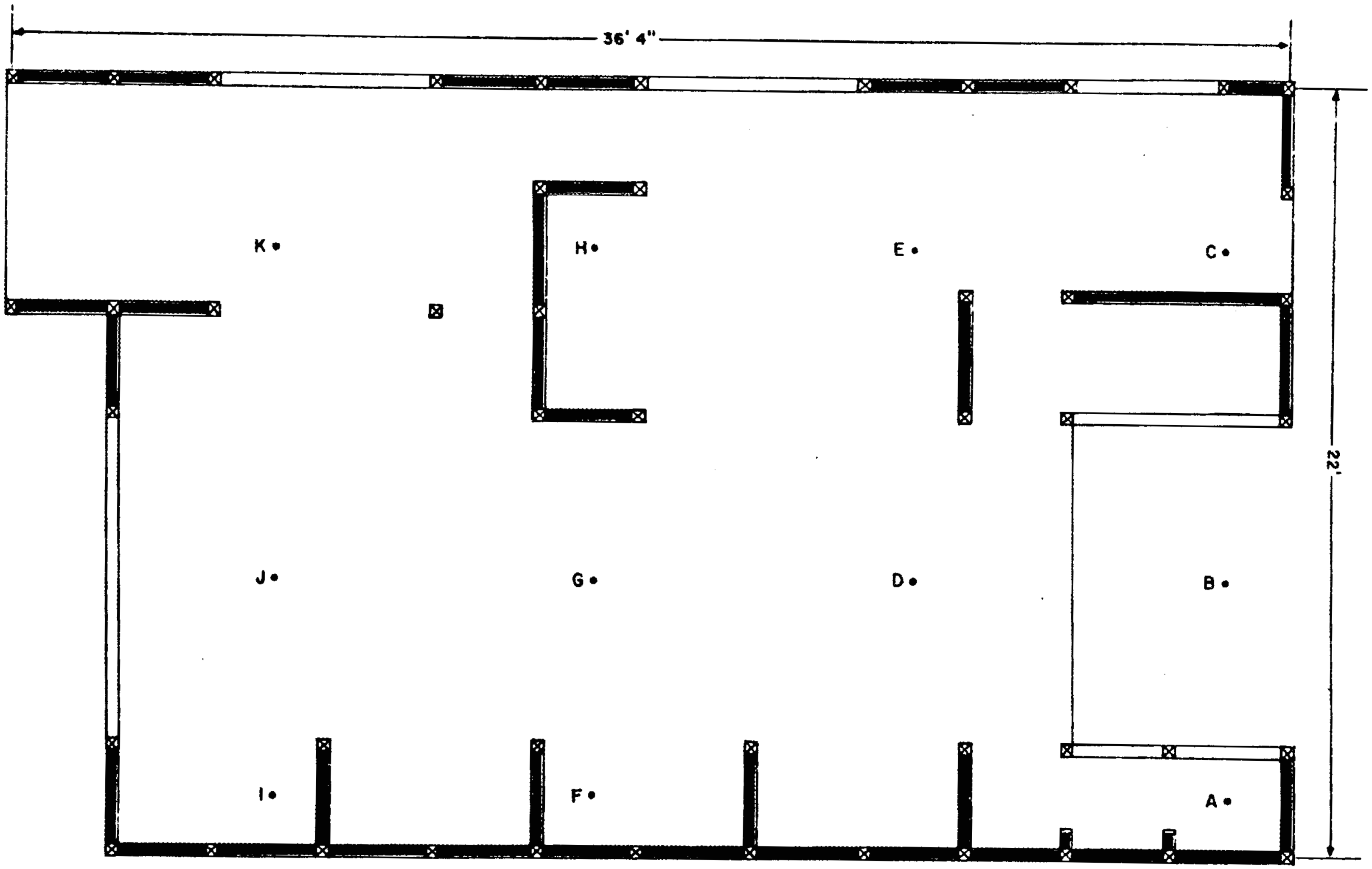


Figure 3.4 Floor Plan of BREN Type B House, First Floor

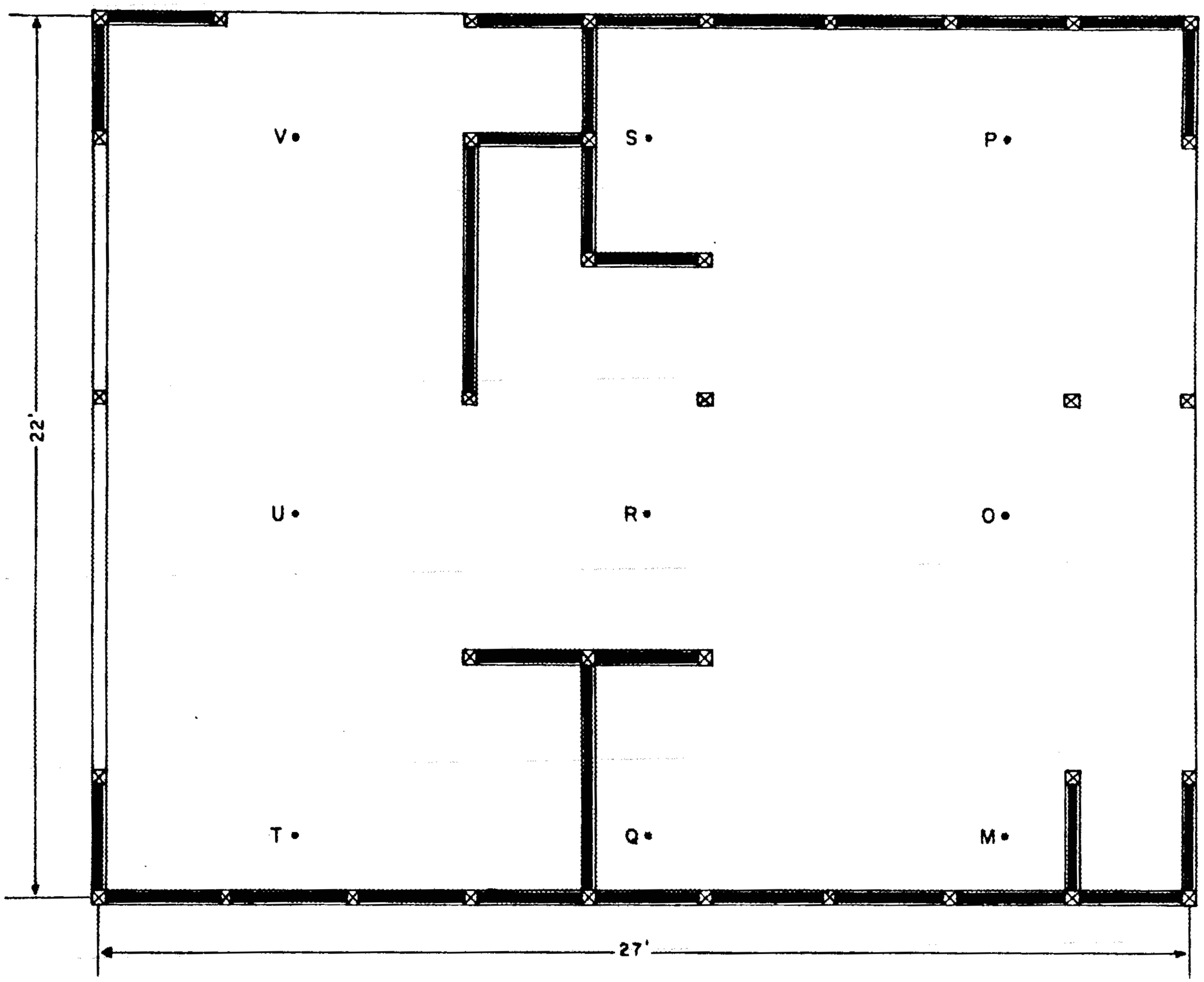
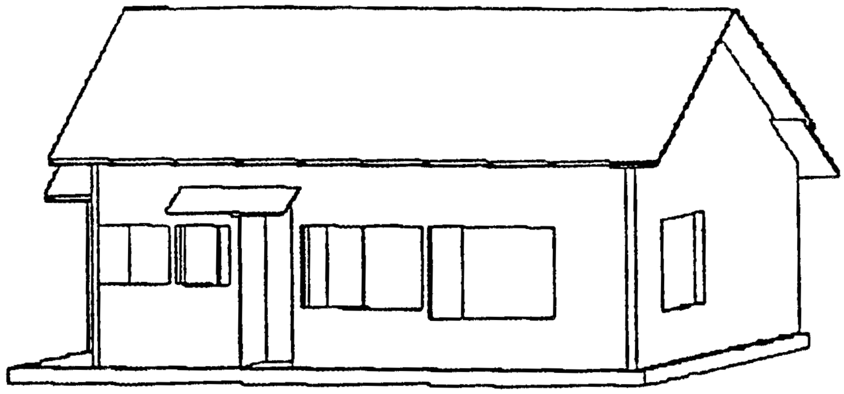


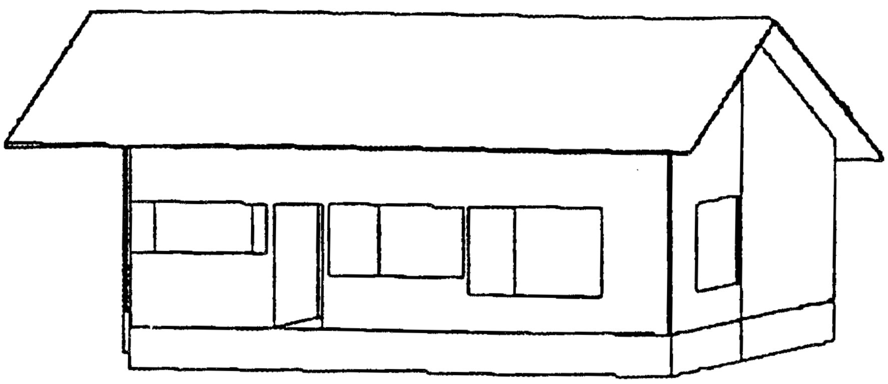
Figure 3.5 Floor Plan of BREN Type B House, Second Floor

Figure 3.6 BREN A House: Comparison of ORNL and DS86 Models with a Photograph of the Actual House as Constructed



ORNL Model

BREN Photograph



DS86 Model

Table 3.1			ZONE DESCRIPTIONS FOR HOUSE A
Zone No.	Major Bodies	Material No.	Zone Description[a]
1	17	4	Support structure under left floor (55.88 thk.)
2	16	5	Left lower level floor (1.27 thk.)
3	5,2	1	Air in right side of house
4	4,1	1	Air in left side of house
5	12	3	Left outer wall (4.445 thk. - 221.0 high)
6	1-4	3	Left rear outer wall (4.445 thk., 221.0-411.5 high)
7	2-5	3	Right rear outer wall (4.445 thk., 280.0-411.5 high)
8	7	3	Right outer wall (4.445 thk. - 280 high)
9	4-1	3	Left front outer wall (4.445 thk., 221.0-411.5 high)
10	5-2	3	Right front outer wall (4.445 thk., 280.0-411.5 high)
11	14	7	Left roof (4.445 thk.)
12	15	7	Right roof (4.445 thk.)
13	3	1	Window in rear outer wall (186.055 wide x 121.92 high)
14	8	1	Window in right outer wall (188.595 wide x 121.92 high)
15	9	1	Window in right outer wall (186.69 wide x 99.06 high)
16	10	1	Door in right outer wall (69.22 wide x 172.72 high)
17	11	1	Window in right outer wall (189.23 wide x 69.85 high)
18	6	1	Door in front outer wall (186.055 wide x 280.0 high)
19	13	1	Opening in left outer wall (654.05 wide x 221.0 high)
20	18	8	Inner wall (5.08 thk. - 172.72 high)
21	19	1	Opening in body 18 wall (653.99 wide x 172.72 high)
22	20	8	Upper inner wall (5.08 thk., 172.72 to 270.0 high)
23	21	8	Inner wall (5.08 thk. - 270.0 high)
24	22	1	Opening in body 21 wall (559.435 wide x 172.72 high)
25	23	7	Small left section of roof (4.445 thk.)
26	24	8	Inner wall (5.08 thk. - 270.0 high)
27	25	1	Opening in body 24 wall (172.105 wide x 172.72 high)

Table 3.1 (cont.) ZONE DESCRIPTIONS FOR HOUSE A			
Zone No.	Major Bodies	Material No.	Zone Description
28	37	8	Upper portion of inner wall (5.08 thk.)
29	26	8	Inner wall (5.08 thk. - 270.0 high)
30	29	8	Inner wall (5.08 thk. - 270.0 high)
31	30	1	Door in body 29 wall (94.25 wide x 172.72 high)
32	31	8	Inner wall (5.08 thk. - 270.0 high)
33	32	1	Opening in body 31 wall (180.975 wide x 172.72 high)
34	33	8	Inner wall (5.08 thk. - 270 high)
35	34	8	Inner wall (5.075 thk. - 270.0 high)
36	35	1	Door in body 34 wall (52.07 wide x 172.72 high)
37	36	8	Upper inner wall (5.13 thk., 172.72 to 270.0 high)
38	27	8	Inner wall (5.08 thk. - 270.0 high)
39	28	8	Upper inner wall (5.08 thk., 172.72 to 270.0 high)
40	38	5	Right lower level floor (1.27 thk.)
41	39	4	Support structure under right floor (55.88 thk.)
42	40	8	Center upper wall (5.08 thk. - 411.5 high)
43	41	6	Air surrounding house

[a]All dimensions are in cm.

Figure 3.7 shows the ORNL and DS86 models from a different viewpoint, together with an illustration from the DS86 report. The various models differ primarily in the treatment of windows and of the entryway at the left. The DS86 model shows a main roof that extends more to the left than the original roof depicted in the photograph, and it does not show the corner of a second roof plane that is visible in the photograph. Except for these minor details, the DS86 and ORNL models match well. The illustration from the report does not match the original BREN building or the DS86 model in the treatment of the corner at the left. It fails to show the inset that is quite apparent in the floor plan, and it differs widely from the photograph in window treatment. One may suspect that it was derived from an earlier model.

A comparison of transmission factors obtained from the ORNL and DS86 models indicated that either would be acceptable for this study. Accordingly, the DS86 model was used for the remainder of the calculations in order to maximize continuity with the earlier work.

The BREN experiments included a two-story residential structure, the "B" house, and it was also modeled in the DS86 residential cluster. As before, it was extracted and examined in detail, producing the "parts catalog" of table 3.2. Figures 3.8 and 3.9 compare this model with a photograph from the BREN report and with an illustration from the DS86 report. The match is quite good.

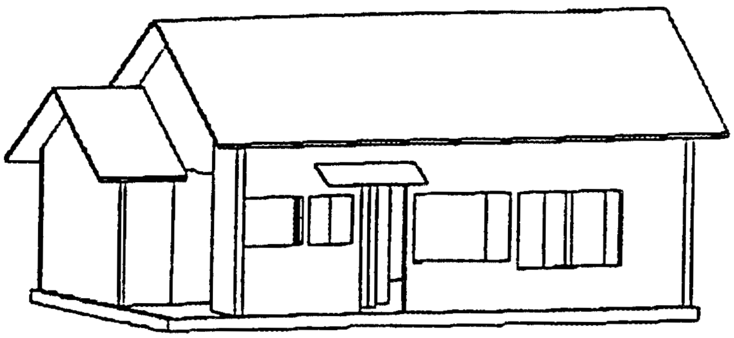
The refurbished A and B houses were reassembled into the DS86 residential cluster configuration, using translation, rotation, and reflection, as illustrated in figure 3.10. For ease of reference, upward in this layout will be designated the north direction and associated with the Y variable, while rightward is east, associated with the X variable as illustrated. Comparing the resulting model depicted in figures 3.11 and 3.12 with the corresponding figures from the DS86 report, one sees that the new cluster faithfully reproduces the original. The DS86 report also dealt with a tenement housing cluster, but its results were similar to those of the B house, and it was not included in the present effort.

The folding of "forward" fluence and adjoint sensitivity requires the establishment of a surface enclosing the cluster. Radiation effects are calculated by discrete ordinates outside this surface and by Monte Carlo inside it. For good accuracy, the method requires that the surface be located such that the incoming fluence would not be perturbed by the presence of the cluster, as discussed in some detail in appendix A. This can be done by making the enclosure either sufficiently large or sufficiently small. There are certain difficulties in using a very large encosure, however, and so the enclosure used in this study was a box just large enough to enclose the dwellings, 25m long, 10.3m wide, and 25.2m high above the ground.

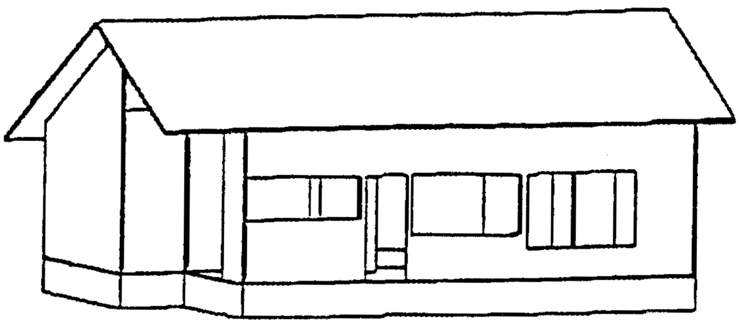
3.3 CONSTRUCTION MATERIALS

The identification of the material numbers in tables 3.1 and 3.2 with material compositions from table 2.2 is shown in table 3.3. It was necessary to identify exterior walls and interior walls by separate numbers so that the frontal shielding calculation, discussed later, could treat them differently. Similarly, air inside the houses was identified as distinct from the outside air for identification in the Monte Carlo processing.

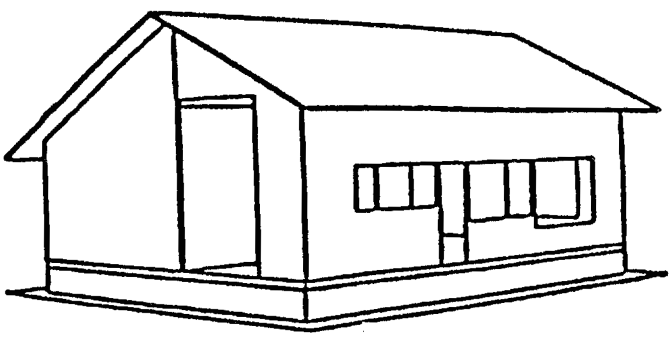
Figure 3.7 BREN A House: Comparison of ORNL and DS86 Models with an Illustration from the DS86 Document



ORNL Model

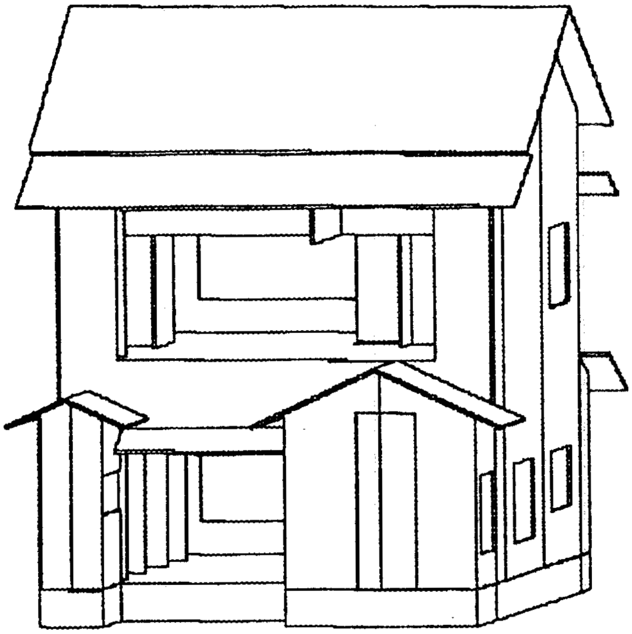


DS86 Model

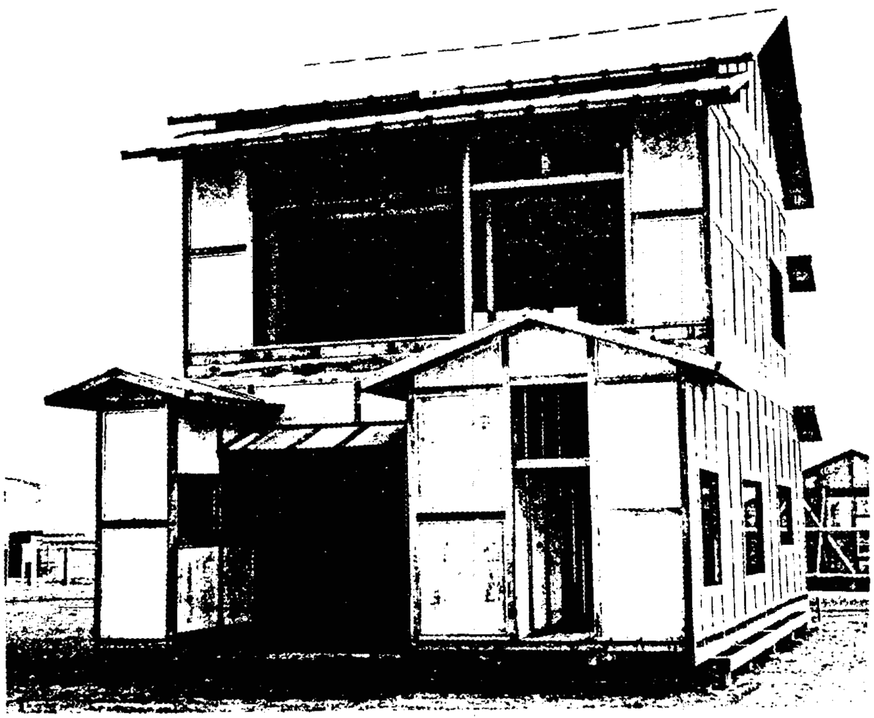


DS86 Illustration

Figure 3.8 BREN B House: Comparison of DS86 Model with a Photograph of the Actual House as Constructed

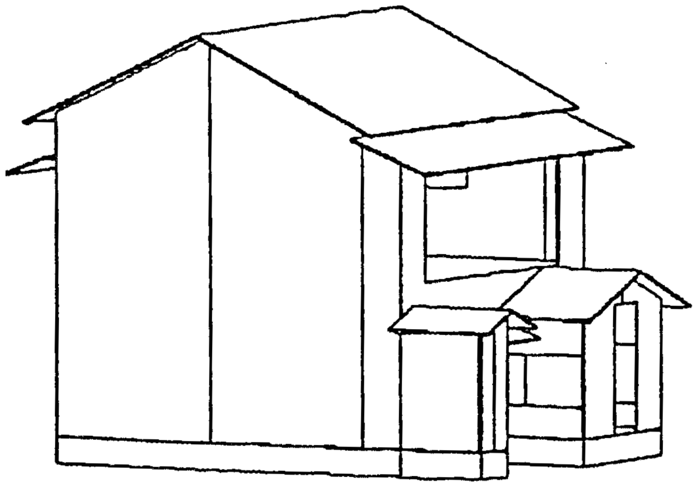


DS86 Model

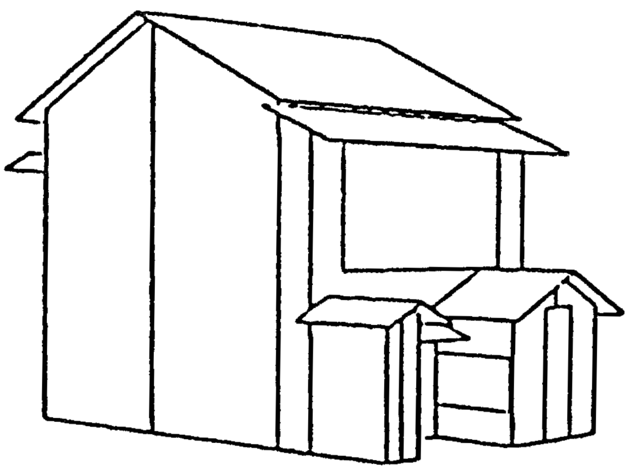


BREN Photograph

Figure 3.9 BREN B House: Comparison of DS86 Model with an Illustration from the DS86 Document



