To the Graduate Council

I am submitting herewith a thesis written by William Bryant Bird entitled "Development of an Optical Surface Method for Transport Calculations " I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nuclear Engineering

Ronald E Pevey

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We have read this thesis
and recommend its acceptance

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Accepted for the Council

Associate Vice Chancellor and
Dean of the Graduate School

Development of an Optical Surface Method for Transport Calculations

A Thesis
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Abstract

The Optical Surface Method (OSM) is a new technique for performing neutron and photon transport calculations for three-dimensional room-like structures An iterative process is used to determine flux values and/or detector responses at points defined by the user. The uncollided fluxes are determined analytically, and one-dimensional discrete ordinates calculations are used to determine transport of radiation through, and reflection from, the walls of the structure The results of these discrete ordinates calculations are stored in response matrix files and are pre-calculated by the MAKERT utility during the problem setup For transport of particles through open space, a simple $1/4\pi r^2$ calculation is used, under the assumption that the air in the room can be treated as a void in most situations

The geometry for a given problem is defined as a series of walls Each wall is defined in terms of its dimensions and material composition Additionally, the walls are divided into a grid of "patches," the size and shape of which are determined by the user of the OSM code. The use of these patch grids allow the inclusion of the spatial distribution of the incoming and outgoing radiation fields for each wall of the structure

Results for the initial test cases show close agreement with detector fluxes and responses predicted by MCNP, while using only a fraction of the computer time required for an MCNP calculation Detector points placed exceedingly close to a wall do not yield accurate results, due to the violation of several assumptions made in the coding of the OSM. This issue will be addressed in future versions of the OSM code.

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1 INTRODUCTION

1.1 The Optical Surface Method

The Optical Surface Method (OSM) is a new technique for performing transport calculations involving neutrons and photons in "room-like" three-dimensional structures It is a fairly simple method, using one-dimensional discrete ordinates calculations to determine transport of radiation through and reflection from the walls of the structure For transport through open space, a basic $1/4\pi r^2$ calculation is used, under the assumption that the air in the room can be treated as a void for most situations.

The geometry is defined as a series of walls composed of various materials. Each of these walls is divided into a number of "patches," the sizes and shapes of which are determined by the user These patches allow us to include the spatial dependence of the radiation incident on the walls of the structure

An iterative process is used to determine the outgoing flux values for each wall patch Initially, only the uncollided flux is calculated, using a $1/4\pi r^2$ calculation, with exponential attenuation through any walls located between a given source and detectors Multiple sources can be defined in a given problem. Similar calculations are then performed for the center-point of each patch Assuming that the incoming radiation field is constant over the entire patch, we now have an incoming flux field (uncollided flux only) on the surface of the wall One-dimensional discrete ordinates calculations then determine the transmitted and reflected fluxes from each patch. These outgoing fluxes are then treated as sources, and $1/4\pi r^2$ calculations, with exponential attenuation in walls, are used to determine the contribution to the flux at the detector points Similarly, we use these same outgoing fluxes to determine the incoming patch fluxes for the next iteration The iterative process continues until the detector responses (detector fluxes if no response function is specified) meet a convergence criteria of 0 01

1.2 The OSM Code

Development of the OSM code system has been performed on an Intel Pentium-II workstation running Windows 98 The code is written in FORTRAN77 and has been compiled using Compaq Visual Fortran, version 6 1. All testing has been performed under Windows 98 and Windows NT 4 0 Three distinct and separate code modules make up the OSM system. The three modules are as follows

- OSM1 this is the front-end of the OSM system This code reads the user input and performs basic data manipulation in preparation for the actual calculation In addition to the main problem output, this code also writes a data file, which used by the OSM2 module.
- OSM2 this module performs the actual OSM calculations and writes results to the output file The bulk of the mathematical manipulation, with the exception of the discrete ordinates calculations, is performed here
- MAKERT this module performs the one-dimensional discrete ordinates calculations that determine the transmission and reflection of radiation in the walls This transmission/reflection data are written to *response matrices*, which are stored in files with names indicating both the material and the thickness of the wall.

In this initial version of the code, the three modules are not linked as closely as they might be in future versions Generally, the MAKERT module is run separately, prior to the other two modules OSM1 and OSM2 are then run consecutively, either manually or through a simple batch process. Future versions of the code should allow for a single batch input that will allow the entire process to be completed with a single step

2 METHODOLOGY

2.1 Method Overview

The Optical Surface Method (OSM) is a new technique for transport calculations involving three-dimensional room-like structures. These structures are defined as a series of *walls* in three-dimensional Cartesian space Each wall, in turn, is divided into *patches*, which allows the code to maintain the spatial profile of the radiation field Following the description of the geometry and the placement of the source(s) and detector(s), an iterative process is used to generate the solution for the flux at the detector points

The size and location of each wall is determined using six numbers that define two corners of the wall in three-dimensional Cartesian space (alternately, these numbers can be thought of as the maximum and minimum values along each axis), as shown in Figure 2-1. The highlighted region of the wall represents two patches one on the near side of the wall and the corresponding patch on the opposite side The user also indicates the materials that make up the wall, as well as the size and shape of the patches.

All sources used with the OSM must be isotropic and must be collapsed to their point equivalents We define each source using three numbers to indicate position in space, one number to indicate the energy group of the emitted particle, and one number to define the strength of the source, in units of particles emitted per second

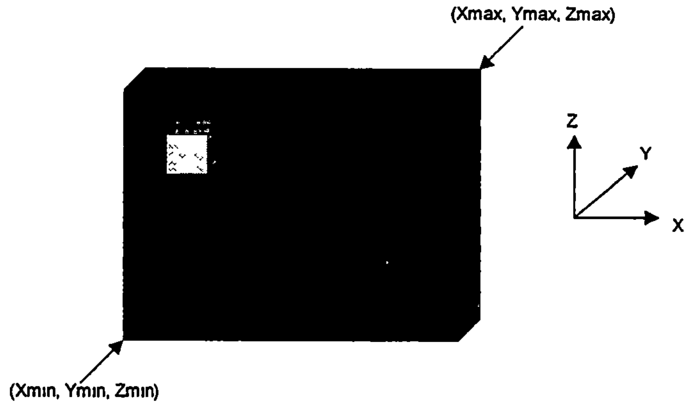

Figure 2-1 Diagram of a Typical Wall

Detectors are completely defined by their position in space, given by x-, y-, and z-coordinates, and the response function to be used.

Following the establishment of the geometry, the uncollided flux is calculated for each detector point This calculation is quite simple, using a simple $1/4\pi r^2$ technique, with exponential attenuation through any intervening walls

Next, similar uncollided flux calculations are performed at the center-point of each patch that has an outward normal vector that faces toward the source This gives us the uncollided incoming flux for each patch The *response matrices* are created via one-dimensional discrete ordinates calculations and are dependent upon both the material and the wall thickness The incoming flux is multiplied by the appropriate values of the response matrices to give outgoing transmitted and reflected fluxes for each patch. The outgoing flux for a given energy group and direction is given by the following equation.

$$\varphi(ia, ig) = \sum_{ja} \sum_{jg} \varphi(ja, jg) R(ia, ig, ja, jg) \tag{2-1}$$

ia = the outgoing direction.

ig = the outgoing energy group.

ja = the incoming direction

jg = the incoming energy group

R(ia,ig,ja,jg) = the response matrix value for transmission/reflection of radiation from direction *ja* and group *jg* to direction *ia* and group *ig*

Following the calculation of these outgoing "first-transmission" fluxes, we treat them as additional sources, calculating the resulting incoming flux for each detector point and patch center-point We add these values to the initial uncollided flux values This process continues until user-specified convergence criteria are met The flow of the computational process is as follows

1 Determine direct contribution from the source to the flux at the detector point(s)

2 Determine direct contribution from the source to flux at each patch center-point

3 Using the response matrices (determined by one-dimensional discrete ordinates calculations) and the incoming flux on each patch, determine the transmitted and reflected fluxes

4 Using the transmitted and reflected fluxes as sources determine the contribution to the flux at each detector point

5 From the detector fluxes, calculate the detector response, if desired

6 Check for convergence of detector response If no response is specified for a given detector, converge on the group-wise fluxes If the solution has converged, end the calculation Otherwise, continue

7 Using the transmitted and reflected fluxes as sources determine the contribution to the incoming flux at each patch center-point

8 Return to step 3.

Alternatively, one might consider modifying the process so that the code converges on the outgoing patch fluxes Once these values have converged, they could be saved and applied to various detector configurations, without having to run the entire problem again This feature may be useful for several different types of analysis, but it has not been included in this initial version of the OSM

2.2 Assumptions

In the development of the Optical Surface Method, it was necessary to make several basic assumptions and approximations These assumptions and their consequences are described in the following paragraphs

- The first major assumption is that there is no "diffusion" of radiation through the walls. That is to say that particles incident on a given patch will not migrate to exit through a different patch. This assumption is reasonable for thin solid walls, where such migration is small. However, for lower density materials and thicker walls, this assumption will break down. One example of such a situation is a problem where skyshine makes an important contribution to the dose. This issue has not been addressed in the testing of the OSM, and users are warned to use caution when modeling systems where skyshine may be an important factor
- We also make an approximation when determining the solid angle subtended by a given patch in reference to a particular point. The fractional solid angle (i e., solid angle in steradians, divided by 4π) of a body relative to a point at the origin is given by equation 2-2

$$\Omega = \int_{dA} \frac{dA}{4\pi R(\bar{r})} \qquad \text{2-2}$$

To avoid the complications that would come about as a result of this integral, we have simplified this relation to *the form shown below.*

$$\Omega \cong \frac{A_p}{4\pi r^2} \qquad 2\text{-}3$$

where A_p is the projected area of the patch, given by $A_p = A^*\cos\theta$, and r is the distance between the reference point and the center point of the patch This simplification is quite good, provided that the reference point is some distance from the patch center point With points that are closer than this minimum distance, the assumption breaks down Typically, this is only a problem near the corners of rooms and/or when sources/detectors are placed close to the walls Under most circumstances, the error in the solid angle calculation decreases to less than one percent at a distance of five to six characteristic lengths The characteristic length of the patch is defined as the largest patch dimension More details on this assumption and the entire solid angle calculation can be found in Appendix A Provided that the source and detector points are sufficiently far from the walls of the structure, this approximation adds only a small amount of uncertainty to the final result.

- It is also assumed that a one-dimensional infinite slab discrete ordinates calculation with standard one-dimensional quadratures is sufficient to describe transport through walls These one-dimensional quadratures depend only on μ, the cosine of the polar angle, where the polar axis is defined to be perpendicular to the surface of the wall However, calculations have shown that incident particles do maintain a "memory" of their initial direction, which means that there is, in reality, some degree of azimuthal dependence in the outgoing flux For this reason, it may be more desirable, in future versions of the code, to adopt a two-dimensional quadrature for the calculation of response matrices In this fashion, the angular dependence of the outgoing fluxes could be more accurately represented, tracking both the polar and azimuthal angles

2.3 Walls, Cross Sections, and Response Matrices

As stated previously, the OSM geometry is defined as a series of rectangular walls, oriented along the three Cartesian axes Each wall is divided into a two-dimensional mesh of patches, which allow the inclusion of the spatial distribution of incoming and outgoing radiation fields

Under the current OSM methodology, only two faces of each wall are "active " This means that the transmission and reflection calculations are only performed for these two faces, with the other four being effectively "dead " For thin walls in most geometries, these dead faces do not cause significant error in the results. However, for thick walls and for certain source-detector configurations, these dead faces could result in serious inaccuracies Future versions of the OSM will allow for all six sides of each wall to be active, which should eliminate these potential problems.

Patches at or near the ends of walls also raise an interesting concern. The OSM methodology assumes that all transmitted particles will exit the wall exactly opposite the incoming patch However, for patches at or near the ends of walls, this will not be the case, as a significant portion of the transmitted flux will actually exit through the end of the wall. This problem would become more severe for thicker walls, as there would be greater opportunity for escape before reaching the opposite face Currently, there are no provisions to correct for this assumption, but it has not shown to be a major source of error in calculations thus far.

Transport calculations for each wall are performed using standard discrete ordinates techniques for one-dimensional infinite slab geometry The one-dimensional quadrature sets used for the S_n computation result in a loss of the azimuthal dependence of the incoming and outgoing flux distributions Thus, one of the inherent assumptions of the OSM is that these flux distributions are azimuthally uniform (i e , they depend solely upon the polar angle) The infinite slab calculation also forces the assumption that there is no interaction between adjacent patches (i e , no diffusion of radiation as it moves through the wall) The end result of these calculations is a series of response matrices, which contain transmission and reflection data for each wall

Group-wise cross section data are obtained from the libraries included with the SCALE code package A simple SCALE run is used to process the data for the materials of interest, with the BONAMI and NITAWL modules providing resonance processing and writing a working library for use in the S_n calculation Currently, the cross section processing and S_n portions of the OSM have only been tested using the 22N-18COUPLED library from SCALE

2.4 Detector Response Functions

Fluence-to-dose conversion factors have been calculated for the 22N18COUPLED energy group structure using the guidelines in the American National Standard for Neutron and Gamma-Ray Fluence-to-Dose Fact`ors (ANSI/ANS-6.1.1-1991).[1] These factors are included with the OSM release in the *ftd.dat* file

2.4.1 Methodology for Determining Response Functions

ANSI/ANS-6.1 1-1991 presents data for computing the dosimetric quantity for neutron and gamma ray fields Values are given for effective dose equivalent for neutron energies of 1 eV to 14 MeV and for gamma energies from 0.01 to 12 MeV. Since neutron energies in the 22N-18COUPLED cross section library extend to 14 92 MeV (see Table 4-1), it is assumed that the response information is also valid at these slightly higher energies The purpose of ANSI/ANS-6 1 1-1991 is to provide those involved in the design or analysis of radiation facilities with the means to determine whether calculated fluence levels satisfy radiation exposure limits recognized by the International Commission on Radiological Protection (ICRP) [1] However, the data given in ANSI/ANS-6.1 1-1991 do not account for the position taken by the ICRP to increase the quality factor for neutrons by a factor of 2 However, this factor of 2 has been taken into account in the computer code (MAKDRF) used to generate the conversion factors for the 22N18COUPLED energy group structure.[5]

ANSI/ANS-6 1 1-1991 presents the neutron and gamma ray fluence-to-dose factors in the form of an exponential fourth order polynomial fit This relationship is shown here as equation 2-4.

$$h_E(E) = 10^{-12} x \exp\left(C_0 + C_1 x + C_2 x^2 + C_3 x^3 + C_4 x^4\right) \qquad \text{2-4}$$

$h_E(E)$ = fluence-to-dose factor (Sv-cm^2)

E = particle energy (MeV)

X = ln(E)

The constants, C_0 through C_4, are dependent upon both the particle type (neutron or gamma) and the particle energy Because the orientation of the receptor with respect to the radiation field is not known, the Anterior-Posterior (AP) exposure geometry values are used [1] The values used for neutrons and photons are given in Table 2-1 and Table 2-2, respectively

Table 2-1 AP Polynomial Coefficients for Neutrons

Neutron Energy Bounds	E ≤ 0.01 MeV	E ≥ 0.01 MeV
C_0	3.43E+00	4 95E+00
C_1	7.73E-01	6 64E-01
C_2	9 83E-02	-1 02E-01
C_3	4 90E-03	-1 50E-03
C_4	8.15E-05	3 64E-03

Table 2-2 AP Polynomial Coefficients for Photons

Photon Energy Bounds	E ≤ 0.15 MeV	E ≥ 0.15 MeV
C_0	2 30402	1 5207
C_1	0 75167	0 79329
C_2	-1 04725	-0 07261
C_3	-0 50091	0 01228
C_4	- 06302	0 00347

The MAKDRF code calculates a mean fluence-to-dose conversion factor for each energy group This average value can be calculated using Equation 2-5. MAKDRF uses a Simpson's integration technique with a convergence factor of 0 001 to evaluate the integrals in the expression

$$\bar{h}_{E_i} = \frac{\int_{E_{l_i}}^{E_{u_i}} h_E(E)\Phi(E)d(E)}{\int_{E_{l_i}}^{E_{u_i}} \Phi(E)d(E)} \qquad 2\text{-}5$$

MAKDRF was run to calculate AP fluence-to-dose factors for the 22N18COUPLED group structure The input and output files are provided with the OSM distribution as *22n18 grp* and *ftd.drf*, respectively. When reading in the response function data, OSM requires only the numerical data, without the text that is included in the output. The data is provided with the OSM release as *ftd dat*

2.4.2 Using MAKDRF

The MAKDRF input consists of a simple KOFFI (Keyword Ordered Free-Form Input) input file with two keywords

- Neutron_groups Following this keyword, input the energy boundaries for the neutron energy groups Upper and lower bounds must be supplied for each group

Thus, for the 22N18COUPLED energy structure, which contains 22 neutron groups, 23 values are required

- Gamma_groups Following this keyword, input the energy boundaries for the neutron energy groups. Upper and lower bounds must be supplied for each group Thus, for the 22N18COUPLED energy structure, which contains 18 energy groups, 19 values are required

Results are sent to a user-specified output file. As previously mentioned, the OSM requires only the numerical values, without the text that is included in the output The user should remove this extra information manually, after verifying that the results are satisfactory

2.5 Sources, Detectors, and Streaming

When using the OSM methodology, there are four situations for which streaming of particles between points must be considered. These situations are as follows:

- Isotropic source to point detector
- Isotropic source to wall patch
- Wall patch to point detector
- Wall patch to wall patch

The basic physics governing radiation transport remain the same for each of these situations, but the mathematical representation differs slightly. The remainder of this section will present the mathematical expressions and provide a brief explanation for each case.

2.5.1 Isotropic Source to Point Detector

The interaction between an isotropic point source and a point detector is the simplest of the four cases The expression used to calculate the contribution to the detector flux is given by equation 2-6

$$\delta\phi_{g,unc} = \frac{S_g}{4\pi r^2} e^{-\sum_i d_i \Sigma'_{ig}} \qquad \text{2-6}$$

$\delta\phi_{g,unc} \equiv$ the contribution from this source to the uncollided flux in group g at the detector point

$S_g \equiv$ the source strength in energy group g

$d_i \equiv$ the distance traveled through wall i

$\Sigma^i_{tg} \equiv$ the total cross section for energy group g in wall i

$r \equiv$ the distance between the source and detector

This equation clearly shows the $1/4\pi r^2$ behavior of the flux, and the exponential term accounts for attenuation through any walls situated between the source and detector.

2.5.2 *Isotropic Source to Wall Patch*

This is similar to the previous case, in that the contribution to the scalar flux can be given by an equation quite similar to equation 2-6

$$\delta\phi_g(\bar{r}_p) = \frac{S_g}{4\pi r^2} e^{-\sum_i d_i \Sigma^i_{tg}} \qquad \text{2-7}$$

$\bar{r}_p \equiv$ the position of the patch centerpoint.

Since the incoming angular fluxes have to be translated into the discrete ordinates angular approximation, we had to choose between conserving flux and conserving current. In order to maintain particle balance, we chose to conserve current. The incoming current can be found using the following equation

$$\delta J_g(\bar{r}_p) = \frac{S_g \mu_a}{4\pi r^2} e^{-\sum_i d_i \Sigma^i_{tg}} \qquad \text{2-8}$$

$\mu_a \equiv$ cosine of the incoming angle, relative to the outgoing normal vector for this patch

For each patch, the method requires the incoming angular fluxes, which can be obtained by utilizing the following relation

$$J_g(\bar{r}_p) = \int_{4\pi} \hat{n} \cdot \hat{\Omega}\, \varphi_g(\bar{r}_p, \Omega) d\Omega = \frac{1}{2} \int_{-1}^{1} \mu\varphi(\bar{r}_p, \mu) d\mu \qquad \text{2-9}$$

$\varphi_g(\bar{r}_p, \Omega) \equiv$ angular flux at $\bar{r}_p$ for a given direction, Ω

In order to apply the discrete ordinates formulation to transport inside the wall, it is necessary to place each incoming angular flux contribution into angular bins Each bin is represented by one direction in the discrete ordinates calculations Thus, for an S_n quadrature, there are *n* angular bins into which incoming patch fluxes are grouped Figure 2-2 illustrates this concept for an S_4 Gaussian Quadrature The boundaries for each angular bin are determined by the code, using the μ values and weights input by the user

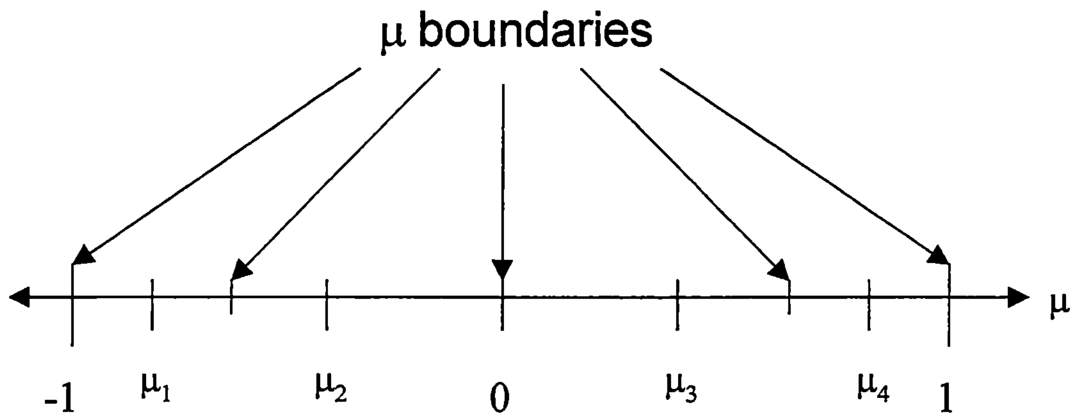

Figure 2-2 Illustration of Angular Bins used for an S4 Gaussian Quadrature

Applying a Gaussian quadrature, this relation becomes:

$$\delta J_g(\bar{r}_p) = \sum_{m=1}^{n} \mu_m wt(\mu_m)\delta\varphi_g(\bar{r}_p, \mu_m) \qquad \text{2-10}$$

$\mu_m \equiv$ cosine of the assigned quadrature direction, relative to the outgoing normal vector for this patch

$wt(\mu_m) \equiv$ weight of direction μ_m.

$\delta\varphi_g(\bar{r}_p, \mu_m) \equiv$ the contribution to the angular flux in direction μ_m from this source

Thus, the contribution to the angular flux will be

$$\delta\varphi_g(\bar{r}_p, \mu_m) = \frac{\delta J_g(\bar{r}_p)}{\mu_m wt(\mu_m)} = \frac{S_g \mu_a}{\mu_m wt(\mu_m) 4\pi r^2} e^{-\sum_i d_i \Sigma_{tg}^i} \qquad \text{2-11}$$

2.5.3 Wall Patch to Point Detector

This case is also quite similar to the first situation, except that the source is not a point source, but is an area source distributed over the face of the patch.