DS86 Model



DS86 Illustration

Figure 3.10 Residential Cluster: Plan View

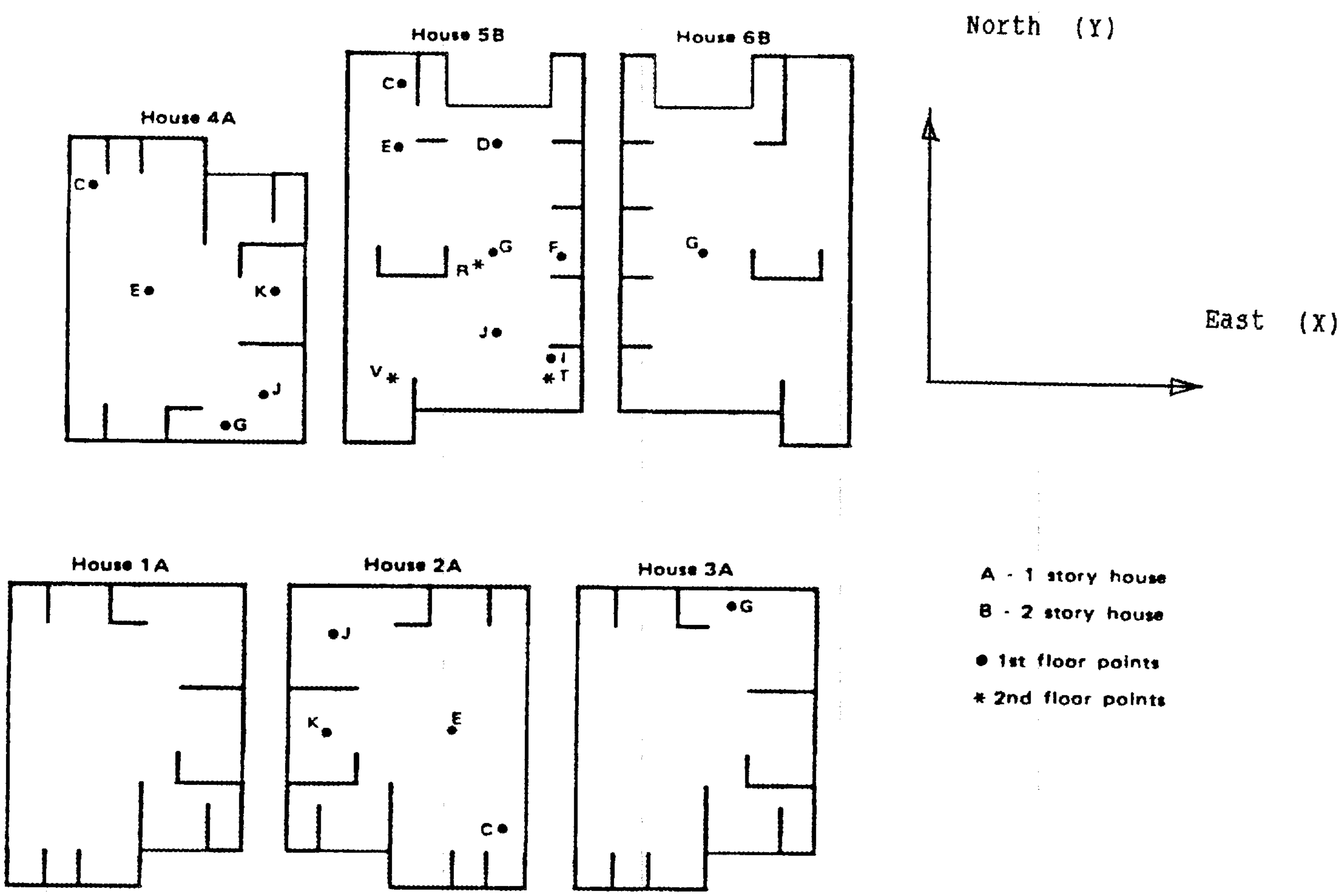
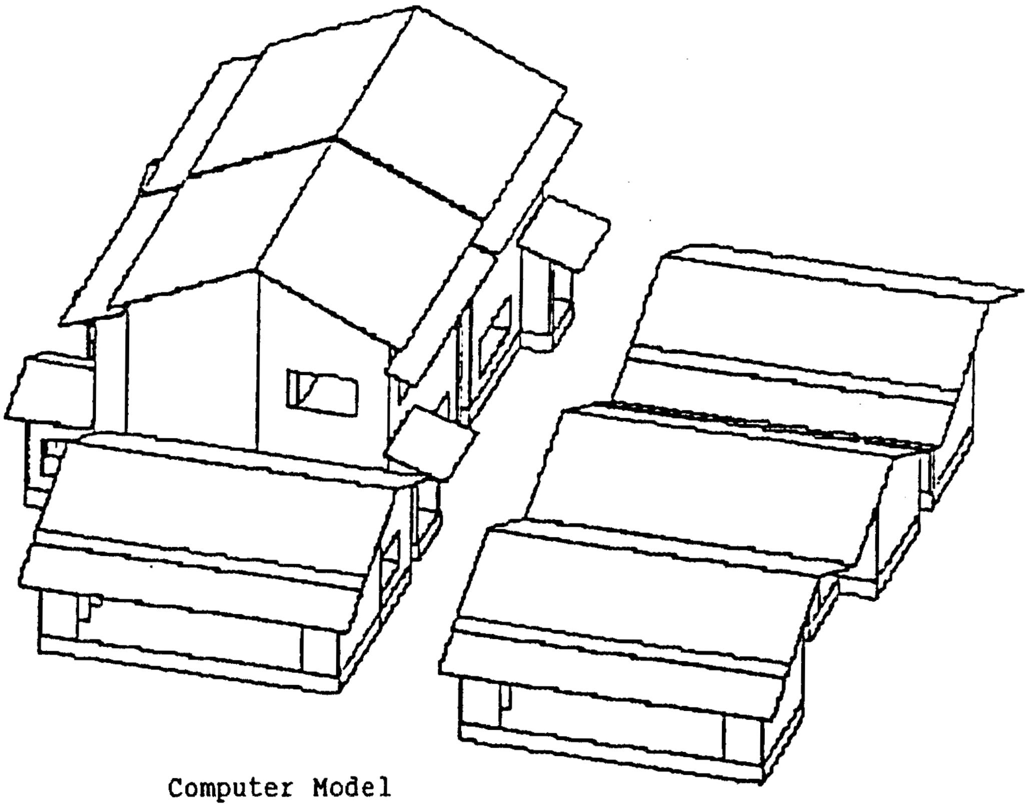
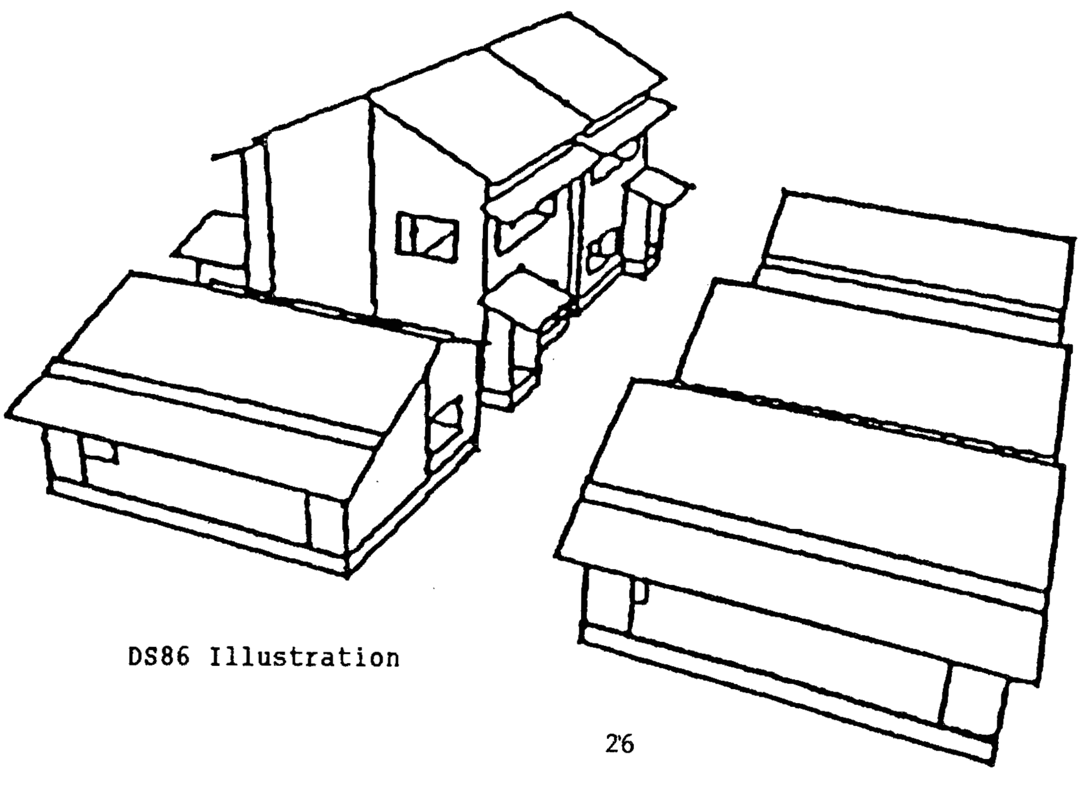


Figure 3.11 Residential Cluster: Computer model Compared with an Illustration from the DS86 Document; View from Southwest

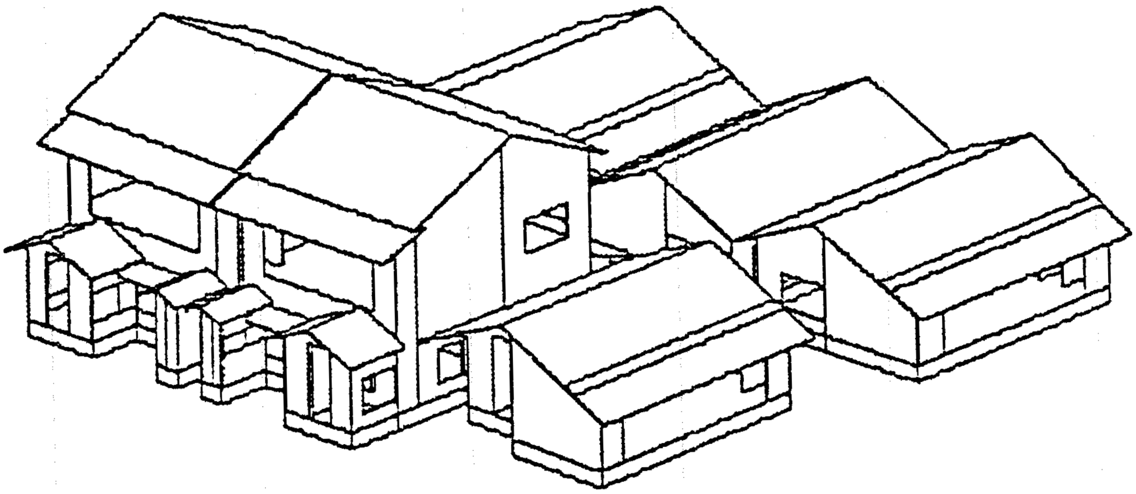


Computer Model

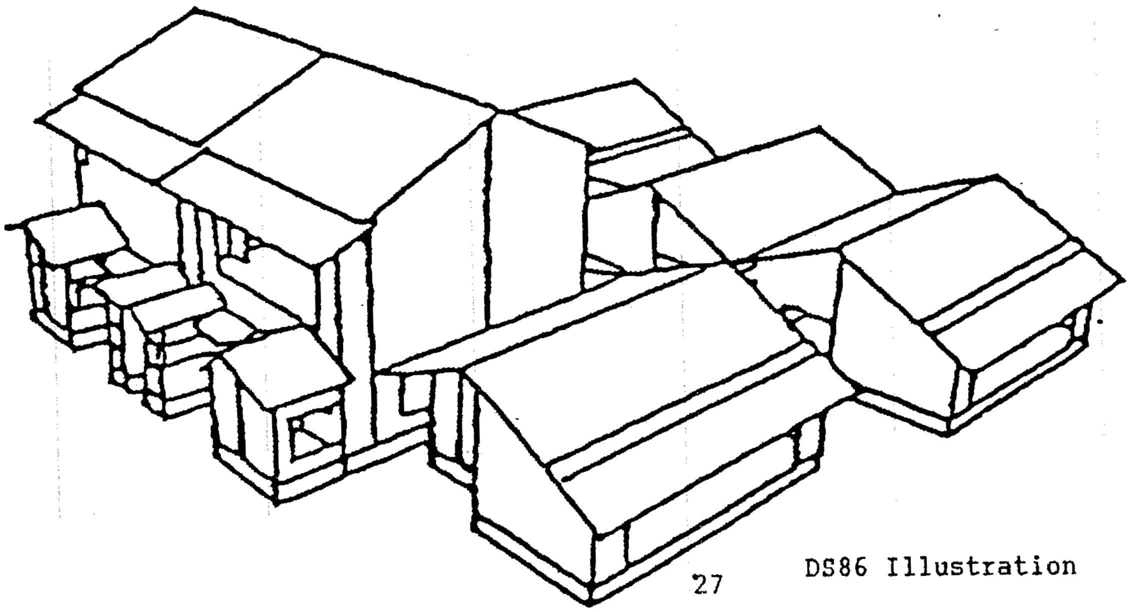


DS86 Illustration

Figure 3.12 Residential Cluster: Computer model Compared with an Illustration from the DS86 Document; View from Northwest



Computer Model



DS86 Illustration

Table 3.2	ZONE DESCRIPTIONS FOR HOUSE B		
Zone No.	Major Bodies	Material No.	Zone Description[a]
173	165,166	1	Air in middle part of house
174	167,168	1	Air in rear part of house
175	169,170	1	Air in rear shed
176	171,172	1	Air in front part of house
177	174	1	Air in right side of right annex
178	176	1	Air in left side of right annex
179	178	1	Air in right side of left annex
180	180	1	Air in left side of left annex
181	181-182	7	Upper front portion of roof (4.445 thk.)
182	182	7	Upper back portion of roof (4.445 thk.)
183	183	7	Roof on rear shed (4.445 thk.)
184	184	7	Lower back portion of roof (4.445 thk.)
185	185	7	Lower front portion of roof (4.445 thk.)
186	186	7	Right roof on right annex (4.445 thk.)
187	187-186	7	Left roof on right annex (4.445 thk.)
188	188	7	Right roof on left annex (4.445 thk.)
189	189-188	7	Left roof on left annex (4.445 thk.)
190	190	7	Small roof over front entrance (4.445 thk.)
191	167-168	3	Rear left outer wall (4.445 thk., 675.64-851.284 high)
192	168-167	3	Rear right outer wall (4.445 thk., 675.64-851.284 high)
193	165-166	3	Front left outer wall (4.445 thk., 675.64-851.284 high)
194	166-165	3	Front right outer wall (4.445 thk., 675.64-851.284 high)
195	191	3	Rear outer wall (4.445 thk. - 675.64 high)
196	196	3	Outer wall between front roofs (4.445 thk.)
197	197	3	Upper front outer wall (4.445 thk. - 225.0 to 610.87 high)
198	192	3	Right annex right wall (4.445 thk. - 269.24 high)
199	193	3	Right annex left wall (4.445 thk. - 269.24 high)

Table 3.2 (cont.)			ZONE DESCRIPTIONS FOR HOUSE B
Zone No.	Major Bodies	Material No.	Zone Description
200	194	3	Left annex right wall (4.445 thk. - 269.24 high)
201	195	3	Left annex left wall (4.445 thk. - 269.24 high)
202	173-174	3	Right annex right front wall (4.445 thk., 269.24-335.28 high)
203	175-176	3	Right annex left front wall (4.445 thk., 269.24-335.28 high)
204	177-178 179-180	3	Left annex front wall (4.445 thk., 269.24-290.195 high)
205	170-169	3	Rear shed right wall (4.445 thk., 273.05-303.53 high)
206	169-170	3	Rear shed left wall (4.445 thk., 273.05-303.53 high)
207	172-171	3	Front right outer wall (4.445 thk., 610.87-645.16 high)
208	171-172	3	Front left outer wall (4.445 thk., 610.87-645.16 high)
209	198	1	Window in 1st floor rear wall (299.72 wide x 121.92 high)
210	199	1	Window in 2nd floor rear wall (492.76 wide x 121.92 high)
211	213	1	Door in rear shed (202.565 wide x 273.05 high)
212	200	1	Window in 1st floor right wall (197.485 wide x 91.44 high)
213	201	1	Window in 1st floor right wall (208.28 wide x 121.92 high)
214	202	1	Window in right annex (149.86 wide x 121.92 high)
215	203	1	Window in 2nd floor right wall (197.485 wide x 121.44 high)
216	212	1	Window in left annex (193.675 wide x 60.96 high)
217	204	1	Door in right annex (91.44 wide x 269.24 high)
218	205	1	Window in 2nd floor front wall (492.76 wide x 261.26 high)
219	211	1	Window in right annex (193.675 wide x 106.68 high)
220	206	5	Upper level floor (1.27 thk.)
221	207	5	Lower level main floor (1.27 thk.)
222	208	5	Floor in rear shed (1.27 thk.)
223	209	5	Right annex floor (1.27 thk.)
224	210	5	Left annex floor (1.27 thk.)
225	214	8	Upper level inner wall (5.08 thk. - 142.28 high)
226	215	8	Lower level inner wall (5.08 thk. - 315 high)

Table 3.2 (cont.)			ZONE DESCRIPTIONS FOR HOUSE B
Zone No.	Major Bodies	Material No.	Zone Description
227	216	8	Lower level inner wall (5.08 thk., 172.72 to 315.0 high)
228	217	8	Lower level inner wall (5.08 thk. - 315.0 high)
229	218	8	Lower level inner wall (5.08 thk. - 315.0 high)
230	219	8	Lower level inner wall (5.08 thk. - 315.0 high)
231	220	8	Lower level inner wall (5.08 thk., 172.72 to 315.0 high)
232	221	8	Lower level inner wall (5.08 thk. - 315.0 high)
233	222	8	Lower level inner wall (5.08 thk. - 315.0 high)
234	223	8	Lower level inner wall (5.08 thk. - 315.0 high)
235	224	8	Upper level inner wall (5.08 thk., 513.08 to 640.0 high)
236	225	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
237	226	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
238	227	8	Upper level inner wall (5.08 thk., 513.08 to 640.0 high)
239	228	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
240	229	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
241	230	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
242	231	8	Upper level inner wall (5.08 thk., 513.08 to 640.0 high)
243	232	8	Upper level inner wall (5.08 thk., 340.36 to 640.0 high)
244	233	8	Lower level inner wall (5.08 thk. - 315.0 high)
245	234	8	Lower level inner wall (5.08 thk. - 315.0 high)
246	235	8	Lower level inner wall (5.08 thk., 172.72 to 315.0 high)
247	236	1	Opening in body 215 wall (286.622 wide x 172.72 high)
248	237	1	Opening in body 218 wall (284.48 wide x 172.72 high)
249	238	1	Opening in body 219 wall (376.555 wide x 172.72 high)
250	239	1	Door in body 223 wall (86.995 wide x 172.72 high)
251	240	1	Opening in body 225 wall (376.555 wide x 172.72 high)
252	241	1	Door in body 225 wall (86.995 wide x 172.72 high)
253	242	1	Opening in body 226 wall (375.92 wide x 296.64 high)

Table 3.2 (cont.)	ZONE DESCRIPTIONS FOR HOUSE B		
Zone No.	Major Bodies	Material No.	Zone Description
254	243	1	Opening in upper level floor (192.405 x 84.137)
255	244	4	Upper level supporting structure (24.09 thk.)
256	245	4	Supporting structure under house (55.88 thk.)
257	246	4	Supporting structure under rear shed (55.88 thk.)
258	247	4	Supporting structure under right annex (55.88 thk.)
259	248	4	Supporting structure under left annex (55.88 thk.)
260	249	1	Opening into rear shed (193.04 wide x 315.0 high)
261	250	6	Air surrounding house

[a]All dimensions are in cm.

Table 3.3 Material Assignment by Material Number

Matl Number		Composition	Use
1		Air	Air Inside the Houses
2		Earth	Ground Outside the Houses
3		Mud	Clay Exterior Walls
4		Earth	Ground Under the Houses
5		Wood	Floors
6		Air	Air Outside the Houses
7		[Mud x 0.90]	Roof Composite
	+	[Wood x 0.45]	
8		Mud	Clay Interior Walls

NOTE:

- The material numbers correspond to the numbers in tables 3.1 and 3.2.
- The composition identifications correspond to those of table 2.2.

The roof composition received a great deal of attention in the DS86 study. Various combinations of tile and mud, with overlapping layers accounted for, were tested and discussed. For this study, the 5-zone model listed as number 5 in table 2, chapter 7, volume 1, of the DS86 report was adopted. Its composition is listed in table 3.4.

In the DS86 study, some of the calculations were performed using special programming that selected from the various layers at random each time a roof penetration was made. In the present study, it was appropriate to use a fixed composition, however, and a model accurately representing the composite was sought.

Recognizing that roof penetration is essentially a 1-dimensional transport problem, the five zones of the selected model, each followed by a wooden subroof, were modeled in a one dimensional discrete ordinates calculation using ANISN. [en67] Fluence spectra calculated for 700 and 2000 meters ground range were applied to the top of each layer in turn, and the reduction in dose as it penetrated each layer was calculated. Single layers of mud at several thicknesses were also calculated, as well as mud followed by a 1.27cm wooden floor, giving the results shown in tables 3.5 and 3.6. In each case, the mud layer was immediately followed by a 2cm wooden subroof support layer. The "ng" column is the ratio of dose due to gammas generated in the roof, subroof, and floor materials to the incident neutron dose. By applying the appropriate area weighting, an attenuation factor for the 5-zone roof was also determined as indicated in the tables.

The tables show that 4.0cm of mud followed by 2cm of wood is an excellent substitute for the 5-zone model for all fluences and ranges considered. For the sake of comparison, the area-weighted average thickness, with density differences considered, was calculated to be 4.4cm of mud. A more accurate comparison is given by the inverse-weighted thickness, however. This gives an effective mud thickness of 3.9cm, close to the result determined by the 1-dimensional discrete ordinates calculations.

As noted earlier, the table also shows attenuation data for 4cm of mud followed by a 1.27cm layer of wood representing the second floor of a two- story house. Comparing that result with the uniform mud results shows that a floor is adequately represented by 0.34cm of mud. (In later discussions, the second floor will also be referred to as a "ceiling")

When penetrations are grouped together to determine the frontal shielding parameter (FS), discussed later, the roof and ceiling penetrations must be converted to an equivalent number of exterior walls. In tables 3.7 and 3.8, the attenuation of various thicknesses of external wall material are shown. From these, it can be deduced that 5cm of wall material represents the roof well, and 5.4cm represents the roof plus a wooden floor. Assuming a nominal wall thickness of 4.445cm, the roof and floor are equivalent to 1.12 and 0.08 unit walls, respectively.

For use in the Monte Carlo calculations, it was also necessary to determine a composite material equivalent to the 5-zone roof plus the 2cm support layer homogenized into a zone 4.445cm thick. This was accomplished by mixing together roof mud at 90% of its nominal density and wood at 45% of its density, as indicated in table 3.3

Table 3.4 5-Zone Tile Roof Model

Zone	Material	Percent of Surface Area
1	Single Tile	17.2
2	Single Tile + Mud	20.3
3	Double Tile	27.1
4	Double Tile + Mud	26.2
5	Triple Tile	9.2

Notes

. Each tile layer is 1.8cm thick.

. Each mud layer is 2cm thick.

. A wood subroof 2cm thick supports the tile and mud.

Table 3.5 Attenuation Factors for Various Roof Materials at 700 Meters Ground Range

MATERIAL		PN	NG	PG	DG	TOT
Void		1.000	0.000	1.000	1.000	1.000
Roof Zone	1	0.520	0.041	0.742	0.646	0.682
"	2	0.417	0.065	0.618	0.510	0.552
"	3	0.415	0.065	0.617	0.507	0.551
"	4	0.340	0.083	0.524	0.412	0.457
"	5	0.337	0.083	0.521	0.410	0.454
3cm Mud		0.460	0.055	0.670	0.571	0.610
4cm Mud		0.407	0.067	0.606	0.497	0.540
5cm Mud		0.362	0.077	0.553	0.440	0.485
4cm Mud + Floor		0.352	0.076	0.586	0.474	0.518
5-zone Roof		0.407	0.067	0.605	0.498	0.540

Notes

pn -- prompt neutrons

ng -- neutron-generated gammas from the mud, tile, and wood

pg -- prompt gammas

dg -- delayed gammas

. All rows of data except the last were derived from 1-D ANISN calculations. The last row is an area-weighted composite representing the reference 5-zone roof listed in table 3.4.

. In each case, the mud or roof zone was followed by a 2cm wooden subroof support layer, and the attenuation factors include that effect.

Table 3.6 Attenuation Factors for Various Roof Materials at 2000 Meters Ground Range

MATERIAL		PN	NG	PG	DG	TOT
Void		1.000	0.000	1.000	1.000	1.000
Roof Zone	1	0.551	0.033	0.769	0.702	0.742
"	2	0.456	0.051	0.650	0.584	0.624
"	3	0.454	0.051	0.648	0.584	0.622
"	4	0.379	0.065	0.555	0.475	0.523
"	5	0.377	0.065	0.555	0.475	0.523
3cm Mud		0.498	0.043	0.702	0.627	0.672
4cm Mud		0.446	0.053	0.640	0.561	0.608
5cm Mud		0.406	0.061	0.586	0.506	0.554
4cm Mud + Floor		0.393	0.060	0.620	0.537	0.587
5-zone Roof		0.444	0.053	0.636	0 .566	0.608

Notes

pn -- prompt neutrons

ng -- neutron-generated gammas from the mud, tile, and wood

pg -- prompt gammas

dg -- delayed gammas

. All rows of data except the last were derived from 1-D ANISN calculations. The last row is an area-weighted composite representing the reference 5-zone roof listed in table 3.4.

. In each case, the mud or roof zone was followed by a 2cm wooden subroof support layer, and the attenuation factors include that effect.

Table 3.7 Attenuation Factors for Various Thickness of Wall Material at 700 Meters Ground Range

MATERIAL	PN	NG	PG	DG	TOT
Void	1.000	0.000	1.000	1.000	1.000
4cm Wall	0.485	0.046	0.656	0.549	0.592
5cm Wall	0.427	0.055	0.603	0.491	0.536
6cm Wall	0.377	0.064	0.554	0.441	0.487

Notes

pn -- prompt neutrons

ng -- neutron-generated gammas from the mud, tile, and wood

pg -- prompt gammas

dg -- delayed gammas

Table 3.8 Attenuation Factors for Various Thickness of Wall Material at 2000 Meters Ground Range

MATERIAL	PN	NG	PG	DG	TOT
Void	1.000	0.000	1.000	1.000	1.000
4cm Wall	0.522	0.037	0.689	0.612	0.658
5cm Wall	0.464	0.044	0.635	0.557	0.604
6cm Wall	0.415	0.051	0.589	0.506	0.556

Notes

pn -- prompt neutrons

ng -- neutron-generated gammas from the mud, tile, and wood

pg -- prompt gammas

dg -- delayed gammas

3.4 DOSE SITES AND FLOOR NUMBERS

The plan requires the selection of specific dose sites in and near the houses to represent typical locations of exposure. Considerable diversity is important in the selection, and yet it is important to keep the number of sites manageable. In order to maintain continuity with previous work, the 21 sites in the interior of the houses in figure 3, chapter 7, volume 1, of the DS86 report, illustrated in figure 3.10 of this report, were chosen. Figure 5 of the DS86 chapter cited also listed numerous exterior sites, illustrated in figure 3.13 of this report, and 5 of these sites were chosen for use in this study. All of the sites are listed in table 3.9, together with their coordinates.

The interior sites correspond to sites used in the original BREN experiments, and the detailed drawings in the BREN reference, reproduced herein as figures 3.2, 3.4, and 3.5, were used to determine the final positioning. Table 3.9 also contains a floor number (FN) parameter, explained in the table, and a subject height parameter (SH), either "p" or "s" following the site designation. The value of SH denotes either prone or standing posture, which, in turn, determines the height above the floor at which the effective dose is calculated.

3.5 ADJOINT SENSITIVITY CALCULATIONS USING MORSE

The sensitivity of the housing cluster to fluence at the folding surface was calculated using the MORSE component of the VCS code system in its adjoint mode. (VCS is explained in some detail in appendix A.) This version of MORSE does not produce final dose results internally. Instead, it writes a history file containing data pertaining to each adjoint "particle" that crosses the folding surface.

An adjoint source with uniform strength in all groups was used with the biasing function listed in table 3.10. The table also shows splitting and Russian Roulette parameters. These arrangements were selected with the help of J.O.Johnson, ORNL, and they performed well. A relatively new "in-group energy biasing" feature was also used in this application. This feature counters the tendency of adjoint calculations to allow particles to scatter endlessly in a single energy group (the "fat particle problem").

In each calculation, a single dose site was selected from table 3.9, and 200 batches of 1000 particles each were started. This required about 22 minutes of system time on a Cray X-MP and produced dose results with fractional standard deviations (FSD's) typically 3% or less. FSD's this small did not add appreciably to the uncertainty of the final result.

This version of MORSE also required the input of a special title to be used as an identification on the history file. The site identification from table 3.9, less the "-" character, was placed into the first 6 characters of the title in order to assist later processing.