The outgoing angular fluxes move through the void in a single direction, eliminating the $1/4\pi r^2$ losses Thus, the contribution to the angular flux at the detector point is equal to the outgoing angular flux, minus exponential attenuation through any intervening walls

$$\delta\varphi_g(\bar{r}_d,\Omega) = \varphi_g(\bar{r}_p,\Omega)e^{-\sum_i d_i\Sigma_{tg}^i} \tag{2-12}$$

Again, the outgoing direction is assigned to an angular bin to conform to the discrete ordinates methodology used in the transmission and reflection calculations The contribution to the scalar flux at the detector point is given by

$$\delta\phi_g(\bar{r}_p) = \int_{4\pi}\delta\varphi_g(\bar{r}_d,\Omega)\,d\Omega \tag{2-13}$$

It is convenient to transform the solid angle, $d\Omega$, to the following form:

$$d\Omega = \frac{\mu_a dA}{4\pi r^2} \tag{2-14}$$

Using equation 2-14, equation 2-13 becomes

$$\delta\phi_g(\bar{r}_p) = \int_A \frac{\delta\varphi_g(\bar{r}_d,\Omega)\mu_a dA}{4\pi r^2} \tag{2-15}$$

At this point, we assume that r, μ, and φ_g are constant over the entire patch This allows us to pull all these terms outside the integral, resulting in Equation 2-16 The approximation is not perfect, but its effects are minimal for most situations, as shown in Appendix A

$$\delta\phi_g(\bar{r}_p) = \frac{\delta\varphi_g(\bar{r}_d,\mu_m)\mu_a}{4\pi r^2}\int_A dA = \frac{\delta\varphi_g(\bar{r}_d,\mu_m)A_p}{4\pi r^2} \tag{2-16}$$

$A_p \equiv$ the projected area of the source patch relative to the center-point of the incoming patch. $A_p = \mu_a(patch\ area)$

Combining this expression with equation 2-12 will give the following expression for the contribution of the outgoing patch flux to the scalar flux at the detector point

$$\delta\phi_g(\bar{r}_p) = \frac{\varphi_g(\bar{r}_p,\mu_m)A_p}{4\pi r^2}e^{-\sum_i d_i\Sigma_{tg}^i} \tag{2-17}$$

2.5.4 Wall Patch to Wall Patch

This case can be viewed as a combination of the second and third cases The contribution to the scalar flux is given by equation 2-17 Applying the relation in equation 2-10 will yield the following expression for the contribution of an outgoing patch flux to the incoming patch flux

$$\delta\varphi_g(\bar{r}_p,\mu_n) = \frac{\varphi_g(\bar{r}_p,\mu_m)\mu_a A_p}{\mu_m wt(\mu_m)4\pi r^2}e^{-\sum_i d_i\Sigma_{tg}^i} \tag{2-18}$$

3 OSM USER INFORMATION

3.1 Discrete Ordinates Code Inputs

This module of the OSM system is actually two separate codes, currently called WORKING and MAKERT These two codes use working libraries created by the SAS1 module of the SCALE code system to create *response matrices* containing the transmission and reflection data for a given wall Detailed instructions are found in the sub-sections for each code The basic procedure for creating the response matrices is as follows

- Run SCALE to create the working library The *scale.in* file included with the code should serve as a template for the SCALE input, with the user changing the material information to represent the wall of interest in the problem
- Run WORKING, using the *working.inp* file included with the code as the input template Here, the user must modify the input to include the proper number of energy groups and the correct materials
- Run MAKERT, using the *makert in* file included with the code as the input template Again, the user must specify several parameters in the input file to accurately model the wall of interest.

Samples of the *scale.in, working inp,* and *makert.in* files can be found in Appendix B These files are also included with the OSM distribution

3.1.1 SCALE

This section assumes that the user is running SCALE version 4.3 or higher on a PC platform The OSM system has not been tested with older versions or on any other platforms, so the user should exercise caution when operating with a different configuration The procedure for the SCALE run is given below

- Copy the scale in file from the OSM directory to the SCALE directory (usually C \SCALE43\ or C \SCALE44\)
- Modify scale in to reflect the material of interest for your problem Consult section M8 of the SCALE[4] manual for information on the Standard Composition Library The Standard Composition Library contains all the materials available for use in SCALE

- To run the SCALE case, type scale95 scale ın scale out Thıs performs a sımple one-dımensional calculatıon The calculatıon ıtself ıs of lıttle ınterest, as the OSM only requıres the cross-sectıon ınformatıon generated by the case
- Copy the file ft04f001 from C \SCALE43\WORK\ to the OSM dırectory Thıs ıs the workıng lıbrary for the SCALE problem that wıll be used by WORKING and MAKERT to generate the response matrıces for the problem

3.1.2 WORKING

WORKING reads the workıng lıbrary created by SCALE and prepares the data for use ın the one-dımensıonal dıscrete ordınates code, MAKERT The maın output of thıs module ıs stored ın the file *mınotaur mac* To run the module, sımply type *workıng* at the DOS command prompt whıle ın the OSM dırectory When prompted for the input file name, respond with *working ınp* The remaınder of thıs sectıon wıll descrıbe thıs input file and provide ınstructıons for modıfyıng ıt to fit a partıcular problem

The *workıng.inp* file ıs a KOFFI (**K**eyword **O**rdered **F**ree **F**orm **I**nput) file, descrıbıng the ınformation necessary to process the SCALE working lıbrary. Several of the entrıes should not requıre any user modıficatıon Other entrıes contaın problem-dependent informatıon to be supplıed by the user. The keywords found ın the ınput file are as follows

- Optıons: thıs entry should not requıre user modıfication
- Ratio thıs entry should not require user modıfication
- Spacıng thıs entry should not requıre user modificatıon
- Order thıs entry specıfies the Legendre order of the scatterıng cross sectıons It requıres a sıngle integer value
- Left. thıs entry should not require user modıfication
- Rıght thıs entry should not requıre user modıficatıon
- Outers thıs entry specıfies the number of outer ıteratıons for the problem It requıres a sıngle ınteger value The recommended value ıs 100
- Inners thıs entry specıfies the number of ınner ıteratıons per outer ıteratıon It requıres a sıngle ınteger value The recommended value ıs 4
- Groups thıs entry specıfies the number of energy groups to be used It requıres a sıngle ınteger value Thıs value must be set to agree wıth the number of groups present ın the workıng lıbrary

- Legendre this entry specifies the Legendre order of the scattering cross sections. It requires a single integer value
- Quadrature. this entry sets the quadrature to be used in the processing of the working library It requires a single integer value This value must be greater than or equal to the quadrature n to be used in the MAKERT code.
- Convergence this entry sets the convergence criteria for the problem It requires a single real value The recommended value is 0 00001
- Dimension· this entry specifies whether the problem is one-, two-, or three-dimensional It requires a single integer value. For the purposes of the OSM, this should always be set to 1
- Regions this entry specifies the names of the material regions. Entries should be character strings. Generally, there will be only one material region. However, in the future, the user may wish to create walls with multiple material regions.
- Thickness this entry specifies the thickness for each material region. One integer entry is required per entry in the regions card
- Material this entry specifies the isotopic content of a given material region The keyword for the material card is the same as the entry given by the user in the regions card This entry requires two values for each isotope present in the material The first is the ZZAAA material ID# assigned to the isotope by SCALE The second is the number density of that isotope in the material in units of atoms/barn-cm. Both of these values can be found in the output file from the SCALE run described in the previous section

3.1.3 MAKERT

MAKERT performs m*G (where m = the number of directions, and G = the number of energy groups) one-dimensional discrete ordinates (S_n) calculations through the wall. The result of this calculation is a set of *response matrices*, which is stored in a file called *makert rt* This module actually performs two calculations The first is a standard one-dimensional S_n calculation, while the second combines all absorption and scattering interactions into a single loss term to compute the uncollided flux through the wall The results of the second calculation are subtracted from the results of the first in order to obtain the response matrix information The response matrices are then stored in the *makert rt* file, along with the total cross sections and integers to indicate the number of energy groups, the quadrature used, and the number of material regions in the wall The format of this file is described in section 3 2.

The *makert.in* file is another KOFFI input file, similar to *working.inp* The keywords found in the input file are as follows

- Groups: this entry specifies the number of energy groups used in the problem It requires a single integer value
- Legendre this entry specifies the Legendre order of the scattering data contained in the SCALE working library. It requires a single integer value
- Materials this entry specifies the names of the materials contained in the wall. It requires character inputs
- Map this entry specifies the "layout" of the wall It requires at least one integer value The entries in the material card are assigned consecutive integer values, beginning with one The user then places the materials in order, from "left to right," in order to define the wall
- Thickness this entry specifies the thickness of each material region It requires real values (the same number used in the map card)
- Composition this entry specifies the isotopic content of a given material region The keyword for the material card is the same as the entry given by the user in the materials card This entry requires two values for each isotope present in the material. The first is the ZZAAA material ID# assigned to the isotope by SCALE The second is the number density of that isotope in the material. Both of these values can be found in the output file from the SCALE run described in the previous section These values should not differ from those used for the material card in working inp
- Nx this entry specifies the number of mesh cells in each material region It requires a number of integer values equal to the number of values in the map card
- Working_library this card indicates the working library to be used for the Sn calculation Assuming the user has not deviated from the instructions in this document, this should always be *ft04f001*
- Quadrature information This can be input using the MU and WEIGHT keywords, but to avoid errors, the user should simply include the values provided in the OSM distribution, to include these values, add the text 'include s4 qad' on its own line in

the input file The files *s4 qad* and *s8.qad* correspond to S4 and S8 quadratures, respectively

3.2 Discrete Ordinates Code Outputs

The end result of the process described in section 3 1 is a file called *makert rt* The user should rename the file to give some indication of the wall characteristics For example, a file entitled *h2o15s4.rt* might include data corresponding to a 15 cm-thick wall of water and an S_4 quadrature.

The *makert.rt* file contains all the cross section and response matrix information for a given wall The first line of the file contains three integer values These three integers indicate the number of energy groups used in the calculation, the quadrature order, and the number of material regions The next values found in the file indicate the quadrature used by the one-dimensional S_n calculation. The first number on the second line of the file is the weight of the first μ in the quadrature The second number is the actual μ value Thus, for an S_4 calculation, there will be eight values to describe the quadrature. Following the quadrature information are the values for the total cross section There will be one value for each energy group

After the total cross sections, the response matrix begins The total number of values is equal to the product of the number of energy groups squared and the quadrature order squared Thus, for a 40-group S_4 calculation, there will be 25,600 values in the response matrix To read the data, use the following FORTRAN logic block, assuming that the response matrix file is open on logical unit one.

```
read(1,'(1p6e12.5)')((((rt(ia,ig,ja,jg),ia=1,nang),ig=1,ngm),*ja=1,
_nang),jg=1,ngm)
```

where *ia* is the outgoing angle, *ig* is the outgoing energy group, *ja* is the incoming angle, *jg* is the incoming energy group, *nang* is the order of the S_n calculation, and *ngm* is the number of energy groups

When performing calculations using the OSM code system, the OSM2 module will perform checks to ensure that the number of energy groups and the quadrature set in the response matrix files match those to be used in the problem

3.3 OSM Code Inputs

This section contains information necessary to create input decks for the OSM code system Complete sample inputs can be found in Appendix C

3.3.1 General Problem Parameters

The user must provide several general parameters for each problem These parameters define the number of energy groups and the quadrature to be used in the calculation These parameters are defined in the input deck using the NGROUPS, NANG, MU, and WT KOFFI keywords

The NGROUPS card requires a single integer value to set the number of energy groups to be used in the problem

Usage NGROUPS=(number of groups)

```
Example:
NGROUPS=40
```

This specifies a 40 group energy structure

The NANG, MU, and WT cards define the quadrature to be used in the calculations. The NANG card requires one integer value to set the number of directions to be used for the calculation

Usage. NANG=(number of directions)

```
Example:
NANG=4
```

The MU card is used to set the mu values for the chosen quadrature Only the positive values are needed, so the required number of entries is equal to NANG/2

Usage MU=mu(1) mu(2) . mu(NANG/2)

```
Example:
MU=0.339981 0.861146
```

The WT card is used to set the weights used for each mu value This card requires NANG entries

Usage WT=wt(1) wt(2) wt(NANG)

```
Example:
WT= 1.73927E-01 3.26073E-01 3.26073E-01 1.73927E-01
```

When combined, the three examples shown here (for NANG, MU, and WT) define a standard one-dimensional S_4 Gaussian quadrature

3.3.2 *Source Description*

The system will only handle point sources, so all sources must be reduced to their point equivalents For each physical source, we need a location in space, the energy group of the emitted particles, and the source strength Location is defined as a vector in 3 dimensional space The energy group is given as an integer, and the source strength is generally given in scientific notation Source spectra can be defined by placing multiple sources at a single location

The ISOSOURCE keyword is used to describe an isotropic source.