Figure 3.13 Residential Cluster: Plan View Showing Exterior Locations

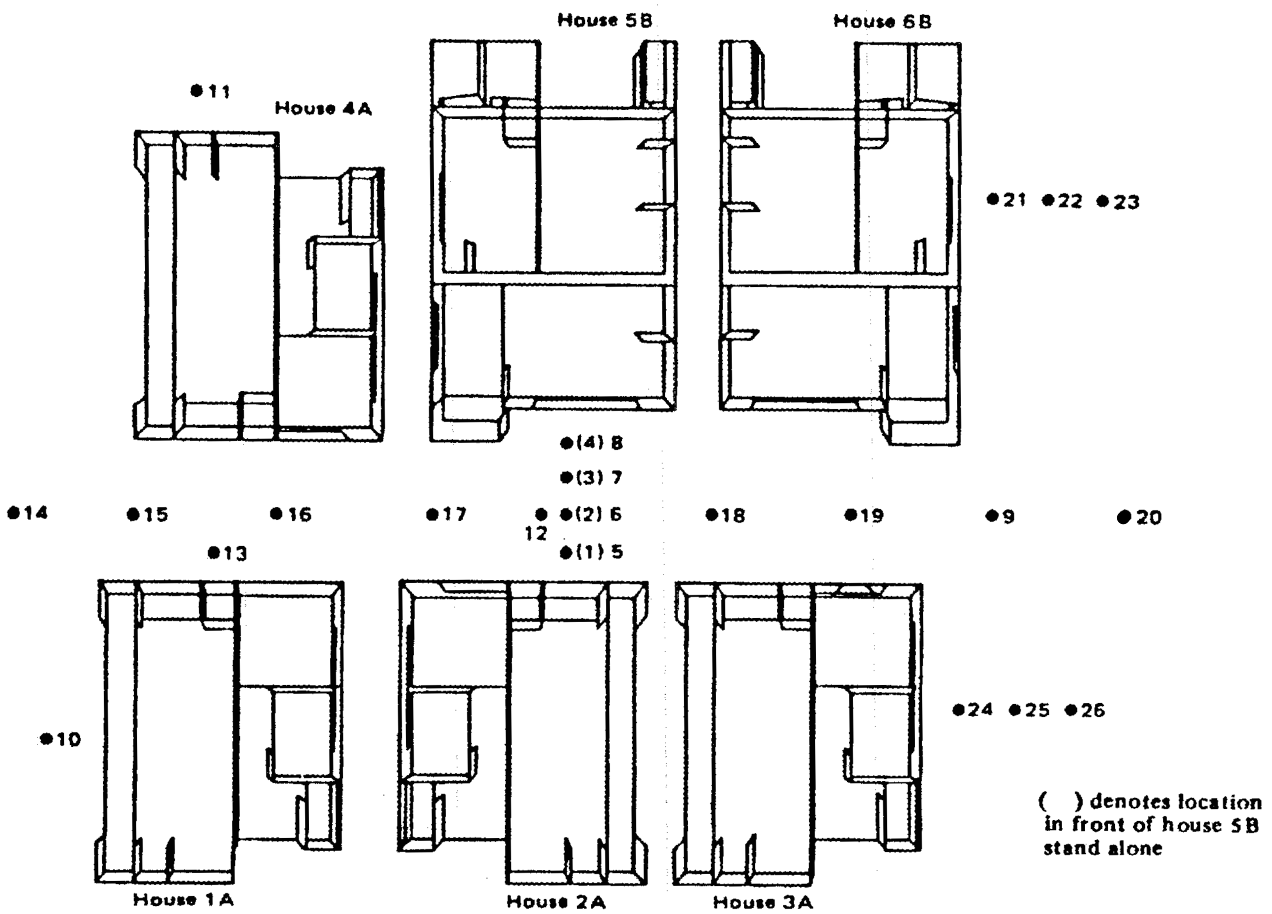


Table 3.9 Dose Sites in Residential Cluster

Site	FN	X	Y	Z
2a/c-p	2	1490.2	280.8	30.0
2a/e-p	2	1293.2	563.8	30.0
2a/j-p	2	1005.2	846.8	30.0
2a/k-p	2	953.2	563.8	30.0
3a/g-p	2	2131.8	942.8	30.0
4a/c-p	2	250.8	2119.2	30.0
4a/e-p	2	447.8	1836.2	30.0
4a/g-p	2	646.8	1457.2	30.0
4a/j-p	2	735.8	1553.2	30.0
4a/k-p	2	787.8	1836.2	30.0
5b/c-p	1	1141.5	2483.9	30.0
5b/d-p	1	1431.5	2216.9	30.0
5b/e-p	1	1141.5	2216.9	30.0
5b/f-p	1	1619.5	1941.9	30.0
5b/g-p	1	1431.5	1941.9	30.0
5b/i-p	1	1619.5	1674.9	30.0
5b/j-p	1	1431.5	1674.9	30.0
5b/r-p	3	1375.5	1934.9	370.0
5b/t-p	3	1622.5	1667.9	370.0
5b/v-p	3	1085.5	1667.9	370.0
6b/g-p	1	2019.5	1941.9	30.0
15 -p	0	129.7	1200.0	30.0
17 -p	0	1000.7	1200.0	30.0
5 -p	0	1408.0	1089.7	30.0
19 -p	0	2247.5	1200.0	30.0
9 -p	0	2509.0	1200.0	30.0
2a/c-s	2	1490.2	280.8	90.0
2a/e-s	2	1293.2	563.8	90.0
2a/j-s	2	1005.2	846.8	90.0
2a/k-s	2	953.2	563.8	90.0
3a/g-s	2	2131.8	942.8	90.0
4a/c-s	2	250.8	2119.2	90.0
4a/e-s	2	447.8	1836.2	90.0
4a/g-s	2	646.8	1457.2	90.0
4a/j-s	2	735.8	1553.2	90.0
4a/k-s	2	787.8	1836.2	90.0
5b/c-s	1	1141.5	2483.9	90.0
5b/d-s	1	1431.5	2216.9	90.0
5b/e-s	1	1141.5	2216.9	90.0
5b/f-s	1	1619.5	1941.9	90.0
5b/g-s	1	1431.5	1941.9	90.0
5b/i-s	1	1619.5	1674.9	90.0
5b/j-s	1	1431.5	1674.9	90.0
5b/r-s	3	1375.5	1934.9	430.0
5b/t-s	3	1622.5	1667.9	430.0
5b/v-s	3	1085.5	1667.9	430.0
6b/g-s	1	2019.5	1941.9	90.0

Table 3.9 (continued) Dose Sites in Residential Cluster

15	-s 0	129.7	1200.0	90.0
17	-s 0	1000.7	1200.0	90.0
5	-s 0	1408.0	1089.7	90.0
19	-s 0	2247.5	1200.0	90.0
9	-s 0	2509.0	1200.0	90.0

Note

. The interior site designations are interpreted as follows:

nh/s-p: n=house number as indicated in figure 3.10
h=house type -- model A or B
s=site designation as indicated in figure 3.10
p=posture - p for prone or s for standing

. The exterior designations are as follows:

s-p: s=site designation as indicated in figure 3.13
p=posture - p for prone or s for standing

. The floor numbers (FN) are interpreted as follows:

0 outside
1 first floor of a multistory house
2 first floor of a one-story house
3 second floor of a multistory house

. The coordinates, X, Y, and Z are with reference to an arbitrary point at ground level near the southwest corner of the cluster.

Table 3.10 Input Controls Used in the Morse Monte Carlo Calculations

Number of batches: 200

Starts per Batch: 1000

Splitting and Russian Roulette Parameters, All Groups Except 46:

WTHIH1:	5.0
WTLOW1:	0.1
WTAVE1:	1.0

Splitting and Russian Roulette Parameters, Group 46:

WTHIH1:	5.0
WTLOW1:	0.2
WTAVE1:	1.0

Source Importance Factors:

Groups	Factor
1-8	1.
9-19	2.
20-27	4.
28-30	2.
31-46	1.
47-50	3.
51-61	6.
62-69	3.

Secondary Particle Production Probability:

GWLOW:	1.0	(All groups and regions)

4. TRANSMISSION FACTOR CALCULATIONS

4.1 FORWARD-ADJOINT FOLDING WITH DRC

The DRC component of VCS folds the forward fluence at the folding surface surrounding the housing cluster with the adjoint sensitivity calculated by MORSE. The version of DRC used in this calculation is discussed in appendix A. Each of the DRC calculations used one of the history files from a single MORSE calculation, together with fluence at a specific range selected from either the prompt or delayed input file. A single calculation produced results for both neutron and gamma doses, and it was able to weight over four dose response functions at a time -- a flat response representing total fluence plus the three responses shown in table 2.3. The ranges and responses are indicated in table 4.1. The term "response type" used later will refer to the choice of one of the response functions listed in table 4.1.

Each calculation also required selection of an azimuth to describe the orientation of the cluster with respect to the source. DRC interprets 0 degrees such that the R axis of the fluence calculation is aligned along the X axis of the cluster, that is, toward the right of the illustration in figure 3.10. Positive azimuth values imply counterclockwise rotation of the cluster. For those who prefer to think of the source moving about the cluster, this would be equivalent to a source starting at the left of the illustration and proceeding in a clockwise direction. (The original DS86 study used an earlier version of VCS in which the source appeared to proceed in the counter-clockwise direction.) In the present study, 8 values of the azimuth starting at 0 and continuing in 45-degree increments were used. The use of 16 values is also feasible, and this would provide more diversity to a future study.

As noted, each DRC case was able to process the 4 response functions in one pass through the fluence file. It was also possible to stack data for the 8 azimuths in a single input stream. For each site, cases for each of 8 azimuths x 4 ranges x 2 fluence files were run, a total of 64. DRC required about 12 seconds for a single case using one response, but it was able to process the four responses together in about 30 seconds. Accordingly, a battery of 64 cases required about 32 minutes of system time on a Cray X-MP.

The output of the DRC cases was collected into a single "Raw DRC Output" file having the file name "FT12". The output from each DRC case carried internal text identifying the range and azimuth used in its production. It also identified each response type by the integer code indicated in table 4.1. The collection procedure inserted source and dose site identification corresponding to the fluence and adjoint history files fetched from storage.

The output for each DRC case categorized dose data for each response into the 7 "detector types" listed in table 4.2. These categories identified dose produced by neutrons penetrating the dwelling directly, gammas produced by neutron interaction with the structure, gammas produced by neutron interaction with the ground, and gammas penetrating the structure directly. In addition, sums over several of the categories were given.

Table 4.1 Ranges and Response Function Used in DRC

Nagasaki Ranges (Meters)	Hiroshima Ranges (Meters)
700	700
1000	1000
1500	1600
2000	2500

Response Functions

1	Total Fluence
2	Free In Air (FIA)
3	Small Intestine (SI)
4	Bone Marrow (BM)

Note:

Total fluence corresponds to a response function of unity in all energy groups. FIA, SI, and BM response functions are listed in table 2.3.

Table 4.2 Particle Detector Types Reported by DRC

1	Neutrons Entering Folding Surface Detected as Neutron
2	Gammas from Neutron Interaction with Dwelling
3	Gammas from Neutron Interaction with Ground
4	Gammas Entering Folding Surface as Gammas
5	All Gammas, i.e. 2 + 3 + 4
6	Gammas Entering Dwelling as Gammas, i.e. 3 + 4
7	Gammas Entering Dwelling as Neutrons, i.e. 1 + 2

The FT12 file for each site, then, contained doses ordered as follows:

> detector type (table 4.2),
> response type (table 4.1),
> azimuth (i.e. 0,...,315 degrees),
> range (table 4.1), then
> source type (prompt or delayed).

In addition, the exterior neutron and gamma fluences were included. The format of this file is specified in table 4.3. A brief example, taken from the Nagasaki calculation, is shown in appendix A.

4.2 THE TRANSMISSION FACTOR MATRIX

The files of raw DRC output were combined into a "transmission factor matrix" by an unpublished FORTRAN code called "TFX". TFX, described in appendix B, scans the FT12 file and calculates transmission factors as defined in table 4.4. The term "fluence type", to be used later, refers to the types of transmission factors indicated in the table. The resulting data are stored in a matrix ordered by:

> fluence type (table 4.4),
> response type (FIA, SI, BM),
> azimuth (i.e. 0,...,315 degrees),
> range (table 4.1), then
> site (table . . . 3.9).

Final ordering of the variables was done at this time. The sites were ordered as listed in table 3.9, and ranges as listed in table 4.1. The azimuths were reordered such that 180 degrees was stored first, proceeding upward through 0 and beyond. This was required because data correlating the transmission factors with the Dikewood data files assumed that 0 degrees implied a detonation location toward the east, or +X position, not the west, or -X, direction as assumed by DRC. The flat response type was dropped, and the remaining responses were stored as ordered in the DRC files. Fluence type was derived from the source type and detector type as indicated in table 4.4.

Each TFX case combined one FT12 file with the matrix produced by previous cases, if any, resulting in a storage file, FT13, that contained the composite matrix, together with a log indicating exactly which DRC jobs produced the files included in its matrix. The matrix contained, for one city, 4 fluence types x 3 response types x 8 azimuths x 4 ranges x 52 sites, for a total of 19,968 transmission factors.

It should be noted that the X position of sites 9-p and 9-s was originally 2665.3cm, and this was outside of the folding surface. Accordingly, those two sites were not used in the Nagasaki study. For Hiroshima, the sites were moved to 2509.0cm as listed in the table. The impact of excluding the two sites from the Nagasaki study was probably negligible.

It may also be of interest to note that the matrix structure is not tied to the particular set of data base parameters to which it is to be applied. Accordingly, its usefulness is not

Table 4.3 Raw DRC File Format

Identification of DRC Processing Job (a80)

--- Repeat Below for All Fluence Types, i.e. Prompt Or Delayed

Source ID (9x, 'source file= ', a6, ...)

Site ID (9x, 'morse file= ', a6, ...)

--- Repeat Below for All Ranges

--- Repeat Below for All Azimuths

Range, Azimuth (i4, 1x, i4, 'degree', ...)

--- Repeat Below for All Response Types

Response Type + Exterior Neutron & Gamma Response (i2, 1p,2e10.3)

Response by Detector (2x, 1p,7e10.3)

FSD by Detector (2x, 1p,7f10.3)

Note:

'...' in the formats indicates additional material not read in processing the file.

Table 4.4 Definitions of Transmission Factors by Fluence Type

For each response type, i.e. FIA, SI, or BM, the transmission factors are calculated according to detector type and source type as follows:

Transmission Factors Using the Prompt Fluence File

prompt neutron TF (FT=0)

$$= \frac{\text{neutron dose due to prompt neutron fluence (DT=1)}}{\text{unperturbed prompt neutron dose}}$$

dwelling gamma TF (FT=1)

$$= \frac{\text{gamma dose due to neutron interaction with cluster (DT=2)}}{\text{unperturbed prompt neutron dose}}$$

direct gamma TF (FT=2)

$$= \frac{\text{gamma dose due to prompt gamma fluence (DT=6)}}{\text{unperturbed prompt gamma dose}}$$

Transmission Factor Using the Delayed Fluence File

delayed gamma TF (FT=3)

$$= \frac{\text{gamma dose due to delayed gamma fluence (DT=6)}}{\text{unperturbed delayed gamma dose}}$$

Note
In each case, the numerator dose is evaluated at the specific dose site using one of the three response function types listed.

The unperturbed dose in the denominator is calculated using the FIA response function at the horizontal location of the dose site, at 1m above the ground, and without the presence of the cluster.

limited to this application. For example, a user could readily identify a given radiation environment with a site, cluster, orientation, and range, then obtaining the transmission factors for the various response types and fluence types from the matrix.

5. FINAL BINNING OF THE TRANSMISSION FACTORS

5.1 THE DIKEWOOD PARAMETER SET

In the original DS86 study, a set of nine of the parameters encoded in the data base was used to characterize the radiation environment. Similarly, the data base at Dikewood Division, Kaman Sciences, Albuquerque, that is the subject of this study contains numerous encoded parameters, and attempts have been made to create sets of DS86 parameters from them. An evaluation by Woolson found that approach unsatisfactory, however. [wo87] Instead, the present study chose a subset of eight Dikewood parameters to represent the radiation environment, and the transmission factors from the matrix discussed earlier were mapped into that set. The chosen parameters are listed in table 5.1.

The city parameter is known, of course, from the data used to generate the fluence file. Fluence type, response type, and ground range are known from the position in the matrix. Subject height and floor number are known from the site identity as indicated in table 3.9. As noted earlier, "p" in the table corresponds to a 30cm subject height, while "s" corresponds to 90cm. The subject position was determined by R.L.Stohler, Dikewood, by rotating the layout drawing to the appropriate angle and observing which third of the house contained the site. Subject positions are shown in table 5.2. The final parameter, frontal shield, required a computer code for its determination, as discussed below.

5.2 THE FRONTAL SHIELDING PARAMETER

The frontal shield parameter required a special computer code constructed from components of MORSE. [em75] This code selected each dose site in turn from table 3.9, positioned the adjoint source at that site, and shot a ray eastward at the elevation angle of the detonation. It then calculated and tabulated the number of wall, roof, and ceiling penetrations encountered between the site and the position of the detonation. Then, the cluster was rotated counter-clockwise, mapping the number of penetrations as a function of azimuth. The results are shown in appendix C. The appendix shows 16 azimuths starting with 0 degrees, but only 8 of these were used in the present calculation.

For binning purposes, it was necessary to convert the number of penetrations of each type into a single parameter. An earlier discussion indicated the following as a satisfactory formula:

$$\text{frontal shield} = \text{walls} + 1.12 \times \text{roofs} + 0.08 \times \text{ceilings} \quad .$$

Great precision in this matter was not required, of course, because the parameter was rounded to the nearest integer for bin selection.

Table 5.1 Dikewood Parameter Set Describing the Radiation Environment

	Name	Description
CY	city	1=Hiroshima, 2=Nagasaki
FT	fluence type	0=prompt neutrons 1=gammas resulting from interaction of prompt neutrons with the cluster materials 2=gammas entering the cluster as prompt gammas 3=delayed gammas
RT	response type	0=free-in-air, 1=small intestine, 2=bone marrow
GR	ground range	meters from hypocenter (the point at ground level directly below the point of weapon detonation)
SH	subject height	centimeters above floor, 30 or 90
FN	floor number	0=outside 1=first floor of a multistory house 2=first floor of a one-story house 3=second floor of a multistory house
SP	subject position	1=front third of house, 2=middle third, 3=rear third
FS	frontal shield	number of walls in line-of-sight to detonation (0=directly exposed, maximum of 3)

Table 5.2 Subject Position for Interior Dose Sites in Residential Cluster

4a/c	3	3	3	2	1	1	1	2
4a/e	2	2	2	2	2	2	2	2
4a/g	1	1	1	2	3	3	3	2
4a/j	1	1	1	2	3	3	3	2
4a/k	1	1	2	3	3	3	2	1
5b/c	3	3	3	2	1	1	1	2
5b/d	2	3	3	3	2	1	1	1
5b/e	3	3	3	2	1	1	1	2
5b/f	1	1	2	3	3	3	2	1
5b/g	2	2	2	2	2	2	2	2
5b/i	1	1	1	2	3	3	3	2
5b/j	2	1	1	1	2	3	3	3
5b/r	2	2	2	2	2	2	2	2
5b/t	1	1	1	2	3	3	3	2
5b/v	3	2	1	1	1	2	3	3
6b/g	2	2	2	2	2	2	2	2
2a/c	1	1	1	2	3	3	3	2
2a/e	2	2	2	2	2	2	2	2
2a/j	3	3	3	2	1	1	1	2
2a/k	3	3	2	1	1	1	2	3
3a/g	2	3	3	3	2	1	1	1

Note

The columns correspond to azimuthal rotation of the source position, starting at the righthand side of the cluster and proceeding clockwise in 45-degree increments. (Clockwise source rotation corresponds to counter-clockwise cluster rotation.)

5.3 BINNING THE DATA

In the final processing step, the TFX code selected each transmission factor in the matrix, determined the combination of Dikewood parameters that corresponded to the matrix position, and added the value to the appropriate "bin", i.e. the collection of transmission factors corresponding to each combination of Dikewood parameters. The average transmission factor for each bin, the number of factors collected in each bin, and the fractional standard deviation (FSD) for the bin were calculated. One set of binned data was produced for each city. The average transmission factors are shown in appendix D. A formatted edit of selected portions of the data is given in appendix E.

Each transmission factor matrix has room for 4 fluence types x 3 response types x 8 azimuths x 4 ranges x 52 sites, or a total of 19,968 transmission factors. The binned data have 4 fluence types x 3 response types x 4 ground ranges x 2 subject heights x 4 floor numbers x 3 subject positions x 4 frontal shield values, or 4608 bins. Because all exterior sites have a subject position of 1, however, the number of bins that can have values is 3840. Thus, an average of 5.2 transmission factors were combined in each bin.

Some bins have no transmission factor values, however. In general, most vacant bins correspond to special circumstances. At the closer ground ranges, for example, most line-of-sight paths from a second-story location to the weapon location penetrate a roof or wall. Also, a site near the rear of a dwelling has relatively little chance of finding an unobstructed view of the weapon location. A few bins are empty by chance, of course, in cases where no values from the transmission factor matrix are mapped into them.

The FSD values are a good measure of the accuracy with which the Dikewood parameters describe the radiation environment. When the binning was done, the FSD values accumulated for each bin were combined into an overall average for each fluence type and response type. The overall averages are given in table 5.3. Bins with no transmission factors were not used in the average, of course. The FSD's range between 5% and 25%, with little dependence on response type. The FSD for the delayed gamma fluence type, often the most important contributor, is about 19% for the FIA response type and 20% for the internal organs.

Some transmission factors will be found to be greater than 1.0. The factors for fluence type = 1 can be significantly larger than 1.0 due to the fact that a low-energy neutron with little dose potential can generate a high-energy gamma. In addition, as noted earlier, the exterior dose is evaluated at a position 1m above the ground, while the dose site may be at a significantly different height. Finally, the interior dose is subject to a small amount of random error due to the Monte Carlo process used to generate it.

Table 5.3 Average Fractional Standard Deviation (FSD) by Fluence Type and Response Type

Nagasaki

	Fluence Type			
Response Type	1	2	3	4
FIA	0.102	0.050	0.241	0.190
SI	0.110	0.049	0.254	0.204
BM	0.106	0.049	0.252	0.202

Hiroshima

	Fluence Type			
Response Type	1	2	3	4
FIA	0.115	0.068	0.228	0.186
SI	0.135	0.068	0.239	0.199
BM	0.129	0.068	0.237	0.197

6. EVALUATION OF RESULTS

The bin FSD's ranged from 5% to 25%, with the very important delayed gamma value at 19%-20%, and this met expectations very well. The DS86 study estimated about 20% uncertainty due to the parameterization, and our data indicate that the Dikewood parameters are as successful as those of the earlier study.

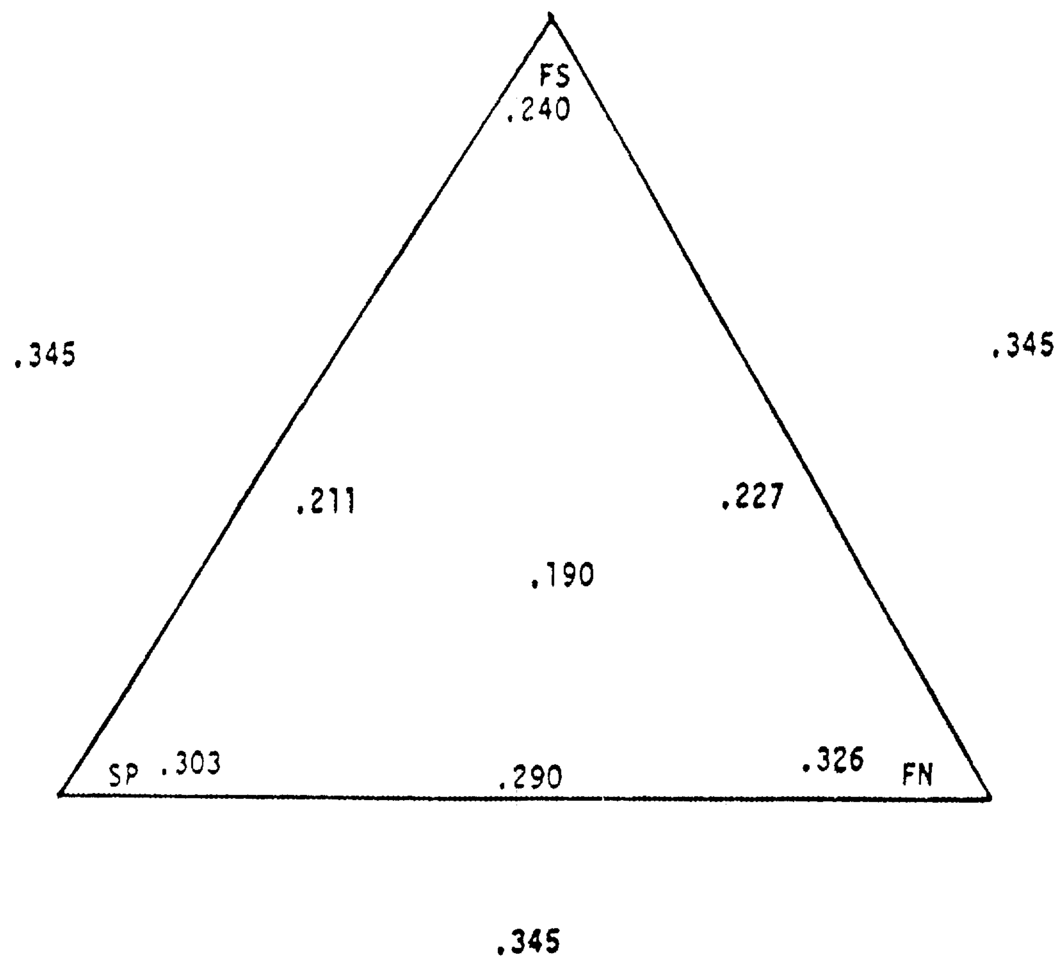
The average bin FSD's can also be used as a test of the relative effectiveness of certain parameters. For the Nagasaki city and delayed gamma fluence type, average bin FSD's were evaluated with frontal shielding (FS), subject position (SP), and floor number (FN) having their normal values, and then with the effect of each parameter, with each combination of two parameters, and finally, with all parameters removed. Figure 6.1 depicts the results in an influence diagram. The numbers at the outside of the triangle indicate an average FSD of .345 with none of the three parameters used. At each vertex, the values of FSD for each parameter, used alone, show that FS is the most effective in reducing FSD, followed by SP, and then FN. Along the legs, the binary combinations of two parameters show that each is compatible with the others in reducing FSD and that the strength ranking is maintained. At the center of the diagram, the combination of the three parameters is seen to reduce the FSD to .190, lower than any of the other combinations.

Certain trends may be noted, although differences much less than the FSD values must be regarded skeptically. At the longer ranges, the transmission factors decrease with increasing values of the FS and SP parameters, as they should. The effects of these parameters interact, so that a large value of one dilutes the influence of the other. In other words, the frontal shielding is not important at the rear of the house, where the radiation comes predominantly through the roof and rear openings, and the subject position is not important for large values of frontal shielding for similar reasons. At shorter ranges, neither of these parameters are as influential, since more of the radiation comes directly through the roof.

It may be noted that the present results do not count interior walls in determining the frontal shield, although it is possible to do so. There are several reasons for excluding them. First, the interior walls tend to give less-complete protection as compared to exterior walls. Some of the interior walls extend for only a short distance outward from the exterior walls. Also, the effect of protection by interior objects and construction is accounted for in the subject position parameter, and it is not desirable to have the two parameters overlapping strongly. Finally, excluding the interior walls corresponds more closely to the procedures used in preparing the data base to which they are to be applied.

Bins found empty due to physical considerations such as those discussed earlier should not be a cause for alarm, since it is unlikely that cases in the data base would correspond to them. A few bins may be empty due to chance failure of the transmission factor matrix to include such a combination, however. These gaps could be filled in by interpolating neighboring values. The use of 16 azimuthal values would probably fill in some of the empty bins, as would the choice of more dose sites. Preliminary application of the data has been made by Stohler, [st91] and the gaps did not prove to be an important obstacle.

Figure 6.1 The effectiveness of parameters FS, SP, and FN in reducing the average bin FSD for transmission factors



In the case of Nagasaki, the altitude of the dwelling proved to be a more serious concern, and approximate corrections were required in Stohler's work. In a future study, altitude might well be included as a parameter in the Nagasaki data, although it would add to the cost and complexity. The dose responses used in this study were appropriate only to adult persons. Since the doses to internal organs depend upon age and body size, it would be desirable to include those effects by calculating response functions for different manikins. That capability still exists at Oak Ridge, although several months of effort would be required to apply it.

7. CONCLUDING COMMENTS

The objective was to obtain transmission factors in a manner consistent with the DS86 method and to express them in a form tailored to the Dikewood data base. The cost was to be minimized by using simplifications suggested by the DS86 results. These things were accomplished. The transmission factor format provides tangible results that can be applied easily by any microcomputer. The data are readily inspected and evaluated. Minor changes in the external fluence are no problem, since the factors can readily be applied to new dose values, so long as the energy spectrum and directional distribution of the fluence do not change markedly. The transmission factor matrix, from which the parameters are binned into the Dikewood format, is not tied to any particular parameter set, and so it could have application to other data bases.

The most serious limitations of the data are that only two internal organs can be evaluated, and that the data apply only to adults. In addition, the Nagasaki data might well have accounted for altitude, and this must be dealt with by approximate means in applying the data.

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APPENDIX A

Processing with the Vehicle Code System (VCS), Version 2.0.

VERSIONS OF VCS AND RELATED CODES

In 1974, Oak Ridge National Laboratory reported a code system, the Vehicle Code System (VCS), that calculated the transport of radiation into complex objects situated in an air/ground environment. [rh74, rh74a] VCS performed this task by folding forward fluences generated with the DOT discrete ordinates transport code [rh82] with adjoint boundary crossings from a history file calculated by a special version of the MORSE Monte Carlo code. [em75] The fluences from DOT were prepared for the folding by a code called VISA, and the actual folding was done by DRC. The initial version of this system was released to the public in 1975, while the most recent update was in 1984. [cc75]

Since the release of VCS, improvements have been made to several components. Modifications to MORSE allow it treat special difficulties that are likely to occur in this application more gracefully. In addition, it now has a special feature to prevent the "fat particle problem" that can occur in adjoint calculations, a situation where an adjoint "particle" may tend to scatter endlessly within a single energy group rather than outward to another group. The repair, the "in-group biasing" feature, artificially forces the particle to scatter out and adjusts the weight appropriately.