Usage: ISOSOURCE=x y z (energy group) strength

```
Example:
ISOSOURCE=
0 0 1 11 1.7E6
0 0 1 18 2.4E9
```

This specifies an isotropic source at location (0,0,1) with a strength of 1.7E6 particles per second in group 11 and 2 4E9 particles per second in group 18

Input of a non-isotropic source has not yet been implemented.

3.3.3 *Materials*

Materials will be entered using the MATERIAL keyword

Usage MATERIAL=id# filename

where filename is the name of a file containing cross-section and response matrix data.

```
Example:
MATERIAL=lead10s4.mat
```

This example defines a single material, with the material data contained in the file *lead10s4.mat*. The format of the *.mat* files is shown in the section describing the discrete ordinates code outputs It is important to remember that a given material file is only good for a particular energy group structure and a particular quadrature set The code will return a serious error if the material file does not conform to the parameters set for the problem It is also important to note that the MATERIAL label is somewhat misleading here, as the response matrices are dependent upon the wall thickness, as well as the composition

3.3.4 Geometry

The OSM system currently supports walls that run parallel to the three Cartesian axes Walls are defined using the WALLX, WALLY, and WALLZ keywords, for walls with outgoing normal vectors pointing in the x, y, and z directions, respectively

Usage WALLX=id# xmin ymin zmin xmax ymax zmax mat gridy gridz sense

WALLY=id# xmin ymin zmin xmax ymax zmax mat gridx gridz sense

WALLZ=id# xmin ymin zmin xmax ymax zmax mat gridx gridy sense

where gridx is the number of divisions made normal to the x axis

gridy is the number of divisions made normal to the y axis

gridz is the number of divisions made normal to the z axis

sense defines the orientation of the wall

The *sense* entry requires an integer value and defines the "left" and "right" sides of the wall On the left side of the wall, incoming particles have a positive mu value, while on the right side, the incoming particles have a negative mu value A *sense* value of zero for a WALLX will define the left side of the wall as the side that lies on the plane X=xmin Any other *sense* value will define the left side of the wall as the side that lies on the plane X=xmax Similar logic applies for WALLY and WALLZ cards For walls composed of a single material, the sense is unimportant, as the response matrices are symmetric. However, for a laminated wall (example lead lined on one side with polyethylene), the response matrices will not be symmetric, making it important for the user to properly define the sense of each wall.

The inputs are essentially identical The different keywords simply determine the direction of the normal vector and how the wall is divided into segments

```
Example: (normal to x, y, or z, axis)
WALLX=1  0  0  0 10 60 60 1 10 10 0
WALLX=2 50  0  0 60 60 60 1 10 10 0
WALLY=3 10  0  0 50 10 60 1 10 10 0
WALLY=4 10 50  0 50 60 60 1 10 10 0
WALLZ=5 10 10  0 50 50 10 1 10 10 0
WALLZ=6 10 10 50 50 50 60 1 10 10 0
```

This example forms a cube 60 cm on a side, with 10 cm thick walls, each composed of material 1. Each wall is divided into a 10x10 grid of identical segments

Generally, we define walls in such a manner that the discrete ordinates calculation is performed across the “thinnest” dimension However, allowing the user to define the normal direction gives greater flexibility to the code.

3.3.5 *Detector Points*

The system can handle this in two ways The user can either specify a list of individual points or define a mesh Multiple dose calculation points and/or meshes can be defined in the same problem

Individual points are input using the DOSEPOINT keyword

Usage DOSEPOINT=x y z respfcnid#

```
Example 1: (individual points)
DOSEPOINT=
 0  0  0 1
 0 10  0 1
 0  0 10 1
 0 10 10 1
10  0  0 1
10 10  0 1
10  0 10 1
10 10 10 1
```

This defines a series of points that correspond to the corners of a cube 10 cm on a side, starting at the origin and extending into the first octant, with all the points using response function number 1 If only flux information is desired for a given detector point, specify a *respfcnid#* of zero This will prompt the code to only provide group-wise fluxes for that point

The second, simpler, method utilizes the DOSEMESH keyword to define a mesh of points where the dose will be calculated The volume is restricted in that it must be rectangular with the sides of the rectangle parallel to the x, y, and z axes.

Usage. DOSEMESH=x1 y1 z1 x2 y2 z2 gridx gridy gridz respfcnid#

Where gridA is the number of mesh divisions in the A direction

The points (x1,y1,z1) and (x2,y2,z2) define opposite corners of the volume of interest Delta is the spacing between mesh points

```
Example 2: (mesh)
DOSEMESH=0 0 0 10 10 10 1 1 1 1
```

Examples 1 and 2 are exactly equivalent. The mesh option would be used to create a dose map within a particular volume, while individual points would be used for detector studies

3.3.6 Response Functions

A response function must be specified for each detector point If flux is the desired quantity, define *respfcnid#* as zero in the DOSEPOINT or DOSEMESH card If response information (such as absorbed dose) is desired, a group-wise response function must be entered The response functions themselves should be contained in separate files, referenced in the input deck To input the response functions, use the RESPFCN keyword

Usage. RESPFCN=id# values(*number of energy groups)

The values for the response function can be input directly in the input deck However, it is more likely that the user will want to define these in separate files, as a set of response functions will generally be used for multiple problems Use the *include* statement to implement this (Note. the include statement MUST be on its own line!)

```
Example:
RESPFCN=
1
include airresp.dat
2
include newresp.dat
```

This example points to two separate response functions, contained in the *airresp.dat* and *newresp dat* files The files containing the response functions should be in ASCII format and should contain one value for each energy group.

3.4 OSM Code Outputs

Output is printed to a user-specified file in the OSM directory The output is fairly straightforward and easily interpreted A complete output file for the first sample problem is contained in Appendix C

4 SAMPLE PROBLEMS AND RESULTS

Several sample problems were run durıng the testıng of the OSM The results of three of these calculatıons are shown here. Complete ınput and output fıles are gıven ın Appendıx C The three sample problems reported here are

- Source ın a Box This ıs a sımple problem descrıbıng a cubıc box contaınıng a 14 MeV neutron source A detector ıs placed outsıde the box
- Duct Problem. Thıs problem ıs designed to demonstrate the utılity of the OSM for a common shieldıng problem
- Crıtıcality Source problem Thıs problem descrıbes a crıtıcalıty source restıng at the bottom of a pıt. The desıred result ıs the response of two detectors set at a gıven dıstance from the source.

All three of these sample problems were run usıng the 22N-18COUPLED cross section lıbrary included wıth the SCALE code system The group structure for thıs lıbrary ıs shown ın Table 4-1.

Table 4-1 Energy Group Boundarıes for the 22N-18COUPLED Cross Sectıon Lıbrary

Group	Particle Type	Energy Boundaries (eV)
1	Neutron	1 22E+07 – 1 492E+07
2	Neutron	1 00E+07 – 1 22E+07
3	Neutron	8 18E+06 – 10 0E+07
4	Neutron	6 36E+06 – 8 18E+06
5	Neutron	4 96E+06 – 6 36E+06
6	Neutron	4 06E+06 – 4 96E+06
7	Neutron	3 01E+06 – 4 06E+06
8	Neutron	2 46E+06 – 3 01E+06
9	Neutron	2 35E+06 – 2 46E+06
10	Neutron	1 83E+06 – 2 35E+06
11	Neutron	1 11E+06 – 1 83E+06
12	Neutron	5 50E+05 – 1 11E+06
13	Neutron	1 11E+05 – 5 50E+05
14	Neutron	3 35E+03 – 1 11E+05
15	Neutron	5 83E+02 – 3.35E+03
16	Neutron	1 01E+02 – 5 83E+02
17	Neutron	2 90E+01 – 1 01E+02
18	Neutron	1 00999E+01 – 2 90E+01
19	Neutron	3.05999E+00 – 1 00999E+01
20	Neutron	1 12E+00 – 3 05999E+00
21	Neutron	4 14E-01 – 1 12E+00
22	Neutron	1 00E-02 – 4 14E-01
23	Photon	8 00E+06 – 1 00E+07

Table 4-1 Energy Group Boundaries for the 22N-18COUPLED Cross Section Library (Continued)

24	Photon	6.50E+06 – 8 00E+06
25	Photon	5.00E+06 – 6 50E+06
26	Photon	4 00E+06 – 5 00E+06
27	Photon	3 00E+06 – 4 00E+06
28	Photon	2.50E+06 – 3 00E+06
29	Photon	2 00E+06 – 2 50E+06
30	Photon	1 66E+06 – 2 00E+06
31	Photon	1 33E+06 – 1.66E+06
32	Photon	1.00E+06 – 1.33E+06
33	Photon	8.00E+05 – 1 00E+06
34	Photon	6 00E+05 – 8 00E+05
35	Photon	4 00E+05 – 6 00E+05
36	Photon	3 00E+05 – 4 00E+05
37	Photon	2 00E+05 – 3 00E+05
38	Photon	1 00E+05 – 2.00E+05
39	Photon	5 00E+04 – 1.00E+05
40	Photon	1 00E+04 – 5 00E+04

4.1 Source in a Box

This is the simplest meaningful problem for which the OSM would normally be applied First, a cubic 'box' of water is constructed, centered about the origin, with an inside width of two meters The 'walls' (i.e , the water) are 15 cm thick Next a source of 14 MeV neutrons (energy group 1), is placed at the origin; this source emits $1.0*10^{20}$ neutrons per second Finally, a detector is placed 3 meters from the origin, along the x-axis, which places it 185 cm outside the wall This problem was modeled in both the OSM and in MCNP. The input files for the two codes are sample1.inp and sam1 in, respectively The relevant input parameters are contained in Table 4-2.

The energy group structure for the 22N-18COUPLED library is given in Table 4-1 The neutron and photon flux spectra at the detector point are shown in Figure 4-1 and Figure 4-2, respectively As shown in the figures and in Table 4-3, OSM and MCNP give very similar results, with notable differences for high energy neutrons (groups 1-5), thermal neutrons (group 22), and low energy photons (groups 35-40) Comparing these deviations to those seen in the outgoing currents (see Appendix C), it becomes apparent that the differences in results arise from the cross section data, rather than from the methodology For each of the three energy regions where MCNP and the

Table 4-2 Parameters for Sample Problem 1

Specification	OSM	MCNP
Input file	Sample inp (S4) Samples8 inp (S8)	sam1 in
Output file	Sample.out (S4) Samples8 out (S8)	sam1 ino
Geometry	Cubic box with inner dimension of 2 0 meters H_2O walls 15 cm thick.	Cubic box with inner dimension of 2 0 meters H_2O walls 15 cm thick
Source	Group 1, isotropic, placed at origin	14 MeV neutrons, isotropic, placed at origin
Detector Placement	3 0 meters from the source, along the x-axis (300 ,0 ,0)	3 0 meters from the source, along the x-axis (300 ,0.,0)
Cross Sections	22N-18G Coupled Library (from SCALE4 3)	ENDF-V Continuous Cross Sections
Quadrature	S4 and S8	N/A
Tallies	N/A	Point Detector Tally (F5)
Calculation Time	4 minutes (S4) 6 minutes (S8)	~ 4 hours

OSM report significantly different results, similar deviations can be seen in the reflection and transmission data One group is not really sufficient to accurately represent the thermal neutron range, so we must assume that MCNP's point cross section data are more accurate for this group Group 35 includes the 0 511 MeV photons created by the pair production process The MCNP and SCALE cross sections handle this phenomenon differently, which accounts for the different results for this group and the lower energy photon groups These results indicate that the OSM is a viable method for evaluating simple systems of this type

Following the initial calculation using an S_4 Gaussian quadrature, the problem was repeated with an S_8 quadrature As seen in Figure 4-1 and Figure 4-2, the more refined angular treatment has little impact on the results for this problem Despite the minimal impact of the improved quadrature on the scalar flux in this problem, it was decided to use the S_8 treatment for the remaining sample problems

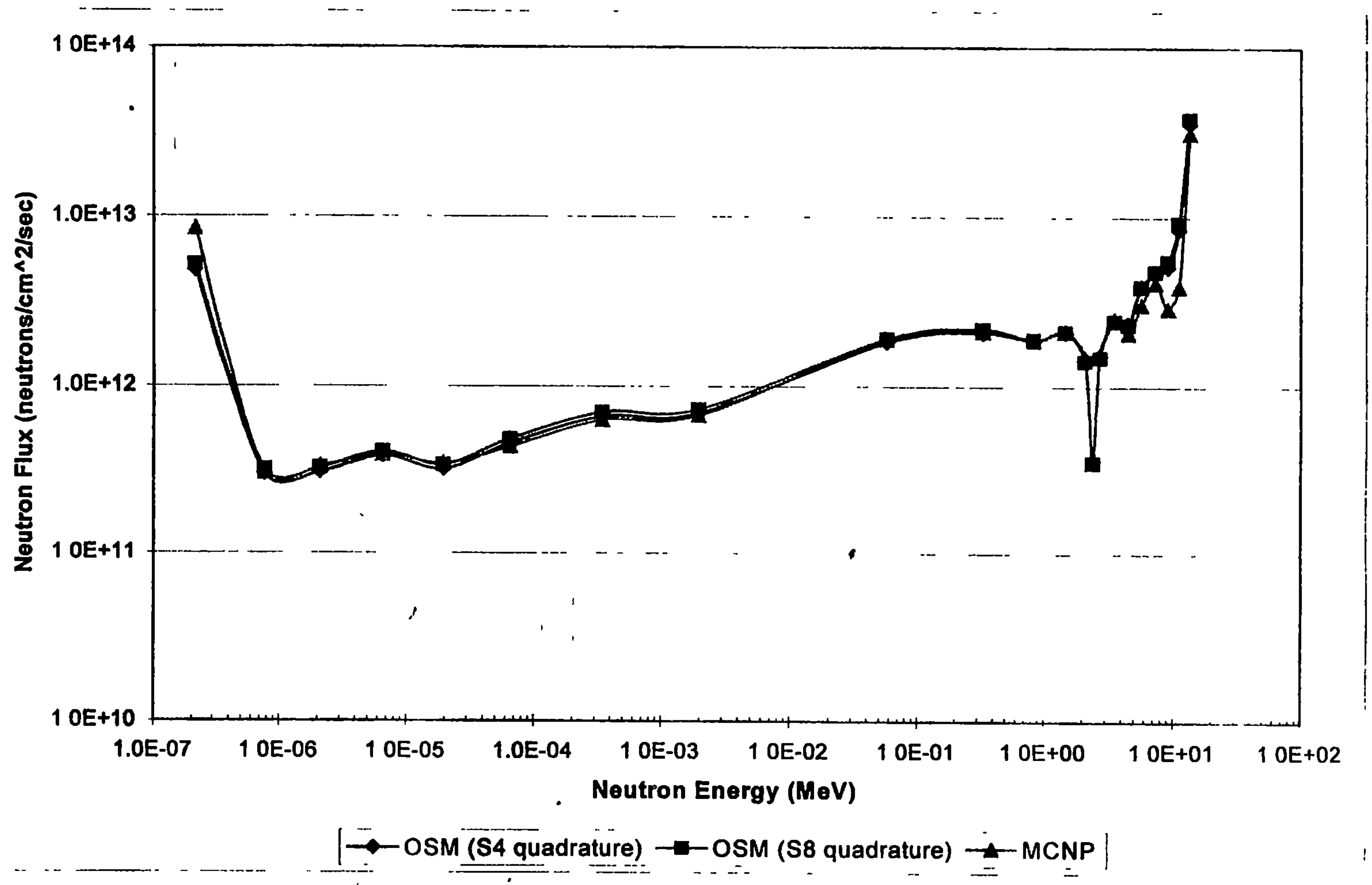

Figure 4-1 Neutron Flux Spectrum for Sample Problem 1

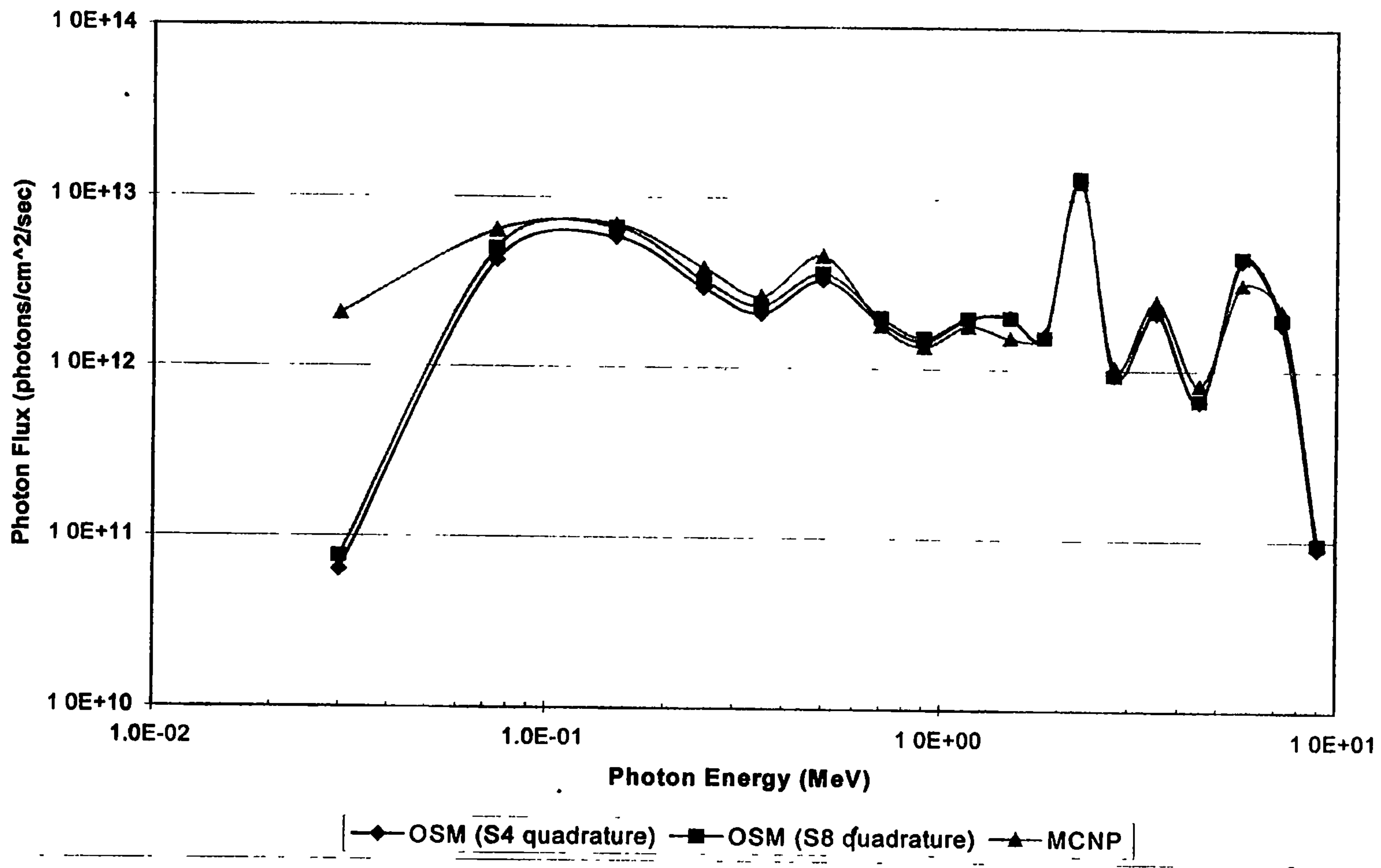

Figure 4-2 Photon Flux Spectrum for Sample Problem 1

Table 4-3 Comparison of Detector Fluxes for Sample Problem 1

GROUP	Detector Flux (OSM S8)	Detector Flux (MCNP)	MCNP Error	Percent Difference
1	3 824E+13	3 1427E+13	0 0189	21 69%
2	9 260E+12	3 8994E+12	0 0238	137 48%
3	5 527E+12	2 9102E+12	0 0286	89.92%
4	4 821E+12	4 1173E+12	0 0228	17 09%
5	3 909E+12	3 0550E+12	0 0209	27 97%
6	2.333E+12	2.0749E+12	0 0226	12.45%
7	2 443E+12	2 5268E+12	0 0204	-3 33%
8	1 491E+12	1 5579E+12	0 0173	-4 30%
9	3 532E+11	3 5244E+11	0 0243	0 23%
10	1 418E+12	1 5028E+12	0 0162	-5 63%
11	2.113E+12	2.1230E+12	0 0162	-0 45%
12	1 914E+12	1 8690E+12	0 0176	2 39%
13	2 183E+12	2 1226E+12	0 0167	2 83%
14	1 929E+12	1.9041E+12	0 0160	1 33%
15	7 277E+11	6 6579E+11	0 0223	9 31%
16	6 962E+11	6 2652E+11	0 0216	11 13%
17	4 841E+11	4 3554E+11	0 0224	11.14%
18	3 401E+11	3 4614E+11	0 0245	-1 75%
19	4 074E+11	3 9056E+11	0 0229	4.31%
20	3 271E+11	3.3220E+11	0 0243	-1 53%
21	3 190E+11	3 0378E+11	0 0257	5 02%
22	5 198E+12	8 4885E+12	0 0053	-38 77%
23	9 573E+10	9 6238E+10	0 0236	-0 53%
24	1 988E+12	2 2372E+12	0 0108	-11 13%
25	4 634E+12	3 2091E+12	0 0108	44 42%
26	6 600E+11	8 1681E+11	0 0131	-19 20%
27	2 196E+12	2 5135E+12	0 0102	-12 64%
28	9 268E+11	1 0354E+12	0 0172	-10 49%
29	1 347E+13	1 2715E+13	0 0093	5 95%
30	1 534E+12	1 6166E+12	0 0131	-5 13%
31	2 000E+12	1 5200E+12	0 0153	31 56%
32	1 985E+12	1 7866E+12	0 0131	11 11%
33	1 512E+12	1 3456E+12	0 0147	12 39%
34	1 989E+12	1 7899E+12	0 0133	11.14%
35	3 639E+12	4 5993E+12	0 0094	-20 88%
36	2 311E+12	2 6177E+12	0 0124	-11 71%
37	3 256E+12	3 8605E+12	0 0096	-15 66%
38	6 655E+12	6 9188E+12	0 0134	-3 82%
39	5 016E+12	6 3958E+12	0 0106	-21 57%
40	7 647E+10	2 0301E+12	0 0556	-96 23%