The DRC component has seen several rounds of upgrading to make it more versatile and reliable. The version used in this study has the capability to process several response functions in a single case, saving a significant portion of the processing cost. In addition, a special feature causes it to write a file containing the data necessary for the transmission factor calculation.

The DOT code was replaced with the newer DORT, [rh88] and VISA was updated. With these changes, the code system is informally designated VCS 2.0. This configuration was assembled for the special purpose of performing the calculations distributed here, and there is no intent to qualify it for general use.

The MASH code system [jo92] includes all of these improvements except the special output file in DRC. MASH, prepared especially for the analysis of military vehicles, replaces the "COMBGEOM" geometric description used in MORSE with an alternate "GIFT" procedure. GIFT is somewhat more flexible than COMBGEOM, but it tends to use much more computer time on many problems. Accordingly, VCS 2.0 is the appropriate system for the present study.

An important limitation of the VCS or MASH method is that the folding surface, for rigorously accurate results, must be placed such that the inward fluence on the surface is not perturbed by the presence of the object being studied. This can be satisfied in two ways. First, the enclosed volume may be made so large that the likeihood of particles reflecting from the object, scattering in air, and returning to the object would be small. In the case of air, this might require a cylinder 100m or more in radius.

There are problems with such a large surface. First, the adjoint Monte Carlo procedure is not ideally suited to calculating histories in such a large environment. The running time is likely to be long and the accuracy less than desired. In addition, DRC assumes that the fluence on the folding surface is dependent on height and direction, but not on the lateral position around the surface. For a large cylinder, this can lead to unacceptable errors.

Alternately, the folding surface can be made so small that a particle reflecting from the object being studied and escaping the enclosed volume would not likely scatter into the volume again. This approach was used in the present calculations.

Slater has developed a new component, DRC2, for use with VCS or MASH. [sl92] This code performs the task of DRC, while accounting for the fluence variation over the folding surface. Slater examined a number of test problems, demonstrating the inaccuracy found with very large enclosures unless the proper fluence variation is used. The effect was not so strong as one might expect, however. Although DRC2 was not used in the present study, it might be a valuable addition to a future study if the additional detail does not increase the cost unacceptably.

PROCEDURE FILES

As noted earlier, a number of procedure files were used to perform the computer operations required in the study, and it may be of interest to examine certain of these. Table A.1 shows the JVCS program that was the primary controller for the processing of the MORSE and DRC work required for the Nagasaki calculations. JVCS is written in the COSMOS control language used with the CTSS system on the Cray computers at Los Alamos. Briefly, this controller fetches programs and data files from memory and modifies the MORSE input to reflect the number of batches required, as well as the number of histories per batch, the adjoint source location, and the site identification. The MORSE calculation (called mash300 here) follows.

Next, a short diagnostic analysis run is provided by the FDRC.1 procedure and the TFX code, described in a later section. Finally, the FDRC control procedure runs a full set of DRC cases, and TFX analyzes them. FDRC is written in the FORTRAN Command Language (FCL) used at Los Alamos. The procedure selects combinations of the two fluence files and four ranges, modifies the DRC input data to reflect those choices, processes the DRC case, and stacks the output onto the results file, FT12, with appropriate header records for identification. FDRC is quite similar to FDRCX, table A.2, except that FDRC uses ground ranges appropriate to Nagasaki. The FDRC.1 procedure is similar to FDRC, except that FDRC.1 uses only half as many fluence files, half as many ranges, and half as many azimuths. The resulting brief output files were useful in evaluating the results of the early runs.

After all of the MORSE and DRC jobs had been processed, it was required to combine their results into a single entity using TFX. The FSUM procedure illustrated in table A.3 performs this job. FSUM selects sites from a list, fetches the DRC output files, combines them into a composite transmission factor matrix, and then bins them into the final results file. The FSUM illustrated has been modified for use at Hiroshima. The differences in the Nagasaki processing were that sites 9s and 9p were not used, and that the files were fetched from a different storage place.

The Hiroshima processing re-used the MORSE output files from the previous runs, so new procedures were required. The COSMOS control program JLB, table A.4, fetches the programs and data files needed for the DRC processing, modifies the FCL procedure FLB, table A.5, as needed, and invokes FLB. FLB procedure selects sites within a range specified by JLB, fetches each of the MORSE history files in turn, and invokes the FDRCX procedure of table A.2 to execute the DRC cases and stack their results. When all DRC cases have been processed, FSUM combines them into the composite output as before.

Examples of the TFX output are given in following sections. An example of the stacked DRC output files created on FT12.1 during the Nagasaki analysis is shown in table A.6. This example was produced by the FDRC.1 procedure. The full FT12 used in the analysis had a similar structure, but it contained 8 times as much data. An FT12 file was produced for each site in each city.

Table A.1 The JVCS Control Program in the COSMOS Language

```
*deck       jvcs
*select printlog=jlog,ttyecho=y
        savefiles=/dos/vcs/dump
        savelog=/dos/vcs/dump
*let node='/dos/vcs/pl/4aes'
*/
*/oto  lib
*mass
 default  wait=on waitime=99
 get  dir=/dos/vcs  yvcs  ft08msh  ft40  ft43
 get  dir=/dos/vcs  yvcsin
*/
*lib:  lib yvcs
 x  mash300 drc tfx
*lib yvcsin
 x  ft13  fdrc  fdrc.1
 x  xinmsh xindrc xindrc.1 xintfx
*/
*interrupt on deadstart     to end
           on checkpoint    to end
           on timeup        to end
           on jccerror      to end
           on softwareerror to end
           on hardwareerror to end
*/
*file  endfile=eof,name=$
 dw90 cluster
 $$ 2000 3000  100    1   46   23   46   69    0    1  120    8    0
 $$    0   69    1    0
 ** 1.0   1.0-05   1.0+04   0.0   2.2+05
 ** 447.8  1836.2  90.00  0.0   0.0   0.0   0.0
4a/e s:  dw90 cluster
eof
*/
*/ - - - - - replace 1st 5 & label lines of mash input;  run mash
*fred xinmsh
 nv; dl1,5;  cfb1,5;$;  t1,5;
 tpa;4a/e;  dl;  cfa6;$;  t;  wr;ft05msh;
*mash300
*/
*/ - - - - - short diagnostic drc/tfx;  output to otfx.1
*drc1:  fc1  fdrc.1
*tfx1:  fred  xintfx
 sv;  rp2;-13 14;-13 00;  wr;xtfx.1;
*tfx  f5=xtfx.1,f6=otfx.1
*switch  ft12  ft12.1  dst.
*/oto
*/
*/ - - - - - full drc/tfx;  output to otfx
```

```
*drc:  fcl  fdrc
*tfx:  tfx  f5=xintfx,f6=otfx
*/
*/ - - - - - collect and save output
*select printlog=jlog
*destroy pout
*fred pout
 cfa;jlog;  cfa;ftl2;
 nv;  bc*; ;  sv;
 cfa;ft06msh;  cfa;otfx;
*/
*end:
*interrupt off for softwareerror
*select printlog=jlog
*mass
 default  wait=on waitime=99  dir=\node\
 add      -
 store    jlog pout  ft05msh  ft06msh  ft24msh
 store    ftl2  ftl2.1  otfx  otfx.1  yvcsin
*goto
*/
*/ - - - - - full dump;  not used
*route *
 sd check=off talk=on wait=on waitime=99
 add  \node\/dump
 root \node\/dump
sts -
*/
*/prod  su jvcs  t=15 sh=nw pr=10 f=y
*/-------------------------------------------------------------
```

Table A.2 The FDRCX Program in Fortran Control Language

```
! - - - - - fcl procedure to run stacked drc cases
log -rewind; set  logdisp=$logfdrc  logecho=yes  ttyecho=e   !yes/e
sourcefile = 'ft40              ft43'
range      = '0700  1000  1600  2500'
inc = 1
nsource    = 2
nrange     = 4

! - - - - - add run id to output file, ft12
destroy ft12;  fred ft12;  msg  sv
msg  cfa2,2,]:jlog:  end:

      do isource=1,nsource
! - - - - - set up source file and set id into output file
source = sourcefile(isource)
fred  ft12;  msg nv;
msg al]:         source file= {source}:.:  end:
destroy ft15drc;  copy  {source}  ft15drc

    do irange=1,nrange,inc
! - - - - - identify morse file and set range into input file
r = range(irange)
fred ft05;  msg wr:ft05drc:
msg rp*:rrrr:{r}:  end:
write ($*) '-----> '//' '//source//' '//r//'m'

! - - - - - run drc for all azimuths
  drc

! - - - - - add drc output to ft12
fred  ft06drc;  msg  tpa:vehicle escape:  wf.,.:$:
msg  o:$:  dc,,1,32:  bc:          morse  file= :
msg  o:ft12:  cfa,,]:$:  cfa:ft11drc:  end:

log  $logxdrc
    enddo
      enddo

write ($*) 'all done;  drc results are on ft12'
```

Table A.3 The FSUM Control Program in the Fortran Control Language

```
! - - - - - fcl: combines drc output files and runs tfx
..log -rewind; set  logdisp=$log  ttyecho=yes  logecho=yes

nodes = ' 2acp 2aep 2ajp 2akp 3agp 4acp 4aep 4agp 4ajp 4akp 5bcp 5bdp &
 5bep 5bfp 5bgp 5bip 5bjp 5brp 5btp 5bvp 6bgp 15p 17p 5p 19p          &
          2acs 2aes 2ajs 2aks 3ags 4acs 4aes 4ags 4ajs 4aks 5bcs 5bds &
 5bes 5bfs 5bgs 5bis 5bjs 5brs 5bts 5bvs 6bgs 15s 17s 5s 19s 9s 9p    '
fred xtfxsum
msg  sv:  rp2:+:-:  end:

!goto tfx
do inode=1,52
i = nodes(inode)
destroy ftl2
 cfs get /dos/vcs/lb/drc/{i}/ftl2
!cfs get /dos/vcs/xfm/lillie/{i}/ftl2
exist = qqexist('ftl2')
if (exist.ne.1) stop 777

tfx:
tfx f5=xtfxsum,f6=otfx
    if(inode.eq.1) then
fred xtfxsum
msg  sv:  rp2:-:+:  end:
    endif
enddo

outloop:
stop
```

Table A.4 The JLB Program in the COSMOS Language

```
*deck jlb
*select printlog=jlog,ttyecho=y
        savelog=/dos/vcs/dump
*/      savefiles=/dos/vcs/dump
*/
*/oto  fred
*/
*cfs
 get  dir=/dos/vcs  yvcs
 get  dir=/dos/vcs/lb  ft40  ft43  ylbin
*/
*lib yvcs
 x  drc
*lib:
*lib ylbin
 x  flb  fdrcx  xindrc  xindrc.1  drcx
*/
*interrupt on deadstart     to end
           on checkpoint    to end
           on timeup        to end
           on jccerror      to end
           on softwareerror to end
           on hardwareerror to end
*fred:
*let  node='/dos/vcs/lb/drc/j51to52
*fred  flb
rp*;setnode;/dos/vcs/lb/drc/p51to52;
rp*;limits;51,52
wr;xflb;
*fred  fdrcx
nv;  wr;fdrcx.1;  dl5,1;  al
inc = 3
nsource = 1
.
*/
*/ - - - - - fcl controller program
*fcl  xflb
*/
*end:
*select  printlog=jlog
*cfs
dir=\node\
add -
store  jlog $logflb
*/
*switch jlog $jlb
*give $jlb 605001
*/prod  su jlb  t=15  (sh=nw f=y)  pr=10
```

Table A.5 The FLB Program in the Fortran Control Language

```
! - - - - - fcl: combines drc output files and runs tfx
..log -rewind; set  logdisp=$logflb  logecho=yes  ttyecho=yes !yes/e

nodes = ' 2acp 2aep 2ajp 2akp 3agp 4acp 4aep 4agp 4ajp 4akp 5bcp 5bdp &
 5bep 5bfp 5bgp 5bip 5bjp 5brp 5btp 5bvp 6bgp 15p 17p 5p 19p         &
          2acs 2aes 2ajs 2aks 3ags 4acs 4aes 4ags 4ajs 4aks 5bcs 5bds &
 5bes 5bfs 5bgs 5bis 5bjs 5brs 5bts 5bvs 6bgs 15s 17s 5s 19s 9s 9p    '
open (6, file='ft06', status='new')

do inode=limits
node = nodes(inode)
set  ttyecho=e

destroy stop
cfs
 msg  get /dos/vcs/lb/drc/stop
 msg  end
exist = qqexist('stop')
if(exist.eq.1) stop 777

! - - - - - select node and fetch morse history file

destroy ft24msh
cfs
 msg  get  dir=/dos/vcs/xfm/lillie/(node)  ft24msh
 msg  end
exist = qqexist('ft24msh')
if (exist.ne.1) stop 777

! - - - - - short diagnostic set of drc
!destroy ft05;  copy xindrc.1 ft05
!  fcl  fdrcx.1

! - - - - - full production  set of drc
destroy ft05;  copy xindrc   ft05
  fcl  fdrcx

! - - - - - save results for this node
destroy  pout
log  $logxlb
fred  pout
msg  al:1:.:  o:$logxlb
msg  nv:  bc*: :  sv:  wr:$flb:  o:pout:  cfa,,]:$flb
msg  al:1:.:  o:ft05
msg  nv:  bc*: :  sv:  wr:$flb:  o:pout:  cfa,,]:$flb
msg  al:1:.:  o:ft12
msg  nv:  bc*: :  sv:  wr:$flb:  o:pout:  cfa,,]:$flb
msg  end

cfs
```

```
 msg  dir=setnode;  msg  add -
 msg  dir={node};   msg  add -
 msg  store $logxlb pout ft12
 msg  end

write (6, eol='no') node
set  ttyecho=yes
write ($*) node//' completed <-----'
enddo

write (6) 'normal completion of fcl controller; see $log & ft06'
close (6)
```

Table A.6 Brief Composite DRC Results File from the FDRC.1 Procedure

Note
The first two lines are combined into one in the file. They have been split here due to line length limitations.

```
19:30:51 000:00.010 508/03/90 lslcc cosmos 4.3 one 605019 xxx *** +cosm5e0 ***
c2sfba j2acp *** page 1
         source file= ft40
         morse  file= 2a/c p:  dw90 cluster
0700m 000degrees -- drc -- flat, fia, si, bm
 1 1.320e+11 3.328e+12
   4.953e+10 2.583e+10 4.517e+08 1.469e+12 1.496e+12 1.470e+12 7.536e+10
       0.010     0.010     0.101     0.010     0.010     0.010     0.007
 2 8.010e+01 1.310e+03
   3.980e+01 3.248e+01 5.324e-01 5.946e+02 6.277e+02 5.952e+02 7.228e+01
       0.011     0.014     0.158     0.019     0.018     0.019     0.009
 3 2.653e-01 8.992e+00
   1.153e-01 2.443e-01 4.023e-03 3.953e+00 4.201e+00 3.957e+00 3.596e-01
       0.012     0.014     0.164     0.020     0.019     0.020     0.011
 4 3.828e-01 9.985e+00
   1.729e-01 2.693e-01 4.438e-03 4.397e+00 4.670e+00 4.401e+00 4.422e-01
       0.011     0.014     0.163     0.020     0.019     0.020     0.010
0700m 090degrees -- drc -- flat, fia, si, bm
 1 1.320e+11 3.328e+12
   4.697e+10 2.501e+10 4.119e+08 1.373e+12 1.398e+12 1.373e+12 7.198e+10
       0.010     0.010     0.104     0.010     0.010     0.010     0.008
 2 8.010e+01 1.310e+03
   3.777e+01 3.134e+01 4.832e-01 5.417e+02 5.735e+02 5.422e+02 6.911e+01
       0.011     0.014     0.164     0.021     0.019     0.021     0.010
 3 2.653e-01 8.992e+00
   1.098e-01 2.356e-01 3.653e-03 3.603e+00 3.842e+00 3.607e+00 3.454e-01
       0.012     0.014     0.171     0.023     0.021     0.023     0.011
 4 3.828e-01 9.985e+00
   1.646e-01 2.597e-01 4.030e-03 4.011e+00 4.274e+00 4.015e+00 4.243e-01
       0.012     0.014     0.170     0.022     0.021     0.022     0.011
0700m 180degrees -- drc -- flat, fia, si, bm
 1 1.320e+11 3.328e+12
   5.116e+10 2.650e+10 4.503e+08 1.477e+12 1.504e+12 1.478e+12 7.766e+10
       0.009     0.009     0.101     0.011     0.010     0.011     0.007
 2 8.010e+01 1.310e+03
   4.037e+01 3.319e+01 5.149e-01 5.586e+02 5.923e+02 5.591e+02 7.357e+01
       0.010     0.013     0.160     0.018     0.017     0.018     0.008
 3 2.653e-01 8.992e+00
   1.155e-01 2.496e-01 3.887e-03 3.686e+00 3.940e+00 3.690e+00 3.651e-01
       0.010     0.014     0.167     0.019     0.018     0.019     0.010
 4 3.828e-01 9.985e+00
   1.739e-01 2.751e-01 4.287e-03 4.105e+00 4.385e+00 4.109e+00 4.491e-01
       0.010     0.014     0.166     0.019     0.018     0.019     0.009
0700m 270degrees -- drc -- flat, fia, si, bm
 1 1.320e+11 3.328e+12
```

```
   5.543e+10 2.776e+10 5.200e+08 1.807e+12 1.835e+12 1.808e+12 8.319e+10
       0.009     0.009     0.091     0.009     0.009     0.009     0.006
 2 8.010e+01 1.310e+03
   4.519e+01 3.463e+01 5.974e-01 8.481e+02 8.833e+02 8.487e+02 7.982e+01
       0.009     0.013     0.150     0.016     0.016     0.016     0.007
 3 2.653e-01 8.992e+00
   1.295e-01 2.602e-01 4.494e-03 5.725e+00 5.989e+00 5.729e+00 3.897e-01
       0.010     0.013     0.157     0.018     0.017     0.018     0.009
 4 3.828e-01 9.985e+00
   1.943e-01 2.869e-01 4.957e-03 6.360e+00 6.652e+00 6.365e+00 4.812e-01
       0.009     0.013     0.156     0.018     0.017     0.018     0.008
         morse  file= 2a/c p:  dw90 cluster
2000m 000degrees -- drc -- flat, fia, si, bm
 1 4.348e+07 1.405e+10
   1.713e+07 8.669e+06 1.488e+05 5.287e+09 5.295e+09 5.287e+09 2.580e+07
       0.009     0.009     0.095     0.014     0.014     0.014     0.007
 2 3.290e-02 7.786e+00
   1.641e-02 1.059e-02 1.710e-04 2.184e+00 2.194e+00 2.184e+00 2.700e-02
       0.011     0.013     0.153     0.029     0.029     0.029     0.009
 3 1.106e-04 5.522e-02
   4.883e-05 7.947e-05 1.286e-06 1.459e-02 1.467e-02 1.459e-02 1.283e-04
       0.013     0.014     0.160     0.032     0.032     0.032     0.010
 4 1.587e-04 6.116e-02
   7.266e-05 8.761e-05 1.419e-06 1.624e-02 1.633e-02 1.624e-02 1.603e-04
       0.012     0.013     0.159     0.031     0.031     0.031     0.009
2000m 090degrees -- drc -- flat, fia, si, bm
 1 4.348e+07 1.405e+10
   1.609e+07 8.358e+06 1.355e+05 4.525e+09 4.533e+09 4.525e+09 2.445e+07
       0.010     0.009     0.100     0.012     0.012     0.012     0.007
 2 3.290e-02 7.786e+00
   1.490e-02 1.021e-02 1.550e-04 1.506e+00 1.516e+00 1.506e+00 2.511e-02
       0.011     0.013     0.160     0.030     0.030     0.030     0.009
 3 1.106e-04 5.522e-02
   4.428e-05 7.657e-05 1.167e-06 9.813e-03 9.890e-03 9.814e-03 1.208e-04
       0.014     0.014     0.167     0.035     0.035     0.035     0.011
 4 1.587e-04 6.116e-02
   6.594e-05 8.443e-05 1.288e-06 1.096e-02 1.105e-02 1.096e-02 1.504e-04
       0.013     0.014     0.166     0.034     0.034     0.034     0.010
2000m 180degrees -- drc -- flat, fia, si, bm
 1 4.348e+07 1.405e+10
   1.786e+07 8.969e+06 1.510e+05 5.957e+09 5.966e+09 5.957e+09 2.683e+07
       0.009     0.009     0.092     0.013     0.013     0.013     0.007
 2 3.290e-02 7.786e+00
   1.703e-02 1.088e-02 1.670e-04 2.727e+00 2.738e+00 2.727e+00 2.791e-02
       0.011     0.013     0.154     0.031     0.031     0.031     0.009
 3 1.106e-04 5.522e-02
   5.044e-05 8.158e-05 1.255e-06 1.839e-02 1.847e-02 1.839e-02 1.320e-04
       0.013     0.013     0.162     0.034     0.034     0.034     0.010
 4 1.587e-04 6.116e-02
   7.516e-05 8.996e-05 1.385e-06 2.045e-02 2.054e-02 2.045e-02 1.651e-04
       0.012     0.013     0.161     0.034     0.034     0.034     0.009
2000m 270degrees -- drc -- flat, fia, si, bm
 1 4.348e+07 1.405e+10
   1.949e+07 9.453e+06 1.921e+05 8.222e+09 8.231e+09 8.222e+09 2.895e+07
```

	0.008	0.008	0.080	0.012	0.012	0.012	0.006
2	3.290e-02	7.786e+00					
	1.944e-02	1.137e-02	2.042e-04	5.318e+00	5.329e+00	5.318e+00	3.081e-02
	0.009	0.012	0.138	0.026	0.026	0.026	0.007
3	1.106e-04	5.522e-02					
	5.826e-05	8.516e-05	1.522e-06	3.721e-02	3.730e-02	3.721e-02	1.434e-04
	0.011	0.013	0.146	0.028	0.028	0.028	0.008
4	1.587e-04	6.116e-02					
	8.616e-05	9.391e-05	1.679e-06	4.123e-02	4.133e-02	4.123e-02	1.801e-04
	0.010	0.012	0.145	0.028	0.028	0.028	0.008

APPENDIX B

The Transmission Factor Exchange Code (TFX)

The TFX code has two general tasks:

- combine raw DRC data files (FT12) into a composite transmission function matrix, keeping a log of the files combined, and

- bin the transfer function data according to the parameter set used by the intended data base.

TFX was constructed for this study alone, and there is no intent to qualify it for general use. Accordingly, it is quite limited in convenience features. The code is listed in table B.1, and the input data are specified in table B.2. A discussion of the major program units follows.

MAIN PROGRAM -- reads and checks input, calls subroutines.

INSITE -- reads and edits site and floor designations. Reads and edits frontal shielding data in same order as site designations. Converts ceilings and roofs to wall equivalents.

INPOSN -- reads and edits site designation and subject position data in random order. Stores data according to previous site designation ordering.

INDOSE -- reads pre-existing transfer function matrix, if any. Reads data from DRC data file. Reads arrays used to match labels in DRC file. Identifies matrix position by matching DRC labels with array entries. Calculates transmission factors. Stores in appropriate matrix position. Keeps log of DRC files added to matrix. Writes matrix and log to output file. Edits matrix.

CALTF -- reads transmission factor matrix. Matches site position with output bin position. Accumulates average transmission factors for each bin, number of matrix entries averaged in each bin, and fractional standard deviation (FSD) for each bin. Writes binned data to file. Provides partial edit.

The logic required to calculate the transmission factor matrix and to relate matrix entries to output bins has been discussed in previous sections.

Table B.1 The Transmission Factor Code, TFX

```
c note:  unresolved calls are to be satisfied from the dort source
c        files or from the lanl cftlib subroutine library.
c
c        comments revised 21 nov 91.
c
c - - - - - transmission factor exchange code (tfx),
c           w.a.rhoades, oak ridge national lab, april, 1990.
c
c  general task:  read files of:
c                 frontal shield wall, roof, and ceiling penetrations
c                   by azimuth, ground range, and dose site
c                 floor number by dose site (0=outside)
c                 subject position by azimuth and dose site
c                 exterior dose by fluence type, dose type, azimuth,
c                   range, site, and source type
c                 interior dose by detector type, dose type, azimuth,
c                   range, site, and source type
c
c                 and produce transmission factor data for:
c                 subject position (sp), frontal shield (fs),
c                 subject height (sh), floor number (fn),
c                 fluence type (ft), ground range (gr),
c                 and dose type (dt).
c
      program tfx
      dimension lcom(11), limcom(11)
      equivalence (lcom(1),nsources)
      data limcom   /        4,    100,      4,       16,    8
     1,                    4,     7,      9,   99,    99,    99 /
      common /comtfc/ nsources, nsites, nranges, ndegrees, ndeg
     1,               nresp, ndet, nedit, ndin, ndou, ndtf
     2, throof, thceil
     3, nin, nou, nflu, ndos
      character*6 lsites
      common /char  / lsites(100)
      common /comn  / nfloor(100), nsp(1 600)
     1, nwp(12 800), nrp(12 800), ncp(12 800), fs(12 800)
     1, rtf(51 200), ntf(4 608), btf(4 608), stf(4 608)
     2, extn(4), extg(4), resp(28), fsd(28)
     3, lsource(4), lrange(8), ldegree(16), afsd(12)
c - - - - - warning: system must set common to 0.
c
      call link( "f5=ft05, f6=ft06
     1,unit12=(ft12,open), unit13=(ft13,open), unit14=(ft14,open,create)
     2, unit5=(f5,open), unit6=(f6,create,text) // " )
      nin = 5
      nou = 6
      ndin= 12
      ndou= 13
      nflu= 4
```

```
      ndos= 3
      call comfix(0)
      call dtfrd( nsources, -11)
      call dtfrd( throof,  2)
      do 11 i=1,11
   11 if(iabs(lcom(i)).gt.limcom(i)) stop 11
c
c - - - - - - read dose sites, floor number, frontal shield:
      call       insite( lsites, nfloor, nwp, nrp, ncp, fs)
c
c - - - - - - read subject position data
      call       inposn( lsites, nsp, nsp8)
c
c - - - - - - read dose and fsd data; form tf storage file
        call       indose( lsites, lsource, lrange, ldegree
     2, extn, extg, resp, fsd, rtf)
c
c - - - - - - bin final tf data
      if(ndtf.gt.0)
     1  call       caltf( lsites, nfloor, nsp, fs, resp, fsd, rtf
     2, ntf, btf, stf, afsd)
c
      stop
      end


      subroutine insite( lsites, nfloor, nwp, nrp, ncp, fs )
      dimension lsites(*), nfloor(*)
     1, nwp(ndegrees,nranges,nsites), nrp(ndegrees,nranges,nsites)
     2, ncp(ndegrees,nranges,nsites),  fs(ndeg,    nranges,nsites)
      common /comtfc/ nsources, nsites, nranges, ndegrees, ndeg
     1, nresp, ndet, nedit, ndin, ndou, ndtf
     2, throof, thceil
     3, nin, nou, nflu, ndos
       character*6 lsites
c
c - - - - - - read dose sites and floor numbers
      do 100 is=1,nsites
  100 read  (nin, 110) lsites(is), nfloor(is)
  110 format( a6, i2)
          if(nedit.gt.0) then
      write (nou, 111) (is, lsites(is), nfloor(is), is=1,nsites)
  111 format( '0is site    floor'/ (i3, 1x, a6, i7) )
          endif
c
c - - - - - - read wall, roof, and ceiling penetration numbers
      read  (nin, 122) nwp
      read  (nin, 122) nrp
      read  (nin, 122) ncp
  122 format( 32i2)
c
c - - - - - - convert penetrations to equivalent walls
      inc = ndegrees/ndeg
      do 180 is=1,nsites
```

```
      do 180 ir=1,nranges
      do 180 id=1,ndeg
      id2 = inc*id - 1
  180 fs(id, ir,is) =
     1  nwp(id2,ir,is) + throof*nrp(id2,ir,is) + thceil*ncp(id2,ir,is)
          if(nedit.ge.2) then
      write (nou,182)
      write (nou,184) fs
  182 format( '0frontal shield( azimuth, range, site)' )
  184 format( 4( 2x, 4f4.1) )
          endif
      return
      end


      subroutine inposn( lsites, nsp, nsp8 )
      dimension lsites(*), nsp(ndeg,nsites), nsp8(ndeg)
c
c - - - - - a subject position is read for a list of dose sites:
c           sp=1 front third; =2 middle third; =3 rear third
c           only the first four characters of the site designator
c           need match, and the ordering may be different.
c           char4 and char6 are equivalent.
c
      common /comtfc/ nsources, nsites, nranges, ndegrees, ndeg
     1, nresp, ndet, nedit, ndin, ndou, ndtf
     2, throof, thceil
     3, nin, nou, nflu, ndos
      character*6 lsites, char6
      character*4 csite,  char4, end
      equivalence (char6, char4)
      data end /'end '/
c
c - - - - - compare site id with array to store subject position data
      do 140 i=1,nsites
      read  (nin,142) csite, nsp8
  142 format( a4, 2x, 1p8i2)
c - - - - - warning: char4 and char6 are equivalent.
      do 140 is=1,nsites
      char6 = lsites(is)
          if(csite.eq.end  ) go to 150
          if(char4.eq.csite) then
      do 134 iz=1,ndeg
  134 nsp(iz,is) = nsp8(iz)
          endif
  140 continue
  150 continue
c
          if(nedit.ge.0) then
      write (nou,210)
      write (nou,211) nsp
  210 format( '0subject position( azimuth, site)' )
  211 format( 4( 2x, 8i2) )
          endif
```

```
      return
      end


      subroutine indose( lsites, lsource, lrange, ldegree
     1, extn, extg, resp, fsd, rtf)
      dimension lsites(*), lsource(*), lrange(*), ldegree(*)
     1, extn(nresp), extg(nresp), resp(ndet,nresp), fsd (ndet,nresp)
      dimension rtf(nflu,nresp,ndeg,nranges,nsites)
c
c - - - - - - finds location parameters and reads dose, fsd
c
      common /comtfc/ nsources, nsites, nranges, ndegrees, ndeg
     1, nresp, ndet, nedit, ndin, ndou, ndtf
     2, throof, thceil
     3, nin, nou, nflu, ndos
      character*80 ftitle, hist(400)
      character*6 lsites, lsource
      character*6 insource, insite, csite
      character*6 labsour, labsite, labdeg, in
      data labsour, labsite,   labdeg
     1    /'source', 'morse ', 'degree'/
c
c - - - - - - read tf matrix if available; else system must preset 0.
      mod = 0
        if(ndou.gt.0) then
      read (ndou) rtf, hist, mod
      write (nou,201) mod, ndou
  201 format( '0version ', i4, ' read from ', i4 )
        endif
c
c - - - - - - read array arrangements
      read (nin,204) (lsource(i),i=1,nsources)
  204 format( 12a6 )
      call dtfrd( lrange,  -nranges)
      call dtfrd( ldegree, -ndeg    )
c
c - - - - - - read file title
      if(ndin.le.0) go to 290
      read  (ndin,206) ftitle
  206 format( a80 )
      write (nou,207) ftitle
  207 format( '0', a80 )
      mod = mod + 1
      if(mod.gt.400) stop 200
      hist(mod) = ftitle
c
c - - - - - - find source type, dose site, ground range, azimuth
  200 read (ndin,216,end=290) inrange, indegree, in, csite
        if(in.eq.labsour) then
      insource = csite
      go to 200
        elseif(in.eq.labsite) then
      insite   = csite
```

```
      go to 200
        elseif(in.eq.labdeg) then
      go to 210
        endif
      stop 201
  210 continue
  216 format( i4, 1x, i4, a6, 7x, a6 )
c
      isource = 0
      isite   = 0
      irange  = 0
      ideg    = 0
      do 222 i=1,nsources
  222 if(insource.eq.lsource(i)) isource = i
      do 224 i=1,nsites
  224 if(insite  .eq.lsites(i) ) isite   = i
      do 226 i=1,nranges
  226 if(inrange .eq.lrange (i)) irange  = i
      do 228 i=1,ndeg
  228 if(indegree.eq.ldegree(i)) ideg    = i
      if(isource.eq.0) stop 222
      if(isite  .eq.0) stop 224
      if(irange .eq.0) stop 225
      if(ideg   .eq.0) stop 226
c
c - - - - - read fluence for these conditions
      do 238 iresp=1,nresp
      read (ndin,232) extn(iresp), extg(iresp)
  232 format( 2x, 7e10.0 )
      read (ndin,232)
     * (resp(idet,iresp),idet=1,ndet), (fsd (idet,iresp),idet=1,ndet)
  238 continue
c
c - - - - - condense to tf format; ratio to fia; correct to cgy units
      do 244 iresp=1,nresp
      lresp = iresp
      el = 1.
        if(iresp.gt.2) then
      lresp = 2
      el = 100.
        endif
        if(isource.eq.1) then
      rtf(1,iresp,ideg,irange,isite) = resp(1,iresp)/extn(lresp)*el
      rtf(2,iresp,ideg,irange,isite) = resp(2,iresp)/extn(lresp)*el
      rtf(3,iresp,ideg,irange,isite) = resp(6,iresp)/extg(lresp)*el
        else
      rtf(4,iresp,ideg,irange,isite) = resp(4,iresp)/extg(lresp)*el
        endif
  244 continue
c
c - - - - - edit response and fsd
          if(nedit.ge.3) then
      write (nou,260) isource, isite, irange, ideg
  260 format( '0for source, site, range, azimuth= ', 4i4
```

```
     1/ ' external neutron, then gamma dose by response type' )
            if(nedit.ge.4) then
      write (nou,261)
  261 format( ' followed by detector dose and fsd by detector type' )
            endif
c
      do 280 iresp=1,nresp
      write (nou,262) iresp, extn(iresp), extg(iresp)
  262 format( ' -----for response= ', i4, 1p, 2e12.5 )
c
            if(nedit.ge.4) then
      write (nou,264)
     *  (resp(idet,iresp),idet=1,ndet), (fsd (idet,iresp),idet=1,ndet)
  264 format( 1p, 7e12.5 / 0p, 7f12.3 )
            endif
  280 continue
          endif
      go to 200
  290 continue
c
c - - - - - edit transmission factors
      do 300 isite  =1,nsites
      do 300 irange =1,nranges
      iz = 0
      do 300 ideg=1,ndeg
        if(rtf(3,1,ideg,irange,isite).ne.0.) then
      iz = iz + 1
      if(iz.eq.1) write (nou,291) isite, irange
  291 format('0raw transmission factors by fluence, then response type,'
     1, ' then azimuth' / ' for site, range = ', 2i4)
      write (nou,292)
     * ((rtf(iflu,iresp,ideg,irange,isite),iflu=1,nflu),iresp=1,nresp)
  292 format( 4( 2x, 4f6.2 ) )
        endif
  300 continue
c
c - - - - - write tf matrixe
        if(ndou.ne.0) then
      ndou = iabs(ndou)
      rewind ndou
      write (ndou) rtf, hist, mod
      rewind ndou
      write (nou,320) mod, ndou
  320 format( '0version', i4, ' written on', i4 )
        endif
c
      return
      end


      subroutine caltf( lsites, nfloor, nsp, fs, resp, fsd, rtf
     1, ntf, btf, stf, afsd)
      dimension lsites(*), nfloor(*), nsp(ndeg,nsites)
     1, fs(ndeg,nranges,nsites), resp(nflu,nresp), fsd(nflu,nresp)
```

```
     3, rtf(nflu,nresp,ndeg,nranges,nsites)
     1, ntf(nflu,ndos,nranges,2,4,3,4), btf(nflu,ndos,nranges,2,4,3,4)
     1, stf(nflu,ndos,nranges,2,4,3,4), afsd(nflu,ndos)
      dimension hist(400), char1(6)
c
      common /comtfc/ nsources, nsites, nranges, ndegrees, ndeg
     1, nresp, ndet, nedit, ndin, ndou, ndtf
     2, throof, thceil
     3, nin, nou, nflu, ndos
      character*80 hist
      character*6  lsites, char6
      character*1  char1, charp, chars
      equivalence (char1(1),char6)
      data charp, chars
     1   / 'p',   's' /
      data nbins /96/
c
c - - - - - read tf matrix
      rewind ndou
      read  (ndou) rtf, hist, mod
      if(nedit.ge.2) write (nou,290) (i, hist(i), i=1,mod)
  290 format( '0update history - - - - -'/ ( i4, a80 ) )
c
c - - - - - combine tf data of like dw parameters into bins
      do 360 isite=1,nsites
      ish = 0
      char6 = lsites(isite)
      if(char1(6).eq.charp) ish = 1
      if(char1(6).eq.chars) ish = 2
      if(ish.eq.0) stop 310
      ifn = nfloor(isite) + 1
      if(ifn.gt.4) stop 311
c
      do 360 ideg=1,ndeg
      do 360 igr=1,nranges
      isp = nsp(ideg,isite)
      if(isp.le.0) isp = 1
      if(isp.gt.3) stop 312
      ifs =  min( 4., fs(ideg,igr,isite) + 1.5)
      do 360 idt=1,ndos
      do 360 ift=1,nflu
      x = rtf(ift,idt+1,ideg,igr,isite)
        if(x.ne.0.) then
       ntf(ift,idt,igr,ish,ifn,isp,ifs) =
     1 ntf(ift,idt,igr,ish,ifn,isp,ifs) + 1
       btf(ift,idt,igr,ish,ifn,isp,ifs) =
     1 btf(ift,idt,igr,ish,ifn,isp,ifs) + x
       stf(ift,idt,igr,ish,ifn,isp,ifs) =
     1 stf(ift,idt,igr,ish,ifn,isp,ifs) + x*x
       n = ntf(ift,idt,igr,ish,ifn,isp,ifs)
      if(nedit.gt.5) write (nou,355) ifs, isp, ifn, ish, igr, idt, ift
     1, isite, ideg, n, x
  355 format( '@', 7i3, 2x, 2i3, 2x, i3, f10.3)
        endif
```

```
c
c - - - - - heading for snapshot edit
      if(ift.eq.4 .and. idt.eq.1 .and. igr.eq.4 .and. ish.eq.2 .and.
     1   ifn.eq.2 .and. isp.eq.1 .and. ifs.eq.1) then
      write (nou,358) igr, ideg, isite, x
  358 format( '@@', 3i4, 1pe12.5)
      endif
  360 continue
c
c - - - - - - calculate stats on binned tf data
      do 370 ift=1,nflu
      do 370 idt=1,ndos
      do 370 igr=1,nranges
      do 370 ibins=1,nbins
      n   = ntf(ift,idt,igr,ibins,1,1,1)
      sum = btf(ift,idt,igr,ibins,1,1,1)
      sq  = stf(ift,idt,igr,ibins,1,1,1)
      avg = 0.
      dev = 0.
      if(n.ge.1) avg = sum/n
      if(n.ge.2 .and. avg.ne.0.)
     * dev = sqrt( (sq - avg*avg*n)/(avg*avg*(n-1) ))
      btf(ift,idt,igr,ibins,1,1,1) = avg
      stf(ift,idt,igr,ibins,1,1,1) = dev
  370 continue
c
        if(nedit.ge.2) then
      do 373 ift=1,nflu
      do 373 idt=1,ndos
      num = 0
      avg = 0.
      do 372 igr=1,nranges
      do 372 ibins=1,nbins
      n   =        ntf(ift,idt,igr,ibins,1,1,1)
      num = num + n
  372 avg = avg + n*stf(ift,idt,igr,ibins,1,1,1)
  373 if(num.ne.0) afsd(ift,idt) = avg/num
c
c - - - - - - full edit
      do 379 ifs=1,4
      do 379 isp=1,3
      do 379 ifn=1,4
      do 379 ish=1,2
      iz = 0
      do 379 igr=1,nranges
          if(ntf(1,  1,  igr,ish,ifn,isp,ifs).ne.0) then
      iz = iz + 1
      if(iz.eq.1) write (nou,374) ifs,isp,ifn,ish
  374 format( '0-----for ifs, isp, ifn, ish = ', 4i4)
      write (nou,375) igr
  375 format( ' -----tf, fsd, n by ift, idt  for igr=', i6)
      write (nou,376)
     1  ((btf(ift,idt,igr,ish,ifn,isp,ifs),ift=1,nflu),idt=1,ndos)
     2, ((stf(ift,idt,igr,ish,ifn,isp,ifs),ift=1,nflu),idt=1,ndos)
```

```
     3, ((ntf(ift,idt,igr,ish,ifn,isp,ifs),ift=1,nflu),idt=1,ndos)
  376 format( 3( 2x, 4f6.3 ) / 3( 2x, 4f6.3 ) / 3( 2x, 4i6 ) )
          endif
  379 continue
c
c - - - - - snapshot edit
      do 399 ish=2,2
      do 399 igr=1,4
      do 399 idt=1,1
      do 399 ift=4,4
      write (nou,392) ift, idt, igr, ish
  392 format( '0-----summary for ift, idt, igr, ish =', 4i4)
      do 399 ifn=1,4
      write (nou,394) ifn
  394 format( '0-----and for ifn=', i4, ', tf, fsp, n by ifs, then isp')
c
      do 399 isp=1,3
      write (nou,396)
     1  ((btf(ift,idt,igr,ish,ifn,isp,ifs),ifs=1,4)
     2,  (stf(ift,idt,igr,ish,ifn,isp,ifs),ifs=1,4)
     3,  (ntf(ift,idt,igr,ish,ifn,isp,ifs),ifs=1,4))
  396 format( 2( 2x, 4f6.3 ), ( 2x, 4i3 ) )
  399 continue
c
      write (nou,668)
  668 format( '0-----avg fsd')
      write (nou,669) afsd
  669 format( 3( 2x, 4f6.3 ) / 3( 2x, 4f6.3 ) / 3( 2x, 4i6 ) )
        endif
c
      write (ndtf, '(''  tf by ft, dt, gr, sh, fn, sp, fs -----'')' )
      write (ndtf,682) btf
      write (ndtf, '('' fsd by ft, dt, gr, sh, fn, sp, fs -----'')' )
      write (ndtf,682) stf
      write (ndtf, '('' bin population -----'')' )
      write (ndtf,684) ntf
  682 format( 3( 2x, 4f6.3 ) )
  684 format( 3( 2x, 4i6 ) )
c
      return
      end


      subroutine comfix (n)
      common /comdtf/ ldai(2), nid, nod, iprtrg, 160
      nid = 5
      nod = 6
      write (*,66)
   66 format( '0******     tfx (ornl 10 aug 90) ******' )
      return
      end
```

Table B.2 Input Data Requirements for TFX

1. CONTROL INTEGERS -- FIDO FORMAT [rh82]

nsources	number of fluence source files	(2)
nsites	number of dose sites	(52)
nranges	number of ground ranges	(4)
ndegrees	number of azimuths in FS table	(16)
ndeg	number of azimuths in SP table	(8)
nresp	number of response types from DRC	(4)
ndet	number of detectors from DRC	(7)
nedit	edit control (see code for use)	(8)
ndin	raw DRC input unit (0 bypasses DRC input)	(12)
ndou	transmission factor matrix unit	(13)
ndtf	binned output unit (0 bypasses binning)	(14)

Notes

- upper limits allowed: 4, 100, 4, 16, 8, 4, 7, 9, 99, 99, 99.
- ndegrees must be an integer multiple of ndeg.
- no array designators, e.g. "1**", are required for TFX.
- numbers in parentheses indicate values used in this study.
- negative value of ndou indicates no previous matrix; in that case, a dummy file must be supplied to satisfy the "open" statement.

2. CONTROL REALS -- FIDO FORMAT

throof	number of walls equivalent to a roof	(1.12)
thceil	number of walls equivalent to a ceiling	(0.08)

3. DOSE SITES

isites(is), nfloor(is) (a6, i2)

----repeat for is=1,nsites

isite	"nh/s p", where n=building number, h=building type, s=site designation, p=posture, "p" for prone, "s" for standing
nfloor	floor number parameter, 0 through 3

4. FRONTAL SHIELDING

(nwp(ideg,ir,is), ideg=1,ndegrees), ir=1,nranges), is=1,nsites)   (32i2)

(nrp(ideg,ir,is), ideg=1,ndegrees), ir=1,nranges), is=1,nsites)   (32i2)

(ncp(ideg,ir,is), ideg=1,ndegrees), ir=1,nranges), is=1,nsites)   (32i2)

nwp   number of wall penetrations
nrp   number of roof penetrations
ncp   number of ceiling penetrations

5. SUBJECT POSITION

csite, (nsp8(ideg), ideg=1,ndeg)   (a4, 2x, 8i2)

csite   site code; 4 characters must match an isite entry

----repeat for a maximum of nsites records; finish with csite="end"

nsp8   subject position for this site

6. SOURCE FILE DESIGNATIONS

(lsource(is), i=1,nsources)   (12a6)

lsource   label to match label in DRC data file

7. CLUSTER POSITION REALS -- FIDO FORMAT

(lrange(ir), ir=1,nranges)   ranges to match ranges in DRC data file

(ldegree(ideg), ideg=1,ndeg)   azimuths to match azimuths in DRC data file

APPENDIX C

Frontal Shielding Parameter Values

Penetration data are presented for Nagasaki in table C.1, then for Hiroshima in table C.2. For each city, data are ordered by azimuth (16 values), then by range (4 values), then by dose site (52 values), then by penetration type (wall, roof, or ceiling). Thus, each two lines correspond to a single dose site and penetration type.