4.2 Duct Problem

Following the completion of the first sample problem, it was decided to move on to a slightly more challenging test of the OSM methodology For this purpose, a simple duct problem was created The problem consists of two identical rooms on either side of a 60 cm-thick concrete wall. This wall has a 38 cm by 38 cm "duct" cut through it, located precisely at the center The outer walls, floor, and ceiling of the two rooms are also constructed of concrete and are 30 cm thick The interior dimensions of each room are 4 7 m by 4 0 m by 4 0 m. A 14 MeV neutron source was placed towards the far side of one room, at a height of one meter above ground A series of detectors was placed in the other room, at heights of 50 and 100 cm Thus, there is no direct line of sight through the duct between the source and detectors Again, the calculation was performed using both OSM and MCNP Table 4-4 lists relevant problem parameters

The duct through the center wall of the system presented an interesting challenge to the OSM code. As stated previously, for the purposes of the transmission and reflection calculations through the walls, only two faces are active In other words, these calculations are performed in the direction of only one of the three Cartesian

Table 4-4 Parameters for Sample Problem 2

Specification	OSM	MCNP
Input file	duct1s8 inp	dux1 in
Output file	duct1s8.out	dux1 ino
Geometry	Two adjacent rooms, each with internal dimensions of 470 cm x 400 cm x 400 cm A 38 cm x 38 cm duct is cut through the center of the 60 cm-thick concrete wall separating the rooms. Outer walls are 30 cm thick	Two adjacent rooms, each with internal dimensions of 470 cm x 400 cm x 400 cm A 38 cm x 38 cm duct is cut through the center of the 60 cm-thick concrete wall separating the rooms Outer walls are 30 cm thick
Source	Group 1, isotropic, placed at (-400, 0, 50)	14 MeV neutrons, isotropic, placed at (-400, 0 , 50)
Detector Placement	Multiple Detectors	Multiple Detectors
Cross Sections	22N-18G Coupled Library (from SCALE4 3)	ENDF-V Continuous Cross Sections
Quadrature	S8	N/A
Tallies	N/A	Point Detector Tally (F5)
Calculation Time	~ 30 minutes	~ 4 hours (σ = 0 05)

axes. In the original duct model, this caused the walls of the duct to not be active Thus, it was necessary to trick the code into performing the transmission and reflection calculations for these faces This was accomplished by defining a thin (1 cm) lining around the outer edge of the duct, but specifying a response matrix file generated for the entire distance from the duct wall to the outer edge of the system (181 cm) Thus, reflection off the duct walls was properly accounted for in the model It is important to note that the transmitted fluxes obtained in this manner are not accurate, as the radiation has been attenuated through the entire 181 cm thickness, but exits the patch after only one centimeter. However, that does not impact the results of this problem, as there are no detectors or walls outside of the two rooms

A series of detector points was defined in the OSM input, three of these were included in the MCNP model as point detector (F5) tallies Flux-to-dose conversion factors were generated as described in Section 2 4 When a detector response function is defined, the code converges on the detector response, rather than the group fluxes. The results for the three detector points are summarized in Table 4-5 Plots of neutron and photon fluxes for the detector at the point (250,100,100) are included as Figure 4-3 and Figure 4-4 It is important to note once again that the OSM code converged on the detector response, rather than the group fluxes Thus, the flux values are not expected to be as accurate as they were in the previous problem. In this problem the detector responses are dominated by the higher energy neutrons and photons, so the convergence of the dose rate will be dependent upon the convergence of the higher energy fluxes The high energy groups tend to converge faster than the low energy groups, so these flux values are accurate, while the lower energy groups are less accurate Again, the extreme dip in the low energy photon fluxes predicted by the OSM is a product of the cross section data in the 22N18COUPLED library, rather than a product of the methodology

Table 4-5 Detector Response Results for Sample Problem 2

Detector Point	**MCNP Response (mr/hr)**	**OSM response (mr/hr)**	**Percent Difference**
(50,50,50)	4 210E+11	4 109E+11	-2 40%
(250,0,100)	2 207E+11	2 069E+11	-6 25%
(250,100,100)	1 967E+11	1.728E+11	-12 14%

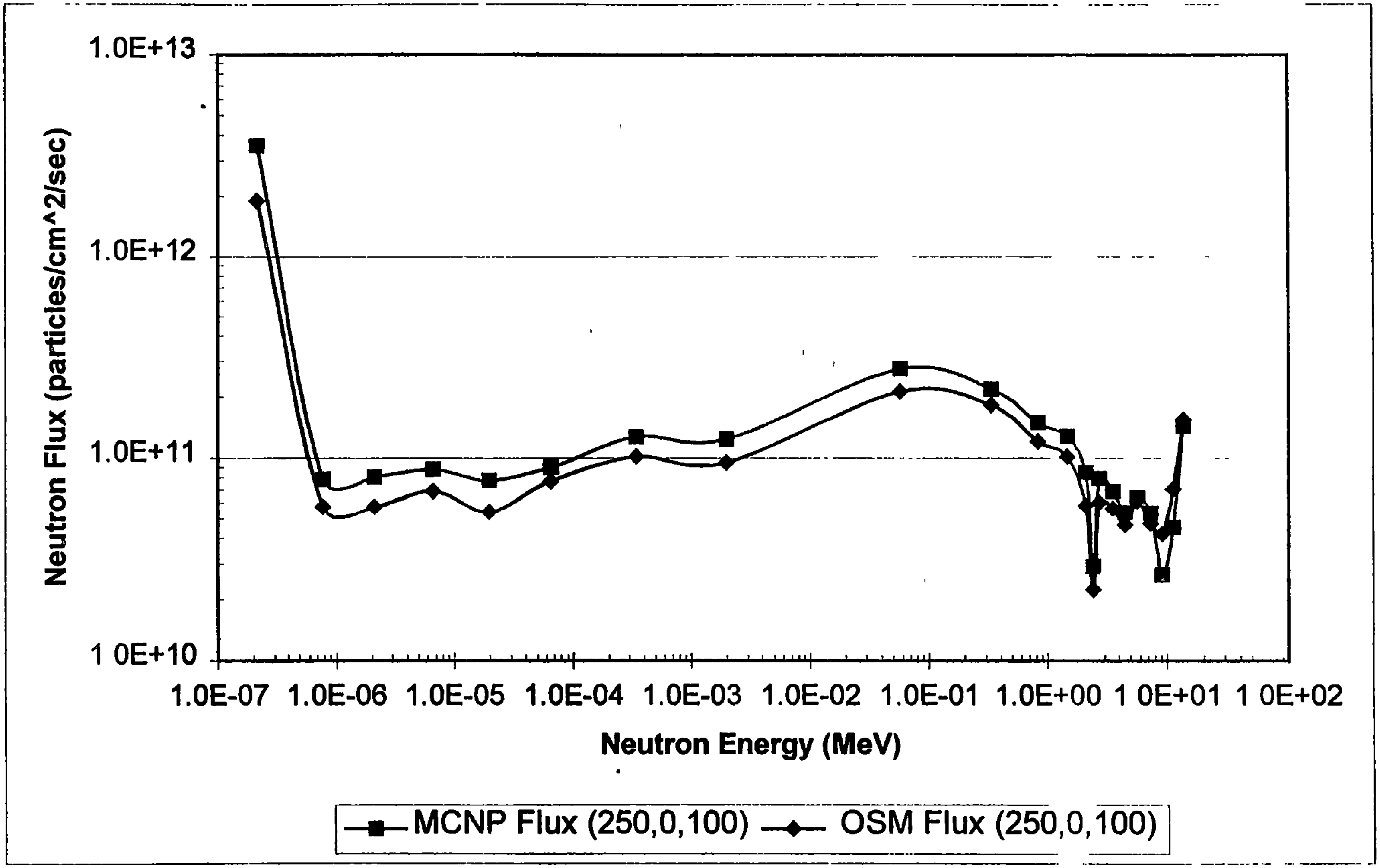

Figure 4-3 Neutron Flux at (250,0,100) for Sample Problem 2

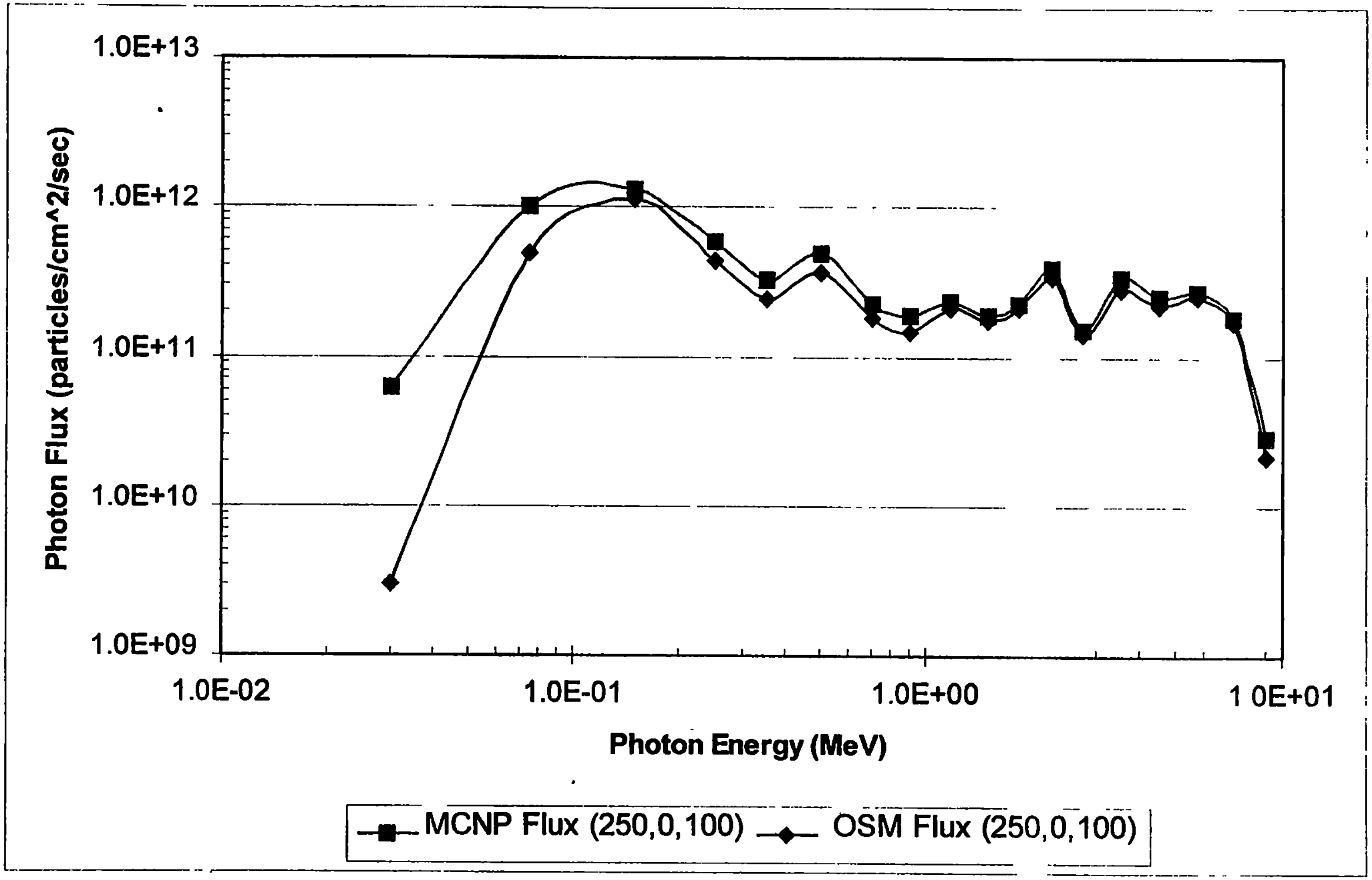

Figure 4-4 Photon Flux at (250,0,100) for Sample Problem 2

4.3 Criticality Source Problem

This problem is based on an analysis of a storage tank containing Uranyl Nitrate solution. The tank is located in a pit underneath a building at the Y-12 Facility in Oak Ridge, Tennessee, the goal of the analysis is to determine the response of two detectors located in nearby buildings to a criticality in the tank For the purposes of this sample problem only the pit has been modeled, because the analysis of the remainder of the system is not yet available Several relevant problem parameters are given in Table 4-6 Four MCNP cases were run, two each for the neutron and photon portions of the source spectrum Different point detector locations were specified in order to provide a wider range of points for comparison