Table C.1 Frontal Shielding Penetrations for Nagasaki

0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1	0	0	0	0	0	1	0	0	0	/wall
0	2	1	1	1	1	1	0	2	1	0	1	1	0	1	0	1	2	1	1	1	1	1	0	1	1	1	2	2	2	1	1	
0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	1	0	0	
0	0	2	1	1	0	0	3	1	2	1	1	2	3	3	0	1	1	2	1	1	0	0	1	0	1	3	3	2	2	4	1	
0	0	0	0	0	0	1	1	1	3	1	1	0	1	1	0	0	0	0	0	1	1	2	1	0	3	1	1	2	1	4	1	
0	0	0	1	0	0	1	0	0	3	2	2	3	2	5	1	0	0	1	1	0	0	2	0	0	3	2	1	2	2	5	1	
0	0	0	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	2	0	1	2	0	0	
0	0	1	0	1	0	0	1	1	1	2	1	1	3	2	0	0	1	1	0	1	1	1	1	2	1	1	1	1	2	3	1	
1	1	1	0	0	0	0	0	0	1	3	1	0	1	0	1	1	0	1	0	1	0	0	0	0	1	2	3	1	1	0	1	
1	0	1	1	0	0	0	0	2	1	4	4	2	2	0	1	1	0	1	0	0	1	1	0	2	1	4	4	2	2	1	1	
1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	2	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	
5	3	0	1	0	0	0	0	0	0	1	1	1	1	1	0	4	2	1	2	2	0	0	0	0	0	1	1	1	1	1	2	
1	2	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	2	0	1	1	0	0	0	0	0	0	0	1	0	1	3	
4	3	1	1	2	1	0	0	0	0	0	1	1	0	1	3	4	1	2	2	3	2	0	0	0	0	0	1	1	0	1	1	
2	0	0	0	0	1	1	1	0	0	0	0	0	0	2	3	2	0	1	0	1	1	1	1	0	0	0	0	0	2	3	3	
3	1	1	2	2	2	2	1	1	0	0	0	0	3	2	4	3	1	1	4	3	1	3	1	1	0	0	1	0	3	3	4	
1	2	1	1	0	0	1	1	0	0	0	0	0	1	2	2	3	2	1	1	0	1	1	1	0	0	0	0	1	3	2	3	
4	2	3	2	2	1	2	1	0	0	0	1	0	2	2	3	4	3	3	1	3	0	2	1	0	0	0	1	0	1	3	3	
3	2	2	1	0	1	0	0	0	0	0	1	1	3	1	1	3	0	1	0	1	1	0	0	0	0	0	0	1	2	1	4	
5	2	2	1	1	3	1	0	0	0	1	0	1	2	1	4	5	3	2	1	1	2	1	0	0	0	1	0	1	3	0	5	
0	3	2	0	0	1	1	0	0	1	1	0	0	0	1	0	1	3	2	1	0	1	2	0	0	1	1	0	0	0	1	0	
3	3	2	1	1	1	2	0	0	1	1	0	0	0	1	0	5	4	3	1	1	2	2	0	0	1	1	0	0	0	1	1	
2	2	2	1	1	1	0	1	1	1	0	0	0	0	1	3	3	3	3	1	1	0	1	1	1	2	1	2	0	0	1	2	
3	3	3	1	1	0	3	2	1	1	1	2	0	0	2	4	3	3	3	2	1	1	2	0	1	0	1	1	0	0	2	4	
2	2	1	1	1	1	1	1	1	2	1	0	1	0	1	1	3	2	3	0	1	1	1	0	1	1	1	1	0	1	0	1	
3	2	3	1	0	3	0	0	1	1	1	1	0	1	0	3	3	3	3	1	1	3	1	1	2	1	1	1	0	1	0	3	
3	3	3	3	1	1	0	0	1	1	0	0	1	3	2	2	3	3	3	3	1	1	1	1	1	1	1	1	0	2	3	3	
3	3	3	4	1	2	0	2	2	1	0	0	1	3	2	3	3	3	2	4	1	1	1	1	2	1	1	0	1	3	4	3	
3	2	3	1	1	1	1	1	1	1	1	0	1	1	3	2	3	3	3	1	1	1	1	1	1	1	1	1	1	0	3	3	
3	3	3	1	0	2	1	2	2	3	2	0	0	1	3	3	3	3	3	2	1	2	2	0	1	1	0	0	0	1	2	3	
3	3	1	1	1	0	1	1	0	1	1	0	1	2	3	3	2	3	2	1	1	0	0	2	1	1	1	0	1	2	2	3	
3	2	3	2	1	1	0	2	2	2	1	1	0	3	3	3	3	2	5	3	1	2	3	2	1	2	1	2	1	2	4	3	
2	3	1	0	0	0	2	1	1	1	1	0	0	1	3	2	3	3	1	0	0	1	2	1	1	1	1	0	0	1	2	3	
3	3	2	0	1	1	2	3	1	2	1	1	1	1	3	3	3	3	2	2	1	1	3	3	0	1	0	1	0	3	5	3	
2	2	1	0	1	0	0	1	1	1	0	1	1	1	1	2	2	2	3	1	1	1	1	1	1	1	2	1	0	1	1	2	
3	2	3	1	0	1	1	0	1	1	1	0	0	0	3	3	3	3	3	0	0	0	1	0	1	1	1	0	0	0	3	3	
2	3	1	1	1	0	1	1	0	1	0	0	0	2	2	2	2	3	1	1	1	0	0	1	1	1	0	0	1	2	2	2	
3	2	2	1	1	0	0	0	1	1	2	1	1	3	3	3	3	2	2	1	1	0	0	0	0	1	1	0	1	2	2	3	
0	1	1	0	1	1	1	0	0	0	0	1	0	0	0	1	2	1	0	0	1	1	1	0	0	0	0	1	1	0	0	2	
2	0	0	0	1	1	1	0	0	0	0	1	1	1	1	2	3	0	0	0	1	1	1	1	1	1	0	1	1	0	2	3	
1	1	1	1	1	1	3	2	3	2	2	1	1	0	1	1	1	1	1	1	1	1	3	3	3	3	3	0	1	1	1	1	
1	1	1	1	1	1	3	3	3	3	3	1	0	1	1	1	1	0	1	1	1	1	4	5	4	3	2	1	0	1	0	0	
0	0	1	1	1	2	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	2	2	
0	3	1	2	1	1	0	0	0	0	0	0	0	2	2	4	0	2	5	1	2	1	0	0	0	0	0	0	0	2	3	5	
0	0	1	1	1	1	0	0	0	0	1	1	2	0	2	1	0	0	1	0	0	2	1	1	0	1	1	1	2	1	3	1	
0	2	1	0	1	2	1	1	0	1	1	2	4	0	2	2	0	3	2	1	0	1	1	0	0	1	1	2	6	1	2	2	
0	0	2	1	1	1	1	1	0	0	0	2	1	3	1	0	0	1	2	1	1	1	1	1	0	0	0	2	2	3	1	2	
0	1	2	1	1	2	2	3	0	1	2	2	0	3	2	2	0	2	2	2	2	1	3	2	0	1	2	2	1	3	2	2	
0	0	0	2	1	1	1	0	0	1	3	1	1	0	0	0	0	0	0	2	0	0	1	0	0	1	3	2	1	1	0	0	
0	0	0	2	1	0	1	2	0	1	3	2	1	1	0	0	0	0	0	2	0	1	2	3	0	2	3	1	2	0	0	0	
0	0	0	0	0	1	1	1	0	1	3	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	4	1	0	0	0	0	

```
0 0 0 0 0 2 1 1 0 2 4 0 0 0 0 0 0 0 0 0 0 1 1 1 0 2 4 1 0 0 0 0
0 0 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 2 1 1 1 1 1 0 0 0 0 0 0 0 0 0
0 2 1 1 1 1 1 0 0 0 0 1 0 0 0 0 1 2 1 1 1 1 1 0 2 2 1 1 2 2 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 1 2 1 0 0
0 0 0 1 1 0 0 3 2 2 1 1 3 3 1 0 0 1 2 1 1 0 0 3 2 2 3 1 2 2 3 0
0 0 0 0 0 0 1 1 1 1 1 1 1 2 1 0 0 0 0 0 0 1 2 1 1 3 1 1 3 1 4 1
0 0 0 1 1 1 2 1 1 3 2 2 3 2 4 1 0 0 0 1 0 0 2 0 0 3 2 2 2 2 5 1
0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 1 1 2 1 1 1 1 1 1 2 0 0
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1 1 0 0 0 0 0 0 0 1 3 2 0 2 0 1 1 1 1 0 0 0 0 0 0 1 2 2 1 1 0 1
1 0 1 0 1 0 0 0 0 1 4 3 1 1 0 1 1 0 1 1 0 1 1 0 2 1 4 3 1 1 0 1
1 1 0 0 0 0 0 0 0 0 1 1 1 1 1 0 1 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0
3 2 0 1 0 0 0 0 0 0 1 1 1 1 1 0 5 3 1 1 2 0 0 0 0 0 1 1 1 1 1 1
1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 1 0 1 1 0 0 0 0 0 0 0 1 0 1 1
5 3 1 1 2 1 0 0 0 0 0 1 1 0 1 3 5 3 2 1 3 1 0 0 0 0 0 1 1 0 2 3
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2 1 1 1 1 1 1 0 0 0 0 0 0 2 2 3 3 2 1 1 0 0 1 1 0 0 0 0 0 2 3 3
4 2 3 2 2 1 1 1 0 0 0 1 1 3 2 4 4 3 3 2 2 1 2 1 0 0 0 1 0 3 3 3
3 2 2 1 0 0 0 0 0 0 0 1 0 3 2 1 3 1 2 1 1 1 0 0 0 0 0 0 1 3 1 3
4 1 2 1 1 3 1 0 0 0 1 0 1 2 2 3 4 1 1 1 1 3 1 0 0 0 1 0 1 2 1 3
1 4 2 0 0 1 1 1 1 1 1 0 0 0 1 1 0 4 2 1 1 1 1 0 0 1 1 0 0 0 1 0
2 3 3 0 0 1 2 0 0 1 1 0 0 0 1 0 4 3 3 1 1 2 2 0 0 1 1 0 0 0 1 0
2 2 2 1 1 1 1 1 1 1 1 0 0 0 2 3 3 3 3 1 0 0 1 1 1 1 0 0 0 0 2 2
3 2 2 1 1 1 1 2 1 1 1 2 0 0 1 3 3 3 3 1 1 0 3 2 1 1 1 1 0 0 1 5
2 2 1 1 1 1 1 1 1 2 1 0 0 0 2 0 2 2 3 0 0 1 2 1 1 1 1 0 0 0 1 1
3 3 3 1 0 1 1 1 1 1 1 1 0 1 0 1 3 3 3 1 1 3 0 0 1 1 1 1 0 1 0 4
3 2 4 3 1 0 1 1 1 1 0 0 1 3 2 2 3 3 3 3 1 1 1 0 1 1 0 1 0 3 2 3
3 3 3 3 1 1 0 1 1 1 1 1 1 2 3 3 3 3 3 4 1 2 0 2 2 1 1 0 1 3 4 3
3 2 3 1 0 0 1 0 1 1 1 0 0 1 3 2 3 3 3 1 1 1 1 1 1 1 1 1 1 1 3 2
3 3 3 1 1 1 1 2 2 3 1 2 0 0 2 3 3 3 3 1 2 2 2 2 2 2 1 0 0 1 3 3
3 3 1 1 1 1 1 1 1 1 0 0 1 2 2 3 3 3 2 1 1 1 1 1 0 1 1 0 1 2 2 3
3 3 3 2 1 1 0 2 1 1 1 1 0 3 2 3 3 3 4 2 1 1 1 2 2 2 1 3 1 3 3 3
2 3 1 1 1 1 1 1 0 1 1 0 0 1 2 2 3 3 1 1 1 1 2 0 1 1 1 0 0 1 2 3
2 3 2 0 0 1 2 3 2 2 1 1 1 1 2 3 3 3 2 0 1 1 2 3 2 2 1 2 1 1 3 3
2 2 0 0 0 0 0 1 1 1 0 0 1 0 0 2 2 2 1 1 1 1 1 1 1 1 1 1 0 1 1 2
3 2 3 1 1 1 1 1 1 1 1 0 0 0 2 2 3 3 3 1 1 1 1 0 1 1 1 0 0 0 3 3
2 2 1 1 1 1 1 0 0 0 0 0 0 2 2 2 2 3 1 1 1 1 1 1 1 1 0 0 0 2 2 2
3 3 2 1 1 0 0 1 1 1 0 1 0 2 2 3 3 3 2 1 1 0 0 1 1 1 1 0 1 2 2 3
0 0 1 1 1 1 1 0 0 0 1 1 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 1 0 0 0 2
2 1 0 0 1 1 1 0 0 0 0 1 1 1 0 2 3 1 0 0 1 1 1 0 0 0 0 1 1 0 1 2
1 0 1 0 0 1 3 2 3 2 2 1 0 0 1 1 1 1 1 1 1 1 3 3 3 2 3 1 1 1 1 1
1 1 1 1 1 1 3 3 3 3 2 0 0 2 1 1 1 1 1 1 2 1 4 3 3 3 3 1 0 1 1 1
0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 1 2 2
0 1 1 1 1 1 0 0 0 0 0 0 0 1 3 4 0 3 4 2 1 1 0 0 0 0 0 0 0 2 2 6
0 0 1 1 1 1 0 0 0 0 1 0 3 1 1 0 0 0 1 1 1 2 1 1 0 1 1 1 2 0 3 1
0 1 1 0 0 2 1 1 0 1 1 1 3 0 4 2 0 2 2 0 1 3 1 1 0 1 1 3 5 0 3 1
0 0 1 1 1 1 1 1 0 0 0 0 0 1 1 0 0 0 2 1 1 1 1 1 0 0 0 2 1 3 1 2
0 1 2 1 1 1 1 2 0 1 1 2 1 3 2 2 0 1 3 1 2 1 4 3 0 1 2 2 1 3 2 2
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0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0

Table C.2 Frontal Shielding Penetrations for Hiroshima

0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	/wall
0	2	1	1	1	1	1	0	1	1	0	1	0	0	0	0	1	2	1	1	1	1	1	0	2	2	1	1	2	2	1	1	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	2	1	0	0		
0	0	0	1	1	0	0	3	2	2	1	1	3	2	2	0	1	1	2	1	1	0	0	1	0	1	3	1	2	2	3	1	
0	0	0	0	0	0	1	1	1	2	1	1	0	1	1	0	0	0	0	0	1	2	1	1	3	1	1	3	0	4	1		
0	0	0	1	0	0	1	0	0	3	2	2	3	1	4	1	0	0	0	1	0	0	2	0	0	3	2	1	2	2	5	1	
0	0	0	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	2	0	0	0	1	1	1	2	0	0	
0	0	1	0	1	0	0	1	1	1	1	1	1	1	2	0	0	1	1	0	1	1	1	1	1	1	2	1	1	2	3	1	
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1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	
4	3	0	1	0	0	0	0	0	0	1	1	1	1	1	0	5	3	1	1	2	0	0	0	0	0	1	1	1	1	1	1	
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	0	1	1	0	0	0	0	0	0	0	1	0	1	1	
5	3	1	1	2	1	0	0	0	0	0	1	1	0	1	3	4	1	2	1	3	2	0	0	0	0	0	1	1	0	2	1	
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3	1	1	2	2	2	2	1	1	0	0	0	1	3	2	3	3	1	2	4	3	1	3	1	1	0	0	1	0	4	3	4	
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```
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APPENDIX D

Full Edit of Transmission Factor Results

Transmission factors for Nagasaki are shown in table D.1, and data for Hiroshima are shown in table D.2. Each line of data lists factors for the four values of fluence type, with the three groups of four corresponding to the three values of response type. Successive lines correspond to the four values of ground range, the two subject heights, the four values of fluence number, the three values of subject position, and the four values of floor shielding.

Table D.1 Transmission Factor Results for Nagasaki

tf by ft, rt, gr, sh, fn, sp, fs -----

0.709	0.354	0.804	0.739	0.207	0.266	0.551	0.451	0.308	0.293	0.611	0.508
0.712	0.340	0.778	0.726	0.211	0.256	0.538	0.451	0.312	0.282	0.596	0.506
0.692	0.315	0.733	0.690	0.209	0.236	0.512	0.439	0.307	0.261	0.567	0.491
0.677	0.282	0.677	0.652	0.206	0.212	0.477	0.420	0.302	0.233	0.528	0.470
0.740	0.328	0.825	0.787	0.217	0.246	0.565	0.481	0.323	0.272	0.627	0.542
0.728	0.322	0.789	0.750	0.216	0.242	0.544	0.466	0.319	0.267	0.603	0.523
0.732	0.295	0.801	0.760	0.222	0.221	0.560	0.485	0.326	0.244	0.620	0.542
0.727	0.262	0.793	0.760	0.222	0.197	0.561	0.493	0.326	0.217	0.621	0.551
0.636	0.416	0.862	0.717	0.183	0.313	0.592	0.437	0.273	0.345	0.656	0.492
0.618	0.411	0.847	0.713	0.179	0.308	0.587	0.444	0.267	0.340	0.649	0.497
0.648	0.386	0.934	0.785	0.193	0.290	0.658	0.504	0.285	0.320	0.727	0.562
0.651	0.345	0.938	0.816	0.196	0.258	0.667	0.533	0.289	0.285	0.737	0.594
0.747	0.411	1.018	0.835	0.220	0.309	0.699	0.510	0.327	0.340	0.775	0.574
0.668	0.401	0.833	0.707	0.199	0.301	0.573	0.437	0.294	0.332	0.635	0.490
0.634	0.369	0.840	0.732	0.191	0.276	0.588	0.467	0.282	0.305	0.651	0.522
0.663	0.332	0.938	0.808	0.202	0.248	0.666	0.526	0.297	0.274	0.737	0.586
0.625	0.415	0.833	0.733	0.179	0.312	0.572	0.449	0.269	0.344	0.633	0.505
0.704	0.415	0.975	0.821	0.205	0.312	0.677	0.511	0.305	0.344	0.749	0.574
0.632	0.379	0.814	0.702	0.187	0.284	0.570	0.447	0.277	0.313	0.630	0.500
0.636	0.333	0.818	0.720	0.191	0.249	0.578	0.467	0.282	0.274	0.639	0.520
0.643	0.415	0.847	0.728	0.187	0.311	0.581	0.444	0.279	0.343	0.644	0.499
0.625	0.401	0.781	0.708	0.184	0.301	0.540	0.439	0.273	0.332	0.598	0.493
0.718	0.376	1.002	0.855	0.217	0.282	0.706	0.549	0.320	0.311	0.780	0.613
0.652	0.333	0.835	0.734	0.198	0.249	0.590	0.476	0.291	0.275	0.653	0.531
0.741	0.471	1.101	0.894	0.215	0.354	0.761	0.547	0.321	0.391	0.842	0.614
0.740	0.455	1.081	0.935	0.218	0.342	0.753	0.586	0.323	0.377	0.833	0.656
0.737	0.419	0.984	0.934	0.222	0.315	0.689	0.601	0.326	0.347	0.763	0.670
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.767	0.476	1.074	0.847	0.224	0.358	0.741	0.517	0.333	0.395	0.821	0.582
0.772	0.460	1.108	0.918	0.229	0.346	0.774	0.575	0.338	0.381	0.856	0.645
0.777	0.423	1.114	0.962	0.236	0.318	0.787	0.620	0.346	0.351	0.869	0.693
0.780	0.374	1.125	0.990	0.240	0.281	0.801	0.650	0.351	0.310	0.886	0.724
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.466	0.375	0.589	0.567	0.134	0.279	0.404	0.353	0.201	0.308	0.448	0.395
0.524	0.373	0.650	0.530	0.155	0.279	0.455	0.334	0.229	0.308	0.503	0.374
0.539	0.333	0.710	0.588	0.162	0.249	0.503	0.380	0.239	0.274	0.556	0.424
0.510	0.403	0.585	0.531	0.146	0.302	0.396	0.318	0.220	0.333	0.439	0.358
0.461	0.415	0.499	0.449	0.131	0.310	0.338	0.272	0.198	0.342	0.375	0.305
0.458	0.381	0.479	0.495	0.134	0.284	0.327	0.311	0.199	0.313	0.363	0.348
0.542	0.337	0.608	0.503	0.163	0.252	0.426	0.320	0.241	0.278	0.472	0.358
0.725	0.405	0.934	0.795	0.211	0.304	0.639	0.482	0.315	0.336	0.708	0.543
0.703	0.403	0.961	0.796	0.206	0.303	0.665	0.494	0.306	0.334	0.736	0.554

0.647	0.374	0.842	0.733	0.193	0.281	0.589	0.467	0.286	0.310	0.652	0.522
0.653	0.334	0.862	0.767	0.198	0.250	0.610	0.498	0.291	0.276	0.675	0.555
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.740	0.399	0.940	0.798	0.220	0.300	0.651	0.496	0.326	0.331	0.722	0.557
0.747	0.368	1.011	0.864	0.228	0.277	0.712	0.554	0.334	0.305	0.789	0.620
0.708	0.335	0.994	0.843	0.218	0.252	0.707	0.549	0.318	0.277	0.782	0.612
0.688	0.466	0.895	0.745	0.200	0.351	0.614	0.450	0.298	0.387	0.680	0.506
0.688	0.451	0.884	0.767	0.202	0.339	0.612	0.474	0.300	0.374	0.677	0.532
0.650	0.417	0.857	0.726	0.195	0.313	0.600	0.460	0.288	0.345	0.664	0.515
0.655	0.370	0.889	0.768	0.199	0.277	0.630	0.498	0.293	0.306	0.696	0.555
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.712	0.456	0.871	0.737	0.211	0.343	0.603	0.456	0.312	0.378	0.668	0.512
0.715	0.420	0.921	0.771	0.216	0.315	0.647	0.492	0.318	0.348	0.715	0.550
0.671	0.378	0.887	0.731	0.204	0.283	0.628	0.472	0.300	0.312	0.694	0.527
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.467	0.388	0.449	0.434	0.134	0.290	0.300	0.256	0.202	0.320	0.333	0.289
0.471	0.373	0.461	0.426	0.136	0.279	0.313	0.258	0.204	0.307	0.348	0.290
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.465	0.380	0.410	0.404	0.137	0.285	0.275	0.242	0.205	0.314	0.305	0.272
0.468	0.313	0.235	0.286	0.146	0.236	0.154	0.169	0.214	0.260	0.172	0.191
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.505	0.369	0.414	0.400	0.148	0.276	0.281	0.245	0.220	0.304	0.312	0.275
0.518	0.331	0.477	0.437	0.153	0.248	0.331	0.276	0.227	0.273	0.366	0.309
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.518	0.328	0.384	0.390	0.153	0.246	0.262	0.242	0.228	0.271	0.291	0.271
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.708	0.354	0.692	0.670	0.206	0.266	0.469	0.405	0.307	0.293	0.521	0.456
0.639	0.344	0.494	0.540	0.188	0.258	0.333	0.328	0.278	0.285	0.371	0.369
0.642	0.312	0.420	0.466	0.193	0.234	0.284	0.287	0.284	0.258	0.316	0.323
0.738	0.243	0.624	0.660	0.227	0.182	0.436	0.424	0.332	0.201	0.484	0.474
0.700	0.338	0.652	0.669	0.205	0.254	0.441	0.404	0.305	0.280	0.490	0.456
0.797	0.266	0.694	0.735	0.240	0.200	0.474	0.454	0.353	0.221	0.526	0.511
0.636	0.303	0.415	0.477	0.190	0.228	0.279	0.294	0.281	0.251	0.311	0.331
0.649	0.255	0.425	0.478	0.196	0.191	0.291	0.300	0.289	0.211	0.323	0.337

0.554	0.417	0.675	0.562	0.158	0.312	0.458	0.336	0.237	0.345	0.508	0.379
0.570	0.400	0.743	0.657	0.165	0.300	0.512	0.408	0.246	0.330	0.567	0.458
0.592	0.380	0.745	0.664	0.175	0.284	0.518	0.421	0.259	0.313	0.574	0.471
0.642	0.348	0.854	0.746	0.193	0.260	0.603	0.483	0.284	0.287	0.668	0.539
0.563	0.414	0.654	0.564	0.162	0.310	0.442	0.337	0.243	0.342	0.491	0.380
0.574	0.403	0.695	0.604	0.167	0.301	0.476	0.371	0.249	0.332	0.528	0.416
0.587	0.377	0.690	0.624	0.175	0.282	0.478	0.394	0.259	0.311	0.530	0.441
0.591	0.337	0.695	0.639	0.178	0.252	0.487	0.411	0.262	0.278	0.539	0.459
0.563	0.412	0.606	0.568	0.162	0.309	0.409	0.340	0.243	0.341	0.455	0.384
0.529	0.397	0.512	0.498	0.153	0.298	0.347	0.302	0.230	0.328	0.385	0.340
0.545	0.364	0.515	0.503	0.161	0.273	0.352	0.313	0.240	0.301	0.391	0.351
0.589	0.332	0.609	0.584	0.177	0.249	0.425	0.374	0.261	0.274	0.471	0.417
0.578	0.419	0.587	0.551	0.168	0.315	0.394	0.328	0.251	0.347	0.437	0.370
0.577	0.405	0.580	0.537	0.169	0.304	0.393	0.326	0.252	0.335	0.436	0.367
0.569	0.375	0.554	0.527	0.168	0.282	0.380	0.329	0.250	0.310	0.421	0.369
0.551	0.329	0.478	0.484	0.164	0.246	0.329	0.305	0.243	0.272	0.365	0.342
0.716	0.471	0.908	0.757	0.207	0.354	0.620	0.456	0.309	0.390	0.688	0.514
0.674	0.463	0.874	0.729	0.198	0.348	0.602	0.449	0.294	0.384	0.667	0.504
0.675	0.427	0.862	0.772	0.202	0.320	0.601	0.491	0.298	0.353	0.665	0.549
0.691	0.377	0.848	0.811	0.209	0.282	0.595	0.525	0.308	0.311	0.659	0.586
0.656	0.491	0.699	0.599	0.191	0.369	0.471	0.355	0.284	0.406	0.523	0.401
0.748	0.458	0.900	0.777	0.220	0.345	0.619	0.479	0.326	0.380	0.686	0.538
0.696	0.431	0.840	0.730	0.209	0.323	0.585	0.462	0.308	0.357	0.648	0.517
0.700	0.381	0.841	0.751	0.212	0.286	0.591	0.484	0.312	0.315	0.655	0.540
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.495	0.403	0.534	0.488	0.142	0.302	0.359	0.290	0.214	0.333	0.399	0.328
0.496	0.392	0.510	0.478	0.144	0.293	0.345	0.290	0.215	0.323	0.383	0.326
0.495	0.360	0.519	0.479	0.146	0.269	0.357	0.299	0.217	0.297	0.396	0.335
0.507	0.325	0.515	0.474	0.151	0.243	0.359	0.301	0.224	0.268	0.397	0.337
0.503	0.404	0.498	0.459	0.146	0.303	0.332	0.270	0.218	0.334	0.370	0.305
0.504	0.393	0.515	0.495	0.146	0.294	0.349	0.300	0.219	0.325	0.387	0.338
0.516	0.368	0.520	0.496	0.152	0.275	0.356	0.309	0.227	0.304	0.395	0.347
0.517	0.330	0.525	0.510	0.154	0.247	0.363	0.325	0.228	0.272	0.402	0.363
0.542	0.409	0.547	0.517	0.156	0.307	0.367	0.307	0.234	0.339	0.407	0.347
0.525	0.394	0.493	0.477	0.152	0.296	0.333	0.288	0.228	0.326	0.370	0.324
0.519	0.362	0.472	0.469	0.154	0.271	0.322	0.291	0.228	0.299	0.357	0.327
0.537	0.327	0.479	0.482	0.160	0.245	0.331	0.306	0.237	0.270	0.367	0.342
0.535	0.409	0.514	0.505	0.155	0.308	0.343	0.298	0.232	0.339	0.381	0.337
0.550	0.401	0.507	0.502	0.161	0.301	0.341	0.302	0.240	0.332	0.379	0.340
0.547	0.370	0.504	0.491	0.163	0.277	0.344	0.304	0.241	0.306	0.382	0.342
0.558	0.330	0.527	0.510	0.167	0.247	0.365	0.323	0.248	0.273	0.405	0.362
0.599	0.464	0.598	0.558	0.174	0.349	0.398	0.327	0.260	0.385	0.443	0.370
0.620	0.454	0.705	0.598	0.182	0.341	0.481	0.362	0.271	0.376	0.534	0.407
0.608	0.414	0.643	0.592	0.181	0.311	0.442	0.368	0.268	0.343	0.490	0.413
0.612	0.368	0.660	0.614	0.184	0.276	0.460	0.390	0.272	0.304	0.509	0.437
0.617	0.469	0.609	0.566	0.180	0.352	0.407	0.334	0.269	0.388	0.452	0.377
0.616	0.456	0.620	0.566	0.183	0.343	0.418	0.340	0.271	0.378	0.465	0.383

0.627	0.422	0.676	0.599	0.188	0.317	0.466	0.373	0.278	0.349	0.517	0.419
0.613	0.369	0.602	0.572	0.186	0.276	0.417	0.362	0.274	0.305	0.462	0.405
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.449	0.379	0.402	0.384	0.128	0.283	0.266	0.224	0.193	0.312	0.296	0.254
0.426	0.368	0.366	0.374	0.123	0.275	0.244	0.224	0.185	0.303	0.272	0.252
0.422	0.337	0.317	0.333	0.124	0.252	0.214	0.204	0.185	0.278	0.238	0.229
0.432	0.306	0.341	0.353	0.127	0.228	0.233	0.222	0.189	0.251	0.259	0.248
0.463	0.392	0.408	0.392	0.135	0.293	0.270	0.228	0.202	0.323	0.301	0.257
0.423	0.390	0.365	0.361	0.123	0.291	0.243	0.215	0.184	0.321	0.270	0.242
0.434	0.356	0.337	0.357	0.128	0.266	0.226	0.218	0.191	0.294	0.251	0.245
0.433	0.313	0.308	0.333	0.129	0.233	0.208	0.207	0.192	0.257	0.231	0.232
0.503	0.405	0.455	0.451	0.144	0.304	0.302	0.265	0.217	0.335	0.336	0.300
0.508	0.389	0.427	0.436	0.147	0.292	0.286	0.261	0.220	0.322	0.318	0.294
0.521	0.364	0.452	0.446	0.154	0.273	0.308	0.275	0.229	0.301	0.342	0.309
0.526	0.332	0.490	0.466	0.155	0.248	0.339	0.295	0.231	0.274	0.376	0.330
0.522	0.411	0.466	0.466	0.150	0.309	0.308	0.273	0.225	0.340	0.343	0.309
0.505	0.395	0.399	0.426	0.147	0.297	0.265	0.253	0.219	0.327	0.295	0.286
0.531	0.368	0.402	0.425	0.157	0.276	0.270	0.260	0.233	0.304	0.301	0.293
0.534	0.328	0.416	0.428	0.159	0.246	0.284	0.267	0.236	0.271	0.315	0.300
0.560	0.472	0.455	0.461	0.163	0.354	0.299	0.267	0.243	0.390	0.333	0.302
0.555	0.463	0.447	0.447	0.164	0.347	0.297	0.264	0.243	0.383	0.330	0.298
0.582	0.443	0.601	0.549	0.174	0.331	0.413	0.341	0.258	0.365	0.457	0.382
0.559	0.383	0.512	0.472	0.168	0.286	0.353	0.295	0.248	0.316	0.391	0.330
0.580	0.477	0.460	0.474	0.169	0.358	0.303	0.275	0.252	0.395	0.337	0.312
0.559	0.461	0.395	0.421	0.165	0.346	0.260	0.248	0.245	0.382	0.290	0.280
0.555	0.434	0.395	0.410	0.165	0.325	0.264	0.248	0.245	0.358	0.293	0.279
0.598	0.396	0.527	0.508	0.180	0.297	0.362	0.319	0.265	0.327	0.402	0.357
0.607	0.357	0.467	0.507	0.177	0.268	0.310	0.300	0.263	0.296	0.345	0.339
0.584	0.349	0.392	0.453	0.171	0.261	0.260	0.272	0.254	0.288	0.290	0.307
0.563	0.324	0.322	0.393	0.167	0.243	0.213	0.239	0.247	0.268	0.237	0.270
0.557	0.293	0.292	0.356	0.166	0.219	0.194	0.219	0.245	0.241	0.216	0.246
0.626	0.356	0.521	0.552	0.181	0.267	0.348	0.328	0.271	0.294	0.387	0.371
0.612	0.343	0.423	0.488	0.179	0.257	0.281	0.294	0.266	0.284	0.313	0.331
0.597	0.315	0.353	0.430	0.177	0.236	0.235	0.263	0.263	0.260	0.261	0.296
0.598	0.282	0.324	0.398	0.178	0.211	0.216	0.245	0.263	0.233	0.240	0.276
0.477	0.407	0.454	0.419	0.135	0.304	0.301	0.244	0.204	0.336	0.335	0.276
0.482	0.393	0.469	0.434	0.138	0.294	0.316	0.261	0.208	0.324	0.351	0.294
0.514	0.365	0.481	0.506	0.151	0.273	0.329	0.317	0.225	0.301	0.365	0.355
0.510	0.327	0.439	0.484	0.151	0.243	0.300	0.307	0.224	0.269	0.333	0.343
0.552	0.419	0.587	0.541	0.158	0.314	0.394	0.322	0.238	0.346	0.438	0.363
0.462	0.408	0.434	0.414	0.133	0.305	0.291	0.248	0.200	0.337	0.323	0.279
0.542	0.377	0.522	0.503	0.162	0.283	0.358	0.313	0.240	0.312	0.397	0.351
0.531	0.324	0.459	0.489	0.158	0.242	0.316	0.310	0.235	0.267	0.351	0.347
0.462	0.400	0.388	0.380	0.131	0.299	0.256	0.220	0.198	0.330	0.285	0.249
0.487	0.382	0.409	0.459	0.140	0.286	0.274	0.278	0.210	0.315	0.304	0.313
0.481	0.360	0.331	0.389	0.140	0.270	0.222	0.239	0.210	0.297	0.247	0.269
0.470	0.320	0.295	0.337	0.138	0.239	0.198	0.208	0.206	0.264	0.221	0.234

0.526	0.412	0.513	0.484	0.150	0.309	0.342	0.284	0.226	0.341	0.380	0.321
0.510	0.395	0.453	0.463	0.148	0.296	0.304	0.278	0.221	0.326	0.337	0.313
0.510	0.361	0.397	0.443	0.150	0.270	0.267	0.274	0.223	0.298	0.297	0.307
0.549	0.324	0.401	0.492	0.164	0.242	0.272	0.311	0.243	0.267	0.302	0.348
0.615	0.491	0.687	0.564	0.179	0.368	0.462	0.332	0.266	0.406	0.513	0.376
0.552	0.485	0.551	0.491	0.163	0.363	0.370	0.294	0.242	0.401	0.410	0.331
0.556	0.448	0.576	0.521	0.166	0.335	0.392	0.321	0.246	0.369	0.434	0.361
0.560	0.398	0.586	0.540	0.168	0.297	0.403	0.340	0.248	0.327	0.446	0.380
0.656	0.490	0.695	0.602	0.190	0.368	0.467	0.356	0.284	0.405	0.519	0.402
0.629	0.479	0.675	0.572	0.185	0.359	0.459	0.345	0.275	0.396	0.509	0.388
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.574	0.401	0.545	0.499	0.172	0.300	0.375	0.313	0.254	0.330	0.417	0.351
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.490	0.400	0.439	0.432	0.141	0.300	0.292	0.253	0.212	0.331	0.325	0.286
0.437	0.382	0.310	0.342	0.126	0.287	0.203	0.200	0.189	0.316	0.226	0.226
0.436	0.350	0.311	0.339	0.127	0.261	0.207	0.206	0.191	0.288	0.231	0.232
0.479	0.318	0.392	0.425	0.142	0.237	0.269	0.268	0.212	0.262	0.298	0.300
0.510	0.412	0.535	0.490	0.146	0.309	0.358	0.289	0.219	0.341	0.398	0.326
0.529	0.382	0.445	0.437	0.159	0.287	0.298	0.261	0.235	0.316	0.331	0.294
0.478	0.361	0.401	0.412	0.140	0.270	0.271	0.254	0.209	0.298	0.301	0.285
0.482	0.316	0.322	0.373	0.143	0.236	0.217	0.232	0.213	0.260	0.241	0.260
0.497	0.407	0.433	0.431	0.142	0.305	0.287	0.252	0.214	0.337	0.319	0.285
0.496	0.386	0.373	0.421	0.144	0.290	0.248	0.251	0.215	0.320	0.276	0.284
0.478	0.357	0.309	0.343	0.140	0.267	0.206	0.208	0.209	0.295	0.229	0.234
0.479	0.320	0.292	0.337	0.140	0.240	0.195	0.208	0.209	0.264	0.218	0.233
0.556	0.416	0.540	0.515	0.160	0.313	0.360	0.303	0.240	0.345	0.400	0.342
0.490	0.389	0.402	0.404	0.143	0.291	0.268	0.239	0.213	0.321	0.298	0.270
0.488	0.356	0.297	0.344	0.144	0.267	0.196	0.208	0.214	0.294	0.218	0.234
0.483	0.319	0.268	0.327	0.143	0.239	0.178	0.200	0.213	0.264	0.199	0.225
0.610	0.464	0.622	0.563	0.177	0.349	0.417	0.332	0.265	0.385	0.464	0.375
0.594	0.439	0.583	0.537	0.175	0.330	0.394	0.322	0.260	0.364	0.437	0.363
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.630	0.475	0.637	0.601	0.184	0.357	0.425	0.357	0.274	0.394	0.473	0.403
0.605	0.453	0.577	0.536	0.179	0.340	0.388	0.322	0.266	0.375	0.431	0.363
0.609	0.416	0.598	0.554	0.183	0.312	0.408	0.343	0.271	0.344	0.453	0.385
0.612	0.359	0.660	0.590	0.187	0.269	0.461	0.375	0.275	0.297	0.511	0.420
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.407	0.379	0.312	0.306	0.116	0.283	0.205	0.174	0.176	0.312	0.228	0.198
0.506	0.373	0.338	0.375	0.149	0.281	0.223	0.220	0.222	0.309	0.248	0.249

0.451	0.344	0.334	0.355	0.132	0.257	0.224	0.217	0.198	0.284	0.249	0.244
0.478	0.319	0.599	0.536	0.141	0.238	0.419	0.345	0.210	0.262	0.464	0.385
0.401	0.400	0.311	0.305	0.116	0.299	0.202	0.174	0.174	0.330	0.226	0.197
0.471	0.340	0.264	0.313	0.147	0.256	0.171	0.180	0.216	0.282	0.191	0.205
0.450	0.352	0.344	0.357	0.132	0.263	0.231	0.218	0.197	0.290	0.257	0.245
0.478	0.312	0.348	0.363	0.143	0.233	0.236	0.225	0.212	0.257	0.262	0.252
0.585	0.431	0.564	0.525	0.166	0.323	0.376	0.310	0.250	0.357	0.419	0.350
0.501	0.401	0.425	0.434	0.144	0.300	0.284	0.260	0.216	0.331	0.316	0.293
0.498	0.360	0.320	0.366	0.146	0.269	0.212	0.221	0.218	0.297	0.236	0.249
0.479	0.297	0.215	0.295	0.144	0.223	0.141	0.179	0.214	0.246	0.158	0.202
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.592	0.412	0.556	0.523	0.172	0.309	0.374	0.315	0.257	0.341	0.416	0.355
0.495	0.367	0.367	0.391	0.145	0.275	0.245	0.238	0.216	0.303	0.273	0.268
0.489	0.324	0.294	0.342	0.144	0.243	0.196	0.210	0.215	0.267	0.219	0.236
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.543	0.457	0.406	0.408	0.160	0.343	0.267	0.239	0.238	0.378	0.298	0.270
0.545	0.420	0.396	0.402	0.163	0.315	0.264	0.242	0.241	0.347	0.294	0.273
0.547	0.353	0.285	0.335	0.163	0.265	0.187	0.201	0.242	0.292	0.209	0.227
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.588	0.461	0.451	0.462	0.173	0.346	0.299	0.274	0.257	0.382	0.332	0.309
0.605	0.411	0.421	0.425	0.180	0.309	0.282	0.256	0.267	0.340	0.314	0.289
0.560	0.371	0.352	0.370	0.166	0.278	0.235	0.225	0.247	0.306	0.262	0.254
0.601	0.351	0.426	0.471	0.176	0.264	0.281	0.277	0.261	0.291	0.313	0.314
0.585	0.333	0.339	0.405	0.173	0.250	0.222	0.240	0.256	0.276	0.248	0.271
0.582	0.308	0.304	0.384	0.174	0.231	0.201	0.233	0.258	0.255	0.224	0.262
0.578	0.275	0.288	0.365	0.174	0.206	0.191	0.224	0.256	0.227	0.213	0.252
0.644	0.319	0.445	0.511	0.191	0.240	0.293	0.301	0.283	0.264	0.327	0.341
0.620	0.313	0.372	0.457	0.184	0.235	0.245	0.272	0.273	0.260	0.273	0.308
0.606	0.290	0.305	0.396	0.182	0.217	0.200	0.240	0.269	0.240	0.223	0.270
0.600	0.266	0.298	0.390	0.180	0.199	0.197	0.240	0.266	0.220	0.220	0.270
0.399	0.377	0.328	0.313	0.113	0.281	0.216	0.180	0.171	0.310	0.240	0.204
0.402	0.367	0.319	0.325	0.115	0.274	0.211	0.192	0.173	0.302	0.235	0.216
0.407	0.340	0.319	0.323	0.118	0.253	0.214	0.197	0.177	0.279	0.238	0.221
0.425	0.308	0.312	0.330	0.124	0.229	0.211	0.205	0.185	0.253	0.234	0.230
0.416	0.408	0.323	0.307	0.118	0.305	0.210	0.175	0.179	0.336	0.234	0.198
0.437	0.391	0.356	0.351	0.126	0.292	0.236	0.207	0.189	0.322	0.263	0.234
0.433	0.365	0.347	0.352	0.126	0.272	0.233	0.215	0.188	0.300	0.259	0.242
0.426	0.329	0.320	0.332	0.124	0.245	0.216	0.206	0.186	0.270	0.240	0.231
0.459	0.385	0.339	0.373	0.132	0.289	0.223	0.216	0.198	0.318	0.248	0.245
0.446	0.375	0.297	0.343	0.129	0.281	0.196	0.203	0.193	0.310	0.218	0.229
0.470	0.351	0.302	0.362	0.137	0.263	0.201	0.221	0.205	0.290	0.224	0.249
0.476	0.314	0.279	0.342	0.140	0.235	0.187	0.212	0.209	0.259	0.208	0.238
0.461	0.390	0.329	0.358	0.133	0.292	0.214	0.205	0.199	0.322	0.239	0.233
0.468	0.382	0.335	0.361	0.136	0.286	0.222	0.212	0.203	0.316	0.247	0.240
0.474	0.354	0.319	0.366	0.139	0.265	0.214	0.223	0.208	0.293	0.238	0.251
0.482	0.318	0.301	0.357	0.142	0.238	0.202	0.221	0.212	0.262	0.225	0.248
0.499	0.495	0.365	0.350	0.146	0.371	0.236	0.197	0.217	0.409	0.263	0.223
0.495	0.479	0.360	0.343	0.146	0.359	0.235	0.197	0.217	0.396	0.262	0.223
0.498	0.442	0.376	0.348	0.148	0.331	0.251	0.208	0.220	0.365	0.279	0.235
0.504	0.393	0.388	0.367	0.150	0.293	0.263	0.225	0.223	0.324	0.292	0.252
0.516	0.500	0.392	0.381	0.150	0.375	0.254	0.216	0.224	0.414	0.283	0.245
0.509	0.483	0.366	0.363	0.149	0.362	0.238	0.209	0.222	0.400	0.265	0.237
0.539	0.448	0.446	0.421	0.160	0.336	0.300	0.255	0.238	0.370	0.333	0.287
0.516	0.394	0.350	0.358	0.152	0.295	0.233	0.217	0.227	0.325	0.259	0.244

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.424	0.387	0.308	0.316	0.121	0.289	0.201	0.180	0.183	0.319	0.224	0.204
0.436	0.376	0.305	0.326	0.126	0.281	0.201	0.192	0.189	0.310	0.224	0.217
0.466	0.354	0.353	0.372	0.137	0.265	0.238	0.228	0.204	0.292	0.264	0.256
0.443	0.311	0.262	0.301	0.130	0.232	0.175	0.184	0.195	0.256	0.195	0.207
0.445	0.396	0.337	0.338	0.127	0.296	0.220	0.192	0.192	0.327	0.245	0.218
0.437	0.380	0.310	0.328	0.126	0.285	0.203	0.192	0.190	0.314	0.227	0.217