4.3.1 Source Characterization

The first step in the analysis is to characterize the source term generated by a criticality in the tank Essentially, the source for this problem is the leakage current through the tank walls C Tyler Scott originally characterized the criticality source

Table 4-6 Parameters for Sample Problem 3

Specification	OSM	DORT	MCNP
Input file	wellflux.inp	Information not available	wn1 in, wn2.in wp1 in, wp2 in
Output file	wellflux.out	Information not available	wn1.ino, wn2 ino wp1.ino, wp2 ino
Geometry	3D Cartesian as Described in Section 4 3 2	2D Cylindrical as Described in Section 4 3 2	3D Cartesian as Described in Section 4.3 2
Source	Spectrum Described in Section 4.3 1	Same as for OSM, but fit to a different group structure	Spectrum Described in Section 4 3.1
Detector Placement	Multiple Detectors	Multiple Detectors	Multiple Detectors (F5 tallies)
Cross Sections	22N-18G Coupled Library (from SCALE4 3)	BUGLE-96 (46N-21G) Coupled Library	ENDF-V Continuous Cross Sections
Quadrature	S8	Upward Biased S16	N/A
Calculation Time	~ 30 minutes (PC)	Information not available	~ 20 hours per neutron case ~11 hours per photon case (σ = 0 05)

using MCNP4B [6] A portion of this analysis was repeated in order to obtain a source spectrum for the 22N-18COUPLED energy group structure The input deck for this MCNP run is included in Appendix C as *fin in* Following the generation of the source spectrum, the source strength was scaled to produce a dose rate of 20 R/minute at a distance of 2 meters from the edge of the source region This 20 R/minute dose rate corresponds to the minimum detectable criticality accident specified by ANS-8.3-1979 [2,6,7] The neutron and photon leakage source spectra are shown in Figure 4-5 and Figure 4-6, respectively

4.3.2 Geometry

The system has been modeled in two dimensions using r-z geometry in DORT, a two-dimensional discrete ordinates code supported by the Oak Ridge National Laboratory. In the translation of the model to the r-z coordinate system, dimensions were scaled in order to conserve the volume of the system A three-dimensional Cartesian model has been constructed in the OSM, working from the same original drawings that were used in the generation of the DORT model. After initial consideration, it was decided that the 2D cylindrical DORT model is not sufficient to gauge the accuracy of the OSM, as the differences in geometry will cause deviations in the problem results Thus, an MCNP model was created in order to have an exact match to the geometry defined in the OSM. The OSM and MCNP input files are included in Appendix C. Diagrams of the system geometry for the 2D cylindrical and 3D Cartesian coordinate systems are included as Figure 4-7 and Figure 4-8, respectively Detectors were placed at various points throughout the OSM and MCNP geometries

4.3.3 Results

This problem demonstrates the application of the OSM to a real-world application, but it also reveals some of the limitations inherent in the methodology. For most of the detector points, the OSM agrees quite closely with the results predicted by the MCNP calculations However, results for several detector points placed close to walls were not satisfactory The dose rates predicted by the OSM and MCNP for 19 detector points are shown in Table 4-7 As seen in the table, the OSM results are within 20% of the values predicted by MCNP for all of the points outside the z=500 plane The points