0.457	0.346	0.292	0.328	0.134	0.259	0.193	0.198	0.201	0.285	0.215	0.223
0.469	0.317	0.325	0.355	0.138	0.237	0.219	0.220	0.206	0.261	0.244	0.247
0.445	0.378	0.252	0.301	0.128	0.283	0.161	0.170	0.192	0.313	0.180	0.193
0.460	0.383	0.294	0.340	0.133	0.287	0.193	0.200	0.199	0.316	0.215	0.226
0.485	0.358	0.296	0.359	0.142	0.268	0.195	0.218	0.212	0.296	0.218	0.245
0.481	0.315	0.265	0.326	0.142	0.236	0.176	0.200	0.211	0.260	0.197	0.225
0.461	0.387	0.278	0.334	0.133	0.291	0.178	0.189	0.200	0.320	0.199	0.215
0.461	0.384	0.276	0.332	0.134	0.288	0.179	0.193	0.200	0.318	0.199	0.218
0.483	0.358	0.285	0.348	0.142	0.269	0.187	0.209	0.212	0.296	0.209	0.236
0.501	0.321	0.290	0.352	0.149	0.240	0.193	0.216	0.221	0.265	0.214	0.243
0.511	0.470	0.343	0.368	0.149	0.353	0.221	0.208	0.222	0.389	0.247	0.236
0.551	0.449	0.441	0.438	0.162	0.337	0.293	0.258	0.241	0.372	0.326	0.291
0.543	0.412	0.373	0.389	0.161	0.309	0.248	0.234	0.239	0.341	0.276	0.264
0.547	0.366	0.378	0.393	0.163	0.274	0.255	0.241	0.242	0.302	0.283	0.271
0.525	0.478	0.371	0.402	0.154	0.359	0.240	0.229	0.229	0.396	0.268	0.260
0.514	0.461	0.315	0.355	0.151	0.347	0.204	0.205	0.225	0.382	0.228	0.232
0.528	0.418	0.333	0.365	0.157	0.314	0.219	0.218	0.233	0.346	0.244	0.245
0.546	0.371	0.369	0.388	0.163	0.278	0.248	0.237	0.242	0.306	0.276	0.266
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.434	0.380	0.266	0.295	0.125	0.285	0.171	0.165	0.188	0.315	0.191	0.188
0.423	0.367	0.243	0.276	0.123	0.275	0.157	0.158	0.185	0.304	0.175	0.179
0.434	0.343	0.275	0.311	0.127	0.256	0.182	0.188	0.190	0.283	0.203	0.211
0.439	0.305	0.238	0.286	0.129	0.228	0.158	0.174	0.193	0.251	0.176	0.196
0.443	0.375	0.266	0.301	0.130	0.281	0.170	0.168	0.195	0.310	0.190	0.191
0.434	0.364	0.239	0.278	0.129	0.273	0.153	0.159	0.192	0.301	0.171	0.180
0.461	0.333	0.246	0.285	0.140	0.250	0.161	0.169	0.207	0.276	0.180	0.191
0.452	0.311	0.264	0.309	0.134	0.232	0.176	0.189	0.200	0.256	0.196	0.213
0.497	0.357	0.271	0.354	0.150	0.269	0.173	0.202	0.222	0.296	0.194	0.229
0.465	0.360	0.254	0.333	0.139	0.271	0.164	0.195	0.206	0.298	0.184	0.220
0.460	0.349	0.264	0.330	0.136	0.262	0.174	0.200	0.203	0.289	0.194	0.225
0.487	0.310	0.273	0.335	0.145	0.233	0.183	0.206	0.216	0.257	0.203	0.232
0.507	0.368	0.273	0.348	0.153	0.278	0.175	0.198	0.226	0.306	0.196	0.225
0.488	0.355	0.214	0.299	0.148	0.268	0.136	0.173	0.219	0.295	0.152	0.196

0.458	0.336	0.197	0.271	0.137	0.252	0.126	0.159	0.204	0.278	0.141	0.180
0.483	0.315	0.258	0.320	0.143	0.236	0.171	0.195	0.213	0.261	0.191	0.220
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.568	0.429	0.376	0.418	0.167	0.323	0.246	0.244	0.248	0.356	0.275	0.276
0.566	0.395	0.339	0.390	0.169	0.297	0.223	0.233	0.250	0.328	0.249	0.263
0.567	0.351	0.328	0.381	0.170	0.263	0.219	0.232	0.251	0.290	0.244	0.261
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.581	0.402	0.347	0.394	0.173	0.303	0.229	0.237	0.256	0.334	0.255	0.267
0.571	0.375	0.389	0.410	0.170	0.281	0.263	0.253	0.253	0.310	0.292	0.284

Table D.2 Transmission Factor Results for Hiroshima

tf by ft, rt, gr, sh, fn, sp, fs -----

0.783	0.882	0.851	0.826	0.373	0.667	0.598	0.510	0.485	0.735	0.661	0.573
0.774	0.611	0.855	0.804	0.299	0.461	0.601	0.505	0.409	0.509	0.665	0.566
0.768	0.359	0.832	0.787	0.253	0.270	0.588	0.507	0.362	0.298	0.650	0.567
0.744	0.243	0.767	0.746	0.232	0.182	0.546	0.491	0.339	0.201	0.604	0.547
0.781	0.855	0.847	0.850	0.372	0.647	0.594	0.526	0.485	0.713	0.657	0.591
0.761	0.600	0.838	0.804	0.293	0.453	0.588	0.505	0.401	0.499	0.651	0.566
0.766	0.352	0.821	0.791	0.251	0.265	0.580	0.509	0.360	0.292	0.641	0.569
0.761	0.232	0.809	0.787	0.238	0.174	0.576	0.519	0.347	0.192	0.638	0.578
0.566	1.183	0.741	0.695	0.228	0.893	0.516	0.426	0.308	0.984	0.571	0.479
0.568	0.826	0.801	0.708	0.192	0.623	0.561	0.443	0.272	0.686	0.620	0.497
0.625	0.516	0.915	0.792	0.190	0.388	0.648	0.512	0.279	0.428	0.716	0.571
0.642	0.345	0.936	0.837	0.193	0.258	0.670	0.556	0.285	0.285	0.741	0.618
0.687	1.202	0.903	0.806	0.301	0.909	0.630	0.495	0.399	1.001	0.697	0.556
0.721	0.828	1.036	0.910	0.260	0.625	0.729	0.574	0.362	0.689	0.806	0.643
0.610	0.493	0.820	0.734	0.190	0.370	0.578	0.472	0.277	0.408	0.640	0.527
0.655	0.332	0.935	0.827	0.200	0.249	0.669	0.548	0.294	0.274	0.740	0.609
0.549	1.179	0.730	0.741	0.222	0.889	0.510	0.458	0.300	0.980	0.564	0.514
0.599	0.834	0.824	0.766	0.207	0.629	0.578	0.481	0.291	0.693	0.638	0.539
0.611	0.508	0.809	0.710	0.186	0.382	0.571	0.456	0.273	0.421	0.631	0.509
0.772	0.334	1.246	1.076	0.235	0.251	0.896	0.717	0.345	0.276	0.991	0.797
0.570	1.198	0.751	0.721	0.238	0.904	0.524	0.442	0.319	0.996	0.579	0.497
0.612	0.826	0.825	0.758	0.216	0.623	0.579	0.475	0.302	0.686	0.640	0.533
0.696	0.508	0.987	0.860	0.218	0.383	0.700	0.556	0.316	0.422	0.774	0.621
0.644	0.333	0.837	0.750	0.195	0.250	0.596	0.494	0.288	0.275	0.660	0.550
0.674	1.415	0.932	0.878	0.280	1.071	0.654	0.541	0.375	1.180	0.722	0.608
0.695	0.963	1.042	0.945	0.243	0.728	0.735	0.597	0.341	0.802	0.812	0.668
0.716	0.572	1.007	0.949	0.222	0.431	0.712	0.616	0.324	0.475	0.787	0.687
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.699	1.445	0.911	0.788	0.296	1.093	0.637	0.480	0.395	1.204	0.705	0.540
0.725	0.981	1.060	0.921	0.257	0.741	0.748	0.580	0.358	0.817	0.826	0.650
0.753	0.580	1.124	0.971	0.236	0.437	0.800	0.631	0.342	0.482	0.883	0.704
0.772	0.375	1.129	1.014	0.237	0.282	0.810	0.677	0.347	0.310	0.896	0.752
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.431	1.128	0.541	0.554	0.172	0.849	0.374	0.337	0.234	0.936	0.413	0.379
0.406	0.717	0.578	0.587	0.133	0.535	0.402	0.368	0.191	0.590	0.445	0.413
0.469	0.473	0.563	0.526	0.141	0.354	0.393	0.335	0.208	0.390	0.435	0.374
0.528	0.332	0.681	0.600	0.158	0.248	0.484	0.394	0.234	0.273	0.536	0.439
0.413	1.109	0.500	0.508	0.166	0.834	0.343	0.305	0.225	0.920	0.380	0.344
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.492	0.500	0.528	0.500	0.150	0.376	0.364	0.314	0.220	0.414	0.403	0.352
0.536	0.337	0.609	0.527	0.161	0.252	0.430	0.343	0.238	0.278	0.476	0.382
0.674	1.179	0.846	0.782	0.288	0.891	0.591	0.477	0.384	0.982	0.653	0.537
0.701	0.809	0.961	0.846	0.249	0.611	0.675	0.530	0.347	0.673	0.746	0.593

0.688	0.500	1.018	0.896	0.213	0.376	0.721	0.580	0.310	0.415	0.797	0.647
0.645	0.334	0.862	0.783	0.195	0.250	0.615	0.517	0.287	0.276	0.680	0.575
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.691	0.836	0.891	0.794	0.249	0.633	0.624	0.497	0.347	0.697	0.690	0.557
0.724	0.499	0.992	0.866	0.228	0.377	0.704	0.559	0.331	0.415	0.778	0.624
0.649	0.336	0.812	0.734	0.197	0.252	0.578	0.482	0.291	0.278	0.640	0.537
0.627	1.394	0.785	0.739	0.266	1.054	0.547	0.450	0.354	1.162	0.605	0.506
0.646	0.950	0.859	0.778	0.229	0.718	0.601	0.485	0.320	0.791	0.664	0.543
0.636	0.573	0.859	0.744	0.198	0.431	0.606	0.476	0.289	0.475	0.670	0.532
0.646	0.371	0.879	0.786	0.196	0.278	0.628	0.518	0.289	0.306	0.694	0.576
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.669	0.968	0.845	0.734	0.241	0.731	0.592	0.456	0.335	0.806	0.654	0.512
0.695	0.574	0.913	0.773	0.218	0.432	0.646	0.497	0.316	0.477	0.714	0.555
0.663	0.378	0.893	0.762	0.201	0.284	0.637	0.501	0.297	0.313	0.705	0.557
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.456	1.129	0.372	0.387	0.208	0.855	0.251	0.224	0.274	0.942	0.279	0.254
0.402	0.741	0.396	0.399	0.142	0.557	0.270	0.241	0.199	0.614	0.299	0.271
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.473	0.313	0.377	0.397	0.139	0.234	0.260	0.253	0.207	0.258	0.288	0.283
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.387	0.764	0.434	0.426	0.134	0.573	0.297	0.259	0.189	0.632	0.329	0.291
0.419	0.450	0.287	0.327	0.136	0.338	0.193	0.200	0.197	0.372	0.214	0.225
0.467	0.279	0.209	0.257	0.145	0.210	0.139	0.157	0.213	0.231	0.155	0.176
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.453	0.490	0.366	0.360	0.138	0.368	0.249	0.221	0.203	0.406	0.276	0.248
0.516	0.331	0.516	0.475	0.153	0.248	0.362	0.307	0.227	0.273	0.401	0.342
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.512	0.329	0.389	0.393	0.152	0.246	0.268	0.249	0.226	0.271	0.298	0.278
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.721	0.931	0.707	0.699	0.341	0.704	0.493	0.427	0.445	0.776	0.546	0.481
0.692	0.633	0.574	0.586	0.270	0.478	0.397	0.359	0.368	0.527	0.440	0.404
0.641	0.422	0.437	0.470	0.204	0.318	0.299	0.292	0.295	0.350	0.332	0.328
0.734	0.243	0.632	0.661	0.226	0.183	0.445	0.432	0.331	0.201	0.494	0.482
0.676	0.963	0.685	0.717	0.312	0.727	0.478	0.439	0.409	0.801	0.529	0.495
0.737	0.602	0.692	0.682	0.288	0.455	0.481	0.422	0.392	0.501	0.533	0.475
0.666	0.394	0.454	0.502	0.214	0.296	0.310	0.312	0.308	0.327	0.344	0.351
0.646	0.255	0.423	0.474	0.195	0.191	0.292	0.303	0.288	0.211	0.325	0.339

0.470	1.135	0.599	0.558	0.185	0.854	0.414	0.337	0.251	0.941	0.458	0.379
0.516	0.801	0.700	0.637	0.174	0.602	0.488	0.397	0.246	0.663	0.539	0.445
0.568	0.503	0.754	0.675	0.172	0.377	0.529	0.432	0.252	0.416	0.586	0.482
0.633	0.348	0.856	0.763	0.190	0.260	0.609	0.503	0.281	0.287	0.674	0.559
0.475	1.144	0.589	0.558	0.196	0.860	0.406	0.336	0.264	0.948	0.450	0.379
0.528	0.807	0.676	0.600	0.184	0.607	0.469	0.370	0.260	0.669	0.519	0.415
0.559	0.498	0.713	0.654	0.172	0.374	0.500	0.419	0.252	0.412	0.553	0.468
0.585	0.337	0.699	0.651	0.176	0.252	0.494	0.426	0.260	0.278	0.547	0.474
0.461	1.149	0.517	0.518	0.192	0.867	0.354	0.310	0.258	0.955	0.393	0.350
0.484	0.799	0.542	0.529	0.169	0.602	0.373	0.325	0.238	0.663	0.413	0.365
0.524	0.491	0.529	0.519	0.161	0.369	0.366	0.327	0.236	0.407	0.405	0.366
0.560	0.332	0.529	0.525	0.167	0.249	0.369	0.339	0.248	0.274	0.409	0.378
0.457	1.223	0.577	0.599	0.189	0.924	0.398	0.364	0.255	1.018	0.441	0.409
0.523	0.830	0.604	0.583	0.186	0.626	0.417	0.359	0.260	0.690	0.462	0.403
0.539	0.504	0.549	0.531	0.166	0.379	0.379	0.334	0.243	0.418	0.420	0.374
0.551	0.330	0.493	0.496	0.164	0.247	0.343	0.319	0.244	0.272	0.380	0.356
0.656	1.418	0.821	0.753	0.276	1.073	0.571	0.458	0.368	1.183	0.631	0.515
0.624	0.976	0.828	0.716	0.220	0.736	0.577	0.443	0.308	0.812	0.639	0.497
0.652	0.582	0.866	0.779	0.203	0.438	0.609	0.500	0.295	0.482	0.674	0.558
0.683	0.378	0.846	0.812	0.207	0.283	0.599	0.534	0.304	0.312	0.663	0.595
0.681	1.447	0.799	0.720	0.292	1.095	0.554	0.436	0.388	1.207	0.613	0.491
0.704	0.982	0.879	0.775	0.252	0.742	0.613	0.481	0.350	0.817	0.678	0.541
0.673	0.589	0.834	0.733	0.210	0.444	0.585	0.467	0.305	0.489	0.648	0.522
0.693	0.382	0.844	0.765	0.210	0.287	0.599	0.501	0.309	0.316	0.663	0.558
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.400	1.085	0.471	0.469	0.162	0.815	0.322	0.280	0.219	0.899	0.357	0.316
0.437	0.773	0.508	0.485	0.150	0.581	0.350	0.297	0.212	0.640	0.387	0.334
0.469	0.476	0.502	0.469	0.143	0.357	0.348	0.295	0.210	0.393	0.385	0.330
0.498	0.325	0.499	0.469	0.148	0.243	0.349	0.303	0.220	0.268	0.387	0.338
0.408	1.125	0.461	0.449	0.169	0.847	0.314	0.266	0.228	0.933	0.348	0.300
0.442	0.783	0.511	0.500	0.153	0.588	0.351	0.306	0.216	0.649	0.388	0.344
0.486	0.487	0.527	0.507	0.148	0.365	0.364	0.320	0.218	0.403	0.404	0.358
0.519	0.329	0.544	0.524	0.154	0.246	0.380	0.339	0.229	0.271	0.421	0.378
0.448	1.165	0.503	0.515	0.186	0.879	0.344	0.309	0.250	0.969	0.382	0.348
0.481	0.802	0.526	0.506	0.167	0.605	0.362	0.309	0.236	0.666	0.401	0.347
0.517	0.491	0.535	0.517	0.158	0.369	0.371	0.326	0.232	0.407	0.411	0.365
0.530	0.327	0.484	0.486	0.158	0.245	0.337	0.314	0.235	0.270	0.374	0.350
0.457	1.177	0.515	0.526	0.194	0.889	0.352	0.315	0.260	0.979	0.391	0.355
0.476	0.812	0.492	0.484	0.170	0.613	0.336	0.293	0.238	0.675	0.372	0.330
0.519	0.494	0.495	0.485	0.161	0.372	0.340	0.303	0.235	0.410	0.377	0.339
0.552	0.330	0.532	0.522	0.165	0.247	0.372	0.337	0.245	0.272	0.412	0.376
0.513	1.347	0.572	0.561	0.221	1.017	0.391	0.333	0.294	1.121	0.433	0.376
0.563	0.942	0.692	0.604	0.201	0.710	0.479	0.368	0.280	0.783	0.530	0.414
0.583	0.560	0.632	0.589	0.181	0.422	0.438	0.369	0.264	0.465	0.485	0.414
0.605	0.368	0.650	0.622	0.182	0.276	0.456	0.403	0.269	0.305	0.505	0.449
0.537	1.388	0.597	0.577	0.236	1.049	0.409	0.344	0.313	1.156	0.453	0.388
0.547	0.950	0.585	0.546	0.201	0.717	0.399	0.329	0.278	0.790	0.443	0.371

0.597	0.571	0.662	0.592	0.188	0.430	0.460	0.372	0.273	0.474	0.509	0.417
0.607	0.370	0.604	0.579	0.184	0.277	0.422	0.373	0.271	0.306	0.468	0.416
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.354	1.041	0.371	0.387	0.147	0.782	0.251	0.228	0.199	0.863	0.279	0.257
0.366	0.712	0.357	0.374	0.127	0.534	0.242	0.226	0.180	0.588	0.269	0.254
0.407	0.448	0.330	0.350	0.125	0.336	0.225	0.217	0.184	0.370	0.250	0.243
0.429	0.308	0.402	0.391	0.126	0.229	0.280	0.252	0.188	0.253	0.310	0.281
0.356	1.089	0.385	0.380	0.149	0.818	0.261	0.223	0.201	0.901	0.290	0.252
0.384	0.754	0.356	0.359	0.139	0.566	0.240	0.214	0.195	0.624	0.266	0.241
0.412	0.470	0.345	0.363	0.127	0.351	0.234	0.224	0.186	0.388	0.260	0.251
0.430	0.319	0.334	0.346	0.127	0.238	0.229	0.219	0.190	0.262	0.254	0.245
0.433	1.150	0.464	0.475	0.179	0.866	0.317	0.283	0.241	0.955	0.351	0.319
0.443	0.786	0.427	0.434	0.156	0.592	0.290	0.262	0.219	0.652	0.322	0.295
0.495	0.484	0.446	0.440	0.152	0.364	0.306	0.274	0.223	0.401	0.340	0.308
0.511	0.331	0.455	0.446	0.151	0.247	0.316	0.286	0.224	0.273	0.351	0.319
0.443	1.175	0.474	0.487	0.187	0.886	0.323	0.289	0.251	0.976	0.358	0.326
0.461	0.808	0.442	0.448	0.164	0.609	0.300	0.270	0.229	0.671	0.333	0.304
0.505	0.492	0.416	0.429	0.156	0.370	0.283	0.266	0.229	0.408	0.314	0.298
0.526	0.329	0.419	0.425	0.156	0.246	0.289	0.270	0.232	0.271	0.321	0.302
0.492	1.389	0.476	0.479	0.217	1.048	0.323	0.281	0.287	1.155	0.358	0.318
0.498	0.949	0.428	0.425	0.184	0.715	0.288	0.252	0.254	0.788	0.320	0.284
0.532	0.584	0.482	0.454	0.167	0.439	0.329	0.280	0.243	0.484	0.365	0.314
0.553	0.384	0.516	0.482	0.166	0.287	0.359	0.307	0.246	0.316	0.398	0.343
0.513	1.415	0.494	0.501	0.228	1.068	0.335	0.296	0.302	1.177	0.372	0.334
0.525	0.965	0.451	0.449	0.194	0.728	0.305	0.268	0.269	0.802	0.338	0.302
0.549	0.586	0.430	0.432	0.172	0.440	0.291	0.264	0.251	0.485	0.324	0.297
0.592	0.397	0.541	0.515	0.178	0.297	0.376	0.329	0.263	0.328	0.417	0.367
0.640	0.978	0.567	0.600	0.302	0.739	0.392	0.363	0.393	0.815	0.435	0.410
0.623	0.662	0.498	0.540	0.240	0.499	0.341	0.330	0.328	0.550	0.379	0.372
0.627	0.378	0.375	0.445	0.206	0.284	0.253	0.275	0.295	0.313	0.281	0.309
0.559	0.298	0.269	0.333	0.165	0.223	0.180	0.207	0.245	0.246	0.201	0.232
0.637	0.950	0.566	0.592	0.303	0.717	0.390	0.357	0.394	0.791	0.432	0.402
0.612	0.674	0.477	0.513	0.233	0.508	0.326	0.312	0.320	0.560	0.362	0.351
0.601	0.411	0.390	0.451	0.191	0.309	0.264	0.280	0.277	0.341	0.294	0.315
0.614	0.268	0.331	0.404	0.185	0.200	0.223	0.253	0.274	0.221	0.248	0.284
0.445	1.149	0.533	0.521	0.178	0.865	0.366	0.313	0.241	0.954	0.406	0.353
0.411	0.760	0.438	0.422	0.139	0.570	0.299	0.255	0.198	0.628	0.331	0.287
0.491	0.483	0.510	0.523	0.149	0.362	0.353	0.332	0.219	0.399	0.391	0.371
0.475	0.320	0.399	0.426	0.140	0.239	0.274	0.273	0.208	0.263	0.305	0.304
0.478	1.189	0.574	0.557	0.198	0.896	0.395	0.335	0.267	0.987	0.437	0.377
0.402	0.788	0.418	0.397	0.139	0.592	0.284	0.239	0.196	0.652	0.315	0.269
0.487	0.494	0.492	0.459	0.149	0.370	0.339	0.286	0.219	0.408	0.376	0.321
0.528	0.318	0.505	0.543	0.157	0.237	0.353	0.354	0.234	0.261	0.391	0.395
0.391	1.135	0.416	0.421	0.159	0.855	0.283	0.249	0.215	0.942	0.314	0.281
0.434	0.783	0.429	0.449	0.150	0.589	0.293	0.274	0.211	0.650	0.325	0.307
0.436	0.461	0.348	0.381	0.132	0.345	0.237	0.237	0.195	0.380	0.264	0.266
0.439	0.315	0.281	0.317	0.128	0.236	0.191	0.200	0.192	0.260	0.213	0.223

0.460	1.179	0.511	0.505	0.193	0.889	0.349	0.301	0.259	0.980	0.387	0.339
0.402	0.775	0.373	0.366	0.138	0.582	0.251	0.217	0.196	0.642	0.279	0.245
0.482	0.483	0.437	0.461	0.147	0.363	0.299	0.288	0.216	0.400	0.332	0.323
0.518	0.325	0.376	0.427	0.154	0.243	0.257	0.272	0.229	0.268	0.286	0.304
0.537	1.448	0.631	0.555	0.227	1.091	0.433	0.330	0.303	1.203	0.480	0.372
0.496	1.005	0.543	0.489	0.178	0.755	0.369	0.294	0.248	0.833	0.409	0.331
0.531	0.605	0.570	0.520	0.166	0.454	0.391	0.324	0.241	0.500	0.433	0.363
0.552	0.398	0.581	0.548	0.165	0.297	0.402	0.351	0.245	0.328	0.446	0.391
0.554	1.473	0.621	0.563	0.237	1.112	0.426	0.334	0.316	1.225	0.472	0.377
0.577	1.006	0.665	0.569	0.207	0.758	0.457	0.345	0.288	0.835	0.507	0.389
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.568	0.401	0.548	0.506	0.170	0.300	0.381	0.322	0.252	0.331	0.423	0.361
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.416	1.124	0.460	0.474	0.174	0.847	0.314	0.283	0.234	0.934	0.348	0.319
0.387	0.764	0.331	0.353	0.137	0.575	0.221	0.209	0.193	0.634	0.246	0.236
0.411	0.457	0.303	0.313	0.125	0.342	0.205	0.191	0.184	0.377	0.227	0.215
0.477	0.319	0.391	0.412	0.142	0.239	0.270	0.264	0.211	0.263	0.300	0.295
0.453	1.128	0.506	0.505	0.197	0.851	0.346	0.300	0.262	0.938	0.384	0.339
0.453	0.758	0.411	0.439	0.175	0.572	0.279	0.265	0.241	0.630	0.310	0.298
0.422	0.474	0.314	0.336	0.129	0.355	0.211	0.205	0.190	0.391	0.235	0.230
0.489	0.326	0.406	0.434	0.145	0.244	0.279	0.278	0.216	0.269	0.310	0.310
0.440	1.169	0.487	0.467	0.178	0.880	0.333	0.277	0.241	0.970	0.369	0.313
0.436	0.796	0.409	0.425	0.155	0.601	0.278	0.256	0.217	0.662	0.308	0.288
0.453	0.472	0.306	0.339	0.139	0.355	0.206	0.208	0.204	0.391	0.229	0.233
0.491	0.323	0.338	0.372	0.145	0.242	0.231	0.235	0.216	0.267	0.257	0.263
0.473	1.208	0.546	0.537	0.198	0.912	0.374	0.320	0.266	1.005	0.414	0.361
0.478	0.812	0.504	0.485	0.168	0.612	0.344	0.294	0.237	0.675	0.382	0.330
0.469	0.481	0.326	0.367	0.146	0.361	0.220	0.225	0.213	0.399	0.244	0.253
0.471	0.313	0.238	0.292	0.140	0.235	0.159	0.181	0.208	0.259	0.177	0.203
0.535	1.379	0.614	0.572	0.228	1.041	0.422	0.341	0.304	1.147	0.467	0.384
0.534	0.920	0.560	0.528	0.192	0.694	0.383	0.318	0.268	0.765	0.424	0.359
0.569	0.541	0.723	0.624	0.178	0.407	0.507	0.394	0.260	0.449	0.560	0.441
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.567	1.444	0.650	0.617	0.244	1.090	0.447	0.370	0.325	1.202	0.495	0.417
0.552	0.952	0.592	0.543	0.201	0.718	0.406	0.329	0.280	0.792	0.450	0.370
0.571	0.568	0.500	0.484	0.180	0.428	0.341	0.298	0.261	0.472	0.379	0.334
0.605	0.360	0.683	0.611	0.184	0.270	0.482	0.396	0.271	0.298	0.534	0.442
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.326	0.997	0.338	0.325	0.129	0.747	0.229	0.189	0.176	0.823	0.254	0.213
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

0.427	0.455	0.419	0.403	0.127	0.340	0.288	0.252	0.189	0.375	0.319	0.282
0.424	0.307	0.260	0.306	0.125	0.229	0.175	0.191	0.187	0.253	0.195	0.214
0.385	1.070	0.355	0.374	0.180	0.807	0.239	0.218	0.237	0.889	0.266	0.246
0.431	0.707	0.272	0.319	0.181	0.535	0.180	0.185	0.244	0.589	0.200	0.210
0.447	0.460	0.358	0.370	0.140	0.345	0.243	0.228	0.205	0.380	0.270	0.256
0.470	0.310	0.350	0.363	0.142	0.232	0.241	0.229	0.211	0.255	0.267	0.257
0.383	1.132	0.431	0.465	0.163	0.855	0.294	0.277	0.219	0.942	0.326	0.313
0.493	0.836	0.557	0.524	0.169	0.630	0.384	0.321	0.239	0.694	0.425	0.361
0.480	0.488	0.399	0.408	0.146	0.367	0.271	0.252	0.215	0.404	0.301	0.283
0.454	0.311	0.216	0.279	0.135	0.233	0.144	0.173	0.201	0.257	0.160	0.194
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.489	0.494	0.406	0.415	0.150	0.371	0.276	0.256	0.220	0.409	0.307	0.288
0.490	0.325	0.321	0.352	0.144	0.243	0.217	0.220	0.215	0.268	0.242	0.247
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.523	0.951	0.498	0.469	0.191	0.717	0.338	0.280	0.265	0.790	0.375	0.315
0.531	0.541	0.297	0.341	0.169	0.408	0.195	0.203	0.244	0.450	0.218	0.229
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.541	0.580	0.400	0.397	0.170	0.436	0.270	0.241	0.248	0.480	0.300	0.272
0.554	0.371	0.358	0.372	0.165	0.278	0.242	0.231	0.245	0.307	0.269	0.259
0.620	0.930	0.505	0.526	0.302	0.703	0.347	0.315	0.391	0.774	0.385	0.355
0.614	0.638	0.398	0.436	0.243	0.482	0.270	0.261	0.330	0.531	0.300	0.295
0.602	0.391	0.318	0.386	0.196	0.294	0.213	0.236	0.282	0.324	0.237	0.265
0.610	0.249	0.288	0.358	0.187	0.186	0.193	0.223	0.275	0.206	0.215	0.250
0.623	0.965	0.539	0.569	0.293	0.729	0.372	0.342	0.382	0.803	0.412	0.386
0.628	0.617	0.437	0.489	0.249	0.465	0.297	0.296	0.338	0.513	0.330	0.334
0.617	0.370	0.324	0.400	0.202	0.278	0.216	0.244	0.290	0.307	0.241	0.275
0.597	0.255	0.284	0.359	0.180	0.191	0.190	0.223	0.266	0.211	0.212	0.251
0.295	0.978	0.258	0.252	0.116	0.731	0.171	0.142	0.159	0.807	0.190	0.161
0.343	0.702	0.317	0.318	0.116	0.525	0.213	0.190	0.166	0.579	0.237	0.214
0.383	0.444	0.330	0.329	0.115	0.331	0.224	0.203	0.170	0.365	0.249	0.228
0.430	0.310	0.332	0.346	0.125	0.230	0.228	0.219	0.188	0.254	0.253	0.245
0.337	1.103	0.323	0.313	0.137	0.828	0.216	0.180	0.185	0.913	0.240	0.204
0.370	0.768	0.350	0.345	0.126	0.575	0.236	0.205	0.179	0.634	0.262	0.231
0.401	0.481	0.335	0.342	0.121	0.360	0.226	0.211	0.179	0.397	0.251	0.237
0.447	0.328	0.349	0.361	0.131	0.245	0.239	0.229	0.196	0.270	0.265	0.256
0.437	1.140	0.420	0.458	0.187	0.860	0.287	0.274	0.249	0.948	0.319	0.309
0.405	0.766	0.345	0.365	0.142	0.576	0.234	0.218	0.200	0.635	0.259	0.246
0.458	0.474	0.332	0.375	0.140	0.356	0.225	0.232	0.206	0.393	0.250	0.260
0.472	0.313	0.282	0.331	0.139	0.234	0.191	0.208	0.207	0.258	0.212	0.233
0.358	1.100	0.336	0.347	0.148	0.828	0.226	0.201	0.200	0.913	0.251	0.228
0.438	0.794	0.402	0.405	0.155	0.598	0.272	0.242	0.218	0.659	0.302	0.273
0.459	0.472	0.317	0.358	0.142	0.354	0.214	0.220	0.208	0.391	0.238	0.247
0.476	0.317	0.297	0.345	0.141	0.237	0.202	0.217	0.210	0.262	0.224	0.243
0.430	1.439	0.384	0.361	0.189	1.082	0.257	0.206	0.250	1.193	0.285	0.234
0.447	0.989	0.374	0.346	0.164	0.743	0.250	0.201	0.227	0.819	0.277	0.228
0.478	0.597	0.378	0.348	0.150	0.448	0.255	0.210	0.218	0.494	0.283	0.236
0.497	0.393	0.388	0.375	0.148	0.294	0.266	0.235	0.220	0.324	0.295	0.262
0.446	1.464	0.407	0.392	0.196	1.103	0.272	0.225	0.260	1.216	0.303	0.255
0.462	1.004	0.386	0.371	0.170	0.756	0.257	0.216	0.235	0.833	0.285	0.245
0.518	0.608	0.450	0.425	0.162	0.457	0.305	0.259	0.236	0.503	0.339	0.292
0.511	0.395	0.357	0.363	0.151	0.296	0.241	0.224	0.225	0.326	0.268	0.252

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.360	1.073	0.339	0.346	0.150	0.807	0.228	0.201	0.202	0.890	0.254	0.228
0.384	0.745	0.320	0.334	0.137	0.560	0.216	0.199	0.192	0.617	0.239	0.224
0.444	0.471	0.371	0.382	0.136	0.353	0.253	0.237	0.200	0.389	0.281	0.265
0.441	0.311	0.273	0.307	0.130	0.232	0.185	0.192	0.194	0.256	0.205	0.215
0.368	1.095	0.341	0.346	0.155	0.824	0.229	0.199	0.208	0.908	0.254	0.226
0.390	0.761	0.330	0.336	0.138	0.572	0.221	0.198	0.194	0.630	0.246	0.223
0.440	0.461	0.318	0.347	0.137	0.346	0.215	0.212	0.200	0.381	0.239	0.238
0.460	0.316	0.311	0.340	0.136	0.236	0.211	0.213	0.203	0.260	0.235	0.239
0.386	1.081	0.308	0.333	0.170	0.815	0.206	0.192	0.226	0.898	0.229	0.218
0.404	0.772	0.300	0.329	0.144	0.582	0.200	0.194	0.202	0.641	0.223	0.220
0.461	0.478	0.303	0.354	0.142	0.359	0.203	0.216	0.208	0.396	0.226	0.243
0.472	0.314	0.253	0.307	0.139	0.235	0.170	0.191	0.208	0.260	0.189	0.214
0.397	1.116	0.337	0.370	0.177	0.842	0.227	0.215	0.234	0.928	0.252	0.243
0.409	0.776	0.304	0.340	0.149	0.585	0.203	0.200	0.207	0.645	0.226	0.226
0.463	0.481	0.306	0.353	0.143	0.362	0.205	0.215	0.210	0.399	0.228	0.242
0.498	0.325	0.303	0.353	0.148	0.243	0.205	0.221	0.220	0.268	0.228	0.248
0.441	1.371	0.383	0.391	0.195	1.032	0.256	0.224	0.258	1.138	0.284	0.254
0.455	0.940	0.334	0.342	0.168	0.708	0.221	0.197	0.233	0.780	0.246	0.223
0.521	0.557	0.385	0.391	0.163	0.419	0.259	0.237	0.238	0.462	0.289	0.267
0.542	0.367	0.381	0.394	0.162	0.275	0.259	0.247	0.240	0.303	0.288	0.276
0.458	1.405	0.408	0.428	0.205	1.060	0.274	0.249	0.271	1.167	0.304	0.282
0.508	0.962	0.459	0.443	0.187	0.726	0.310	0.264	0.259	0.800	0.344	0.298
0.534	0.570	0.430	0.433	0.168	0.429	0.291	0.265	0.245	0.473	0.324	0.298
0.541	0.371	0.374	0.387	0.161	0.278	0.255	0.241	0.240	0.307	0.283	0.270
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.364	1.068	0.292	0.311	0.161	0.805	0.195	0.177	0.213	0.887	0.217	0.201
0.375	0.736	0.258	0.280	0.137	0.554	0.171	0.162	0.191	0.611	0.190	0.184
0.414	0.452	0.268	0.300	0.128	0.339	0.180	0.182	0.188	0.374	0.200	0.205
0.435	0.303	0.234	0.272	0.128	0.227	0.157	0.169	0.192	0.250	0.174	0.189
0.374	1.060	0.304	0.320	0.174	0.798	0.203	0.183	0.229	0.880	0.225	0.207
0.386	0.734	0.260	0.285	0.146	0.552	0.172	0.165	0.202	0.609	0.191	0.187
0.422	0.450	0.213	0.252	0.136	0.339	0.139	0.149	0.198	0.373	0.155	0.168
0.448	0.311	0.263	0.304	0.133	0.232	0.177	0.189	0.199	0.256	0.197	0.212
0.442	1.054	0.328	0.389	0.220	0.797	0.219	0.227	0.285	0.878	0.244	0.257
0.445	0.716	0.249	0.308	0.180	0.541	0.164	0.179	0.244	0.597	0.183	0.203
0.451	0.465	0.298	0.339	0.140	0.349	0.200	0.207	0.205	0.385	0.222	0.233
0.496	0.305	0.268	0.324	0.149	0.229	0.181	0.202	0.221	0.252	0.201	0.227
0.450	1.109	0.329	0.370	0.223	0.840	0.220	0.214	0.290	0.925	0.245	0.243
0.454	0.750	0.250	0.314	0.183	0.567	0.164	0.184	0.249	0.625	0.183	0.208

0.443	0.463	0.229	0.294	0.140	0.349	0.150	0.176	0.204	0.384	0.167	0.198
0.477	0.316	0.249	0.302	0.141	0.237	0.167	0.186	0.211	0.261	0.186	0.209
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.550	0.540	0.360	0.393	0.174	0.407	0.241	0.238	0.252	0.448	0.268	0.268
0.552	0.353	0.308	0.353	0.165	0.265	0.206	0.218	0.245	0.292	0.230	0.244
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.568	0.550	0.364	0.399	0.180	0.415	0.243	0.242	0.261	0.457	0.271	0.273
0.566	0.375	0.400	0.409	0.169	0.281	0.274	0.256	0.250	0.310	0.304	0.288

APPENDIX E

Edit of Transmission Factor Data

Transmission factors for the special case of delayed gamma fluence, FIA response type, and 90cm subject height are shown in table E.1 for Nagasaki and table E.2 for Hiroshima. Each line contains four values of transmission factor for the four frontal shield values, followed by the corresponding four FSD values and the four bin populations. Within the sets of three lines, each line corresponds to a value of subject position. The "fn" label corresponds to the "FN" parameter of table 5.1, increased by 1.

Table E.1 Partial Edit of Transmission Factor Data for Nagasaki

-----summary for ft, rt, gr, sh = 4 1 1 2

-----and for fn= 1, tf, fsp, n by fs, then sp

0.787	0.669	0.552	0.511	0.150	0.173	0.135	0.168	12	5	11	4
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0

-----and for fn= 2, tf, fsp, n by fs, then sp

0.835	0.564	0.541	0.307	0.000	0.198	0.053	0.336	1	8	4	5
0.531	0.459	0.490	0.338	0.127	0.202	0.083	0.219	5	10	3	10
0.000	0.392	0.305	0.301	0.000	0.139	0.202	0.075	0	11	3	4

-----and for fn= 3, tf, fsp, n by fs, then sp

0.728	0.551	0.484	0.358	0.113	0.071	0.196	0.209	4	5	10	5
0.000	0.505	0.515	0.334	0.000	0.167	0.152	0.100	0	21	8	3
0.000	0.466	0.000	0.348	0.000	0.110	0.000	0.000	0	23	0	1

-----and for fn= 4, tf, fsp, n by fs, then sp

0.847	0.599	0.602	0.381	0.000	0.338	0.089	0.000	1	2	2	1
0.000	0.566	0.601	0.402	0.000	0.095	0.000	0.169	0	9	1	2
0.000	0.474	0.000	0.000	0.000	0.108	0.000	0.000	0	6	0	0

-----summary for ft, rt, gr, sh = 4 1 2 2

-----and for fn= 1, tf, fsp, n by fs, then sp

0.750	0.735	0.488	0.457	0.195	0.000	0.149	0.120	13	1	11	7
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0

-----and for fn= 2, tf, fsp, n by fs, then sp

0.707	0.604	0.414	0.351	0.268	0.177	0.242	0.379	3	7	3	5
0.449	0.495	0.437	0.328	0.000	0.192	0.073	0.222	1	15	2	10
0.404	0.361	0.313	0.278	0.175	0.152	0.000	0.088	6	6	1	5

-----and for fn= 3, tf, fsp, n by fs, then sp

0.708	0.537	0.463	0.361	0.212	0.292	0.236	0.204	4	6	8	6
0.798	0.502	0.404	0.332	0.000	0.159	0.110	0.193	1	18	7	6
0.000	0.426	0.523	0.299	0.000	0.106	0.185	0.000	0	21	2	1

-----and for fn= 4, tf, fsp, n by fs, then sp

0.918	0.777	0.572	0.363	0.000	0.000	0.174	0.000	1	1	3	1
0.737	0.566	0.536	0.355	0.000	0.052	0.092	0.132	1	2	7	2
0.000	0.421	0.462	0.000	0.000	0.091	0.107	0.000	0	4	2	0

-----summary for ft, rt, gr, sh = 4 1 3 2

-----and for fn= 1, tf, fsp, n by fs, then sp

0.760	0.477	0.430	0.396	0.231	0.252	0.128	0.109	12	6	8	6

```
   0.000 0.000 0.000 0.000    0.000 0.000 0.000 0.000     0  0  0  0
   0.000 0.000 0.000 0.000    0.000 0.000 0.000 0.000     0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.732 0.624 0.503 0.352    0.204 0.239 0.000 0.309     5  5  1  7
   0.495 0.496 0.412 0.328    0.000 0.223 0.281 0.178     1  9 10  8
   0.286 0.357 0.357 0.285    0.000 0.098 0.417 0.257     1 10  3  4

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.855 0.527 0.443 0.366    0.235 0.327 0.207 0.269     2  8  7  7
   0.864 0.491 0.344 0.348    0.000 0.237 0.375 0.186     1 18  4  9
   0.000 0.425 0.391 0.271    0.000 0.187 0.127 0.098     0 13  9  2

-----and for fn=   4, tf, fsp, n by fs, then sp
   0.962 0.730 0.000 0.421    0.000 0.113 0.000 0.215     1  3  0  2
   0.771 0.599 0.554 0.365    0.000 0.116 0.127 0.220     1  5  3  3
   0.000 0.410 0.425 0.394    0.000 0.170 0.000 0.000     0  4  1  1


-----summary for ft, rt, gr, sh =    4   1   4   2

-----and for fn=   1, tf, fsp, n by fs, then sp
   0.760 0.478 0.398 0.390    0.261 0.387 0.120 0.134    12  3  8  9
   0.000 0.000 0.000 0.000    0.000 0.000 0.000 0.000     0  0  0  0
   0.000 0.000 0.000 0.000    0.000 0.000 0.000 0.000     0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.808 0.639 0.489 0.332    0.183 0.259 0.141 0.307     4  5  3  6
   0.503 0.510 0.373 0.355    0.000 0.237 0.141 0.294     1  9  3 15
   0.000 0.333 0.363 0.309    0.000 0.161 0.446 0.167     0  6  3  9

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.734 0.484 0.492 0.357    0.407 0.365 0.044 0.249     3 11  2  8
   0.843 0.510 0.327 0.352    0.089 0.241 0.252 0.250     2 13  8  9
   0.390 0.428 0.342 0.320    0.125 0.231 0.245 0.200     4 12  4  4

-----and for fn=   4, tf, fsp, n by fs, then sp
   0.990 0.751 0.499 0.358    0.000 0.100 0.000 0.000     1  3  1  1
   0.731 0.572 0.590 0.388    0.071 0.136 0.000 0.241     4  3  1  4
   0.000 0.508 0.370 0.410    0.000 0.000 0.118 0.096     0  1  3  2
```

Table E.2 Partial Edit of Transmission Factor Data for Hiroshima

```
-----summary for ft, rt, gr, sh =   4   1   1   2

-----and for fn=   1, tf, fsp, n by fs, then sp
   0.850 0.717 0.592 0.569   0.132 0.134 0.140 0.156   16  8 11  5
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.806 0.558 0.557 0.313   0.000 0.180 0.046 0.332    1  9  3  5
   0.508 0.449 0.505 0.346   0.109 0.196 0.054 0.204    5 10  3 10
   0.000 0.380 0.374 0.320   0.000 0.194 0.063 0.062    0 10  4  4

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.721 0.599 0.505 0.347   0.096 0.036 0.172 0.058    4  2 15  3
   0.000 0.526 0.537 0.370   0.000 0.156 0.085 0.114    0 24  5  3
   0.000 0.487 0.000 0.370   0.000 0.109 0.000 0.000    0 23  0  1

-----and for fn=   4, tf, fsp, n by fs, then sp
   0.788 0.720 0.563 0.392   0.000 0.000 0.168 0.000    1  1  3  1
   0.000 0.577 0.617 0.428   0.000 0.077 0.021 0.192    0  8  2  2
   0.000 0.501 0.000 0.000   0.000 0.111 0.000 0.000    0  6  0  0


-----summary for ft, rt, gr, sh =   4   1   2   2

-----and for fn=   1, tf, fsp, n by fs, then sp
   0.804 0.682 0.513 0.489   0.184 0.093 0.166 0.127   17  4 12  7
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.910 0.600 0.397 0.345   0.000 0.161 0.303 0.426    1  9  5  3
   0.000 0.500 0.439 0.336   0.000 0.189 0.097 0.235    0 16  2 10
   0.426 0.359 0.319 0.285   0.173 0.153 0.000 0.088    5  7  1  5

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.758 0.583 0.366 0.405   0.182 0.176 0.136 0.241    3  9  5  7
   0.794 0.484 0.485 0.340   0.000 0.153 0.188 0.196    1 18  8  5
   0.000 0.448 0.000 0.314   0.000 0.121 0.000 0.000    0 23  0  1

-----and for fn=   4, tf, fsp, n by fs, then sp
   0.921 0.775 0.569 0.371   0.000 0.000 0.163 0.000    1  1  3  1
   0.734 0.546 0.543 0.443   0.000 0.043 0.094 0.295    1  3  5  3
   0.000 0.449 0.000 0.000   0.000 0.101 0.000 0.000    0  6  0  0


-----summary for ft, rt, gr, sh =   4   1   3   2

-----and for fn=   1, tf, fsp, n by fs, then sp
   0.791 0.502 0.451 0.400   0.227 0.263 0.153 0.107   18  4 11  7
```

```
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.734 0.654 0.459 0.342   0.202 0.239 0.291 0.266    5  4  4  5
   0.500 0.507 0.336 0.347   0.000 0.195 0.260 0.195    1 13  5  9
   0.327 0.363 0.370 0.252   0.173 0.105 0.344 0.147    2  9  4  3

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.860 0.531 0.461 0.358   0.240 0.305 0.233 0.232    2  9  6  7
   0.866 0.485 0.367 0.353   0.000 0.242 0.333 0.222    1 19  4  8
   0.000 0.429 0.415 0.294   0.000 0.187 0.123 0.121    0 11 10  3

-----and for fn=   4, tf, fsp, n by fs, then sp
   0.971 0.733 0.000 0.425   0.000 0.115 0.000 0.211    1  3  0  2
   0.773 0.592 0.484 0.433   0.000 0.101 0.000 0.326    1  6  1  4
   0.000 0.432 0.397 0.399   0.000 0.166 0.130 0.000    0  3  2  1



-----summary for ft, rt, gr, sh =   4   1   4   2

-----and for fn=   1, tf, fsp, n by fs, then sp
   0.787 0.474 0.404 0.359   0.266 0.399 0.073 0.161   18  3 10  9
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0
   0.000 0.000 0.000 0.000   0.000 0.000 0.000 0.000    0  0  0  0

-----and for fn=   2, tf, fsp, n by fs, then sp
   0.827 0.651 0.543 0.361   0.180 0.272 0.000 0.283    4  5  1  8
   0.527 0.524 0.434 0.340   0.000 0.255 0.219 0.275    1  8  4 15
   0.257 0.346 0.363 0.304   0.000 0.131 0.655 0.172    1  6  2  9

-----and for fn=   3, tf, fsp, n by fs, then sp
   0.750 0.496 0.427 0.345   0.407 0.383 0.135 0.269    3 10  4  7
   0.734 0.522 0.292 0.353   0.322 0.261 0.210 0.257    3 12  6 11
   0.393 0.425 0.352 0.302   0.125 0.246 0.388 0.196    4 13  2  5

-----and for fn=   4, tf, fsp, n by fs, then sp
   1.014 0.765 0.506 0.363   0.000 0.092 0.000 0.000    1  3  1  1
   0.762 0.579 0.611 0.387   0.068 0.146 0.000 0.248    4  3  1  4
   0.000 0.515 0.372 0.409   0.000 0.000 0.129 0.109    0  1  3  2
```

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