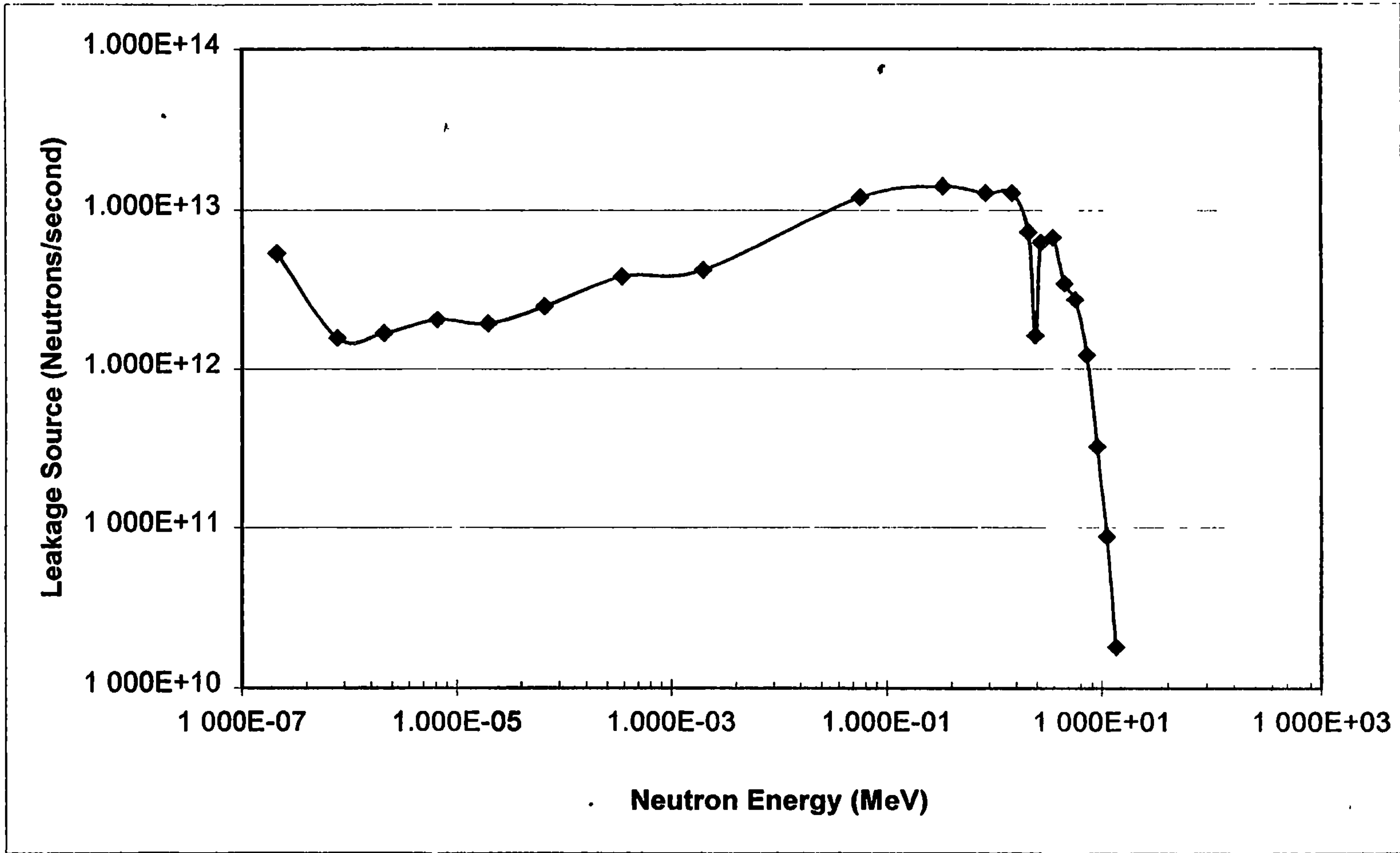

Figure 4-5 Neutron Leakage Spectrum from a Tank of Uranyl Nitrate Solution

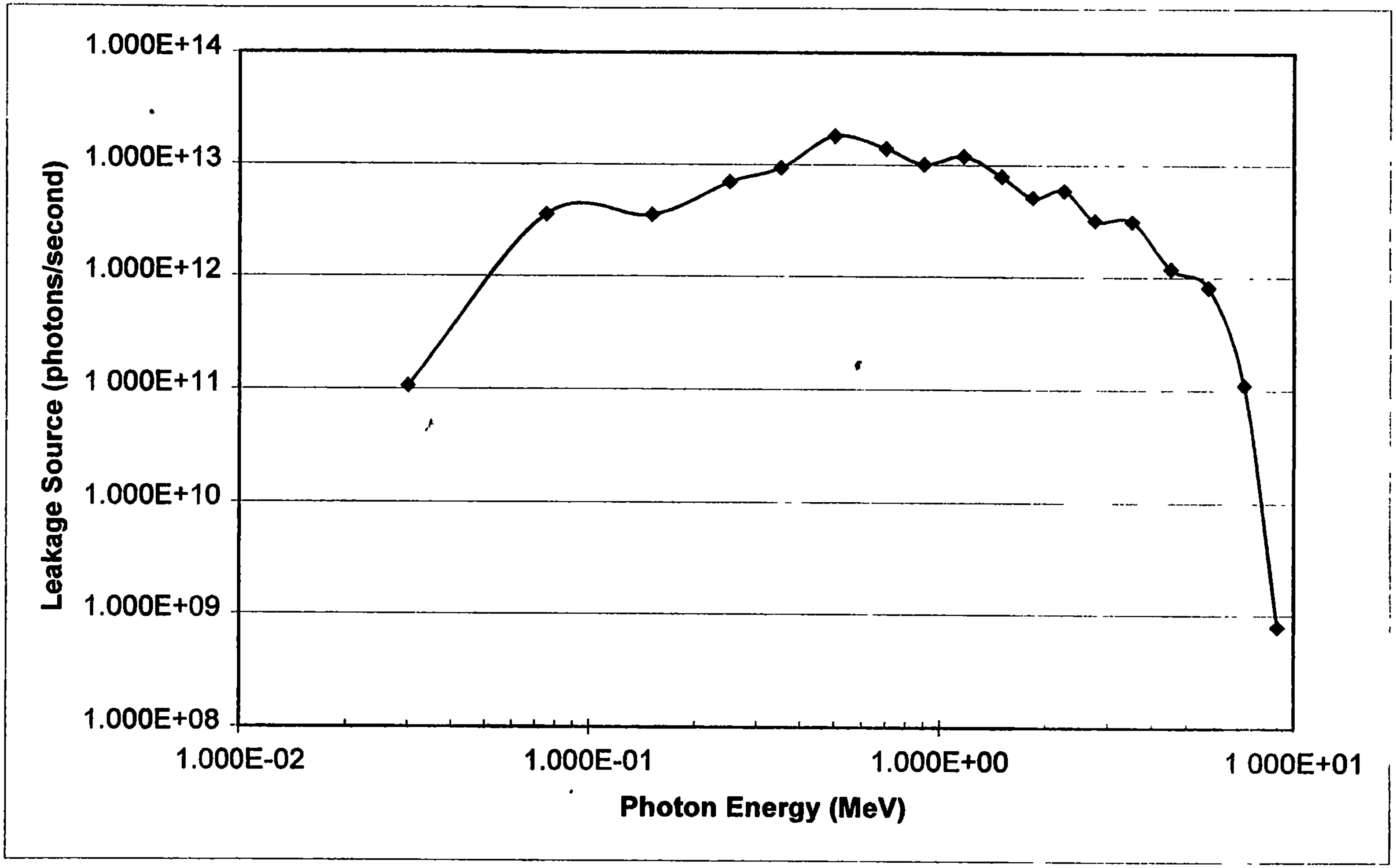

Figure 4-6 Photon Leakage Spectrum from a tank of Uranyl Nitrate Solution

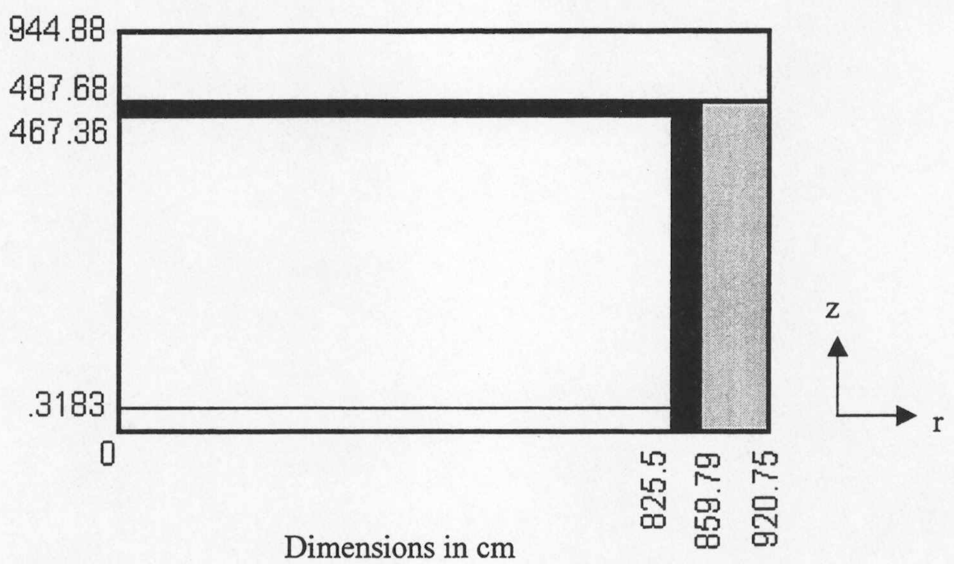

Figure 4-7 Diagram of Sample Problem 3 in 2D Cylindrical Geometry

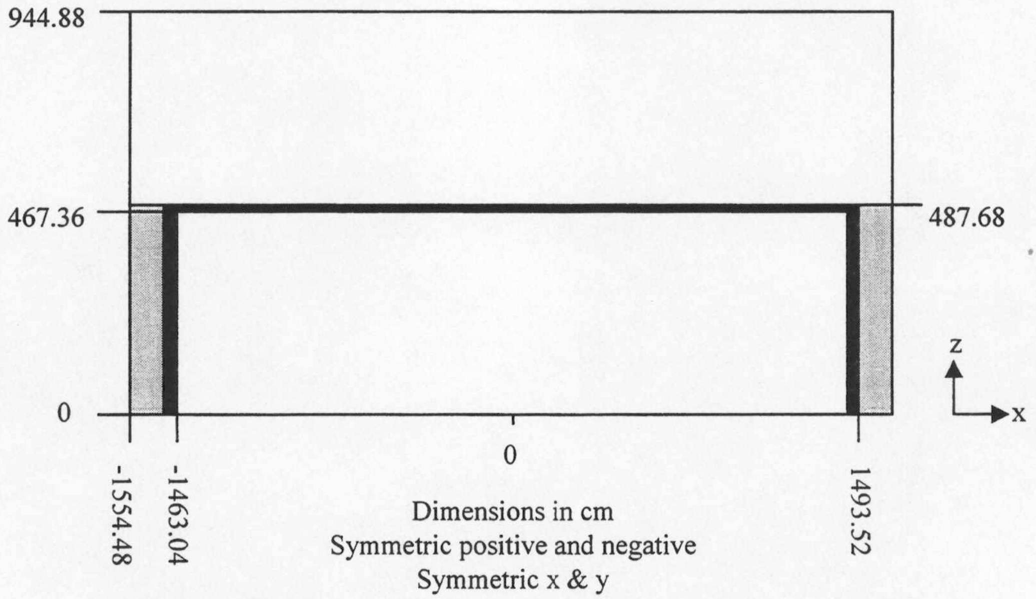

Figure 4-8 Diagram of Sample Problem 3 in 3D Cartesian Geometry

that fall in this plane are within 15 cm of the roof of the well That characteristic length of the patches that make up this wall is approximately 70 cm. Thus, these detector points are well inside a distance of one characteristic length, and results are not expected to be accurate Inside one characteristic length, the formula used to calculate the solid angle of the patch with respect to the detector point is quite inaccurate, as shown in Figure A- A more complete explanation of this problem is found in Appendix A.

Table 4-7 Dose Rates at Detector Points for Sample Problem 3

Detector Location	MCNP Dose Rate (mr/hour)	OSM Dose Rate (mr/hour)	Percent Difference
(0,0,100)	7 617E+07	7 617E+07	-0 003%
(0,0,300)	9 499E+06	9 486E+06	-0 137%
(0,0,500)	7.089E+05	2.325E+05	-67 201%
(0,0,700)	3.757E+05	4 337E+05	15 458%
(0,0,900)	2.282E+05	2.712E+05	18 870%
(200,200,300)	5.317E+06	5 329E+06	0.242%
(400,400,300)	2.392E+06	2 398E+06	0 248%
(800,800,300)	8 030E+05	8 070E+05	0 503%
(1200,1200,300)	4 436E+05	4 434E+05	-0 047%
(400,0,500)	2 517E+05	1 046E+05	-58 442%
(200,200,500)	4 103E+05	2.966E+05	-27.710%
(400,400,500)	1 459E+05	8.336E+05	471 534%
(800,800,500)	1 770E+04	6.214E+03	-64.88%
(1200,1200,500)	9.219E+03	2 583E+04	180 28%
(200,200,700)	2 775E+05	3 003E+05	8.216%
(400,400,700)	1 360E+05	1 312E+05	-3.507%
(800,800,700)	2 738E+04	2 620E+04	-4 295%
(1200,1200,700)	9 155E+03	7 820E+03	-14 581%
(400,0,300)	3 744E+06	3 762E+06	0.465%

As shown in Table 4-7, the results are quite good (within 20 percent of the value predicted by MCNP) for points that do not fall exceedingly close to any of the walls in the system For points that do fall too close to a wall, the method simply does not work, as illustrated by the detectors placed in the z=500 plane Following the tabulation of these results, we decided to explore the behavior of the points in the z=500 plane more closely The initial case used a 40 by 40 grid of patches for the roof of the pit, which corresponds to a patch characteristic length of 73 15 cm Two addition cases were run, using a 45 by 45 patch grid and a 50 by 50 patch grid, resulting in characteristic lengths of 65 02 cm and 58 52 cm, respectively Ideally, one more case would be run, with a very fine grid, corresponding to a characteristic length of approximately 5 cm However, this was not possible due to the large computer memory requirements for such a fine grid

These two additional cases serve to illustrate the effects of placing detectors too close to a wall As shown in Figure 4-9 through Figure 4-12, changing the grid size has a very significant impact on the flux spectrum for detector points placed close to the wall (i.e , in the z=500 plane). This is due to the breakdown of the assumptions made by the OSM at such close distances As expected, for points placed further away from the wall (outside the z=500 plane), the results do not vary with the changes to the patch grid. This is illustrated in Figure 4-13 through Figure 4-16

This problem demonstrates the utility of the OSM for real-world radiation shielding calculations However, it also illustrates some of the shortcomings of the method. Users are advised to exercise caution in the placement of detector points, as any detectors placed within one to two patch characteristic lengths of a wall may yield highly inaccurate results Future versions of the OSM should implement a solution for this issue, or at the very least, issue warning messages when detector points are exceedingly close to any of the wall surfaces defined in the problem

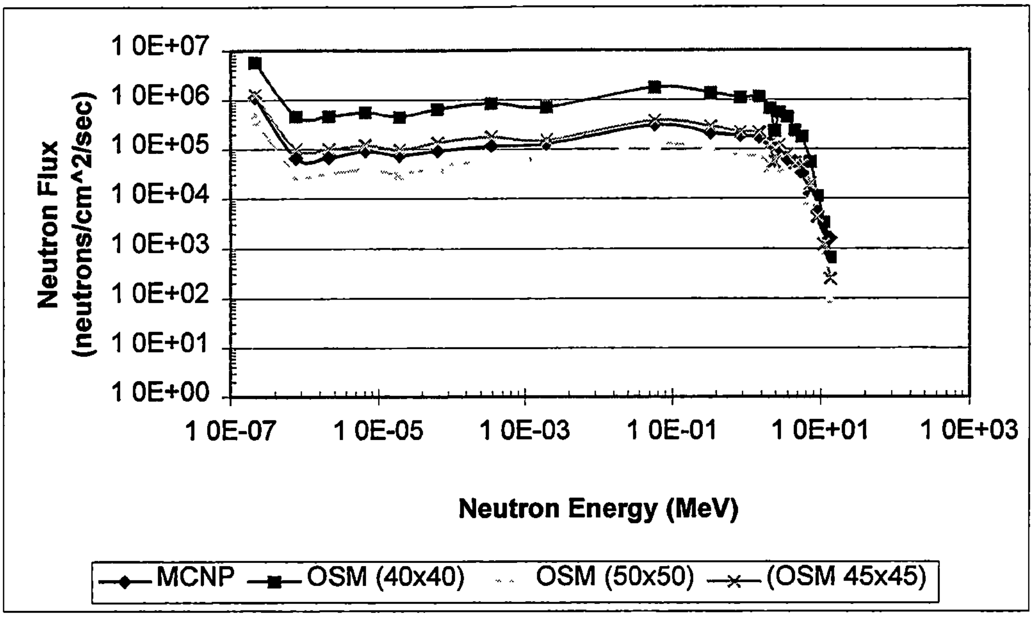

Figure 4-9 Comparison of Neutron Flux for Different Grid Sizes at (400,400,500) in Sample Problem 3

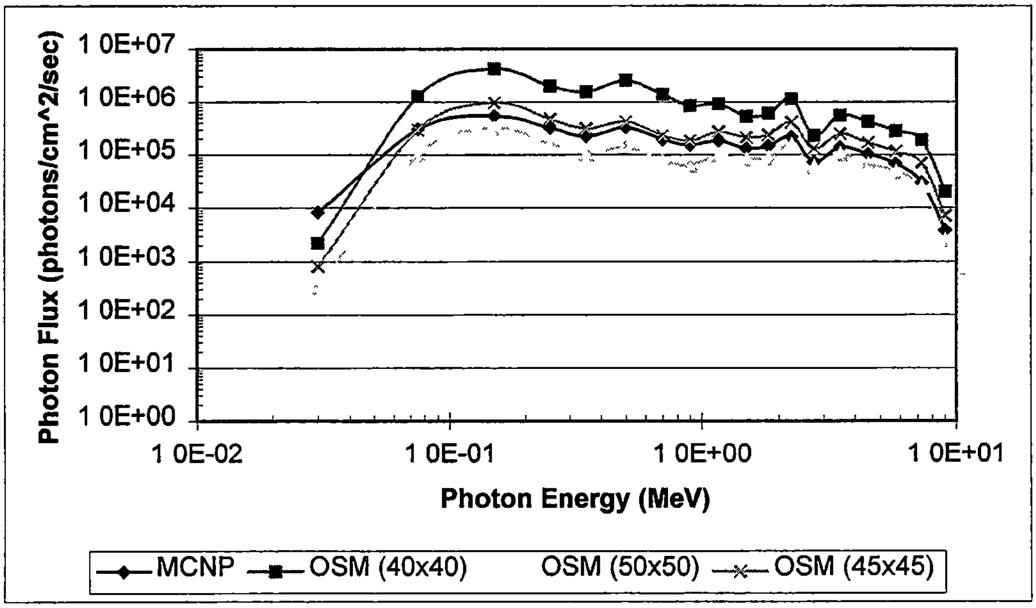

Figure 4-10 Comparison of Photon Flux for Different Grid Sizes at (400,400,500) in Sample Problem 3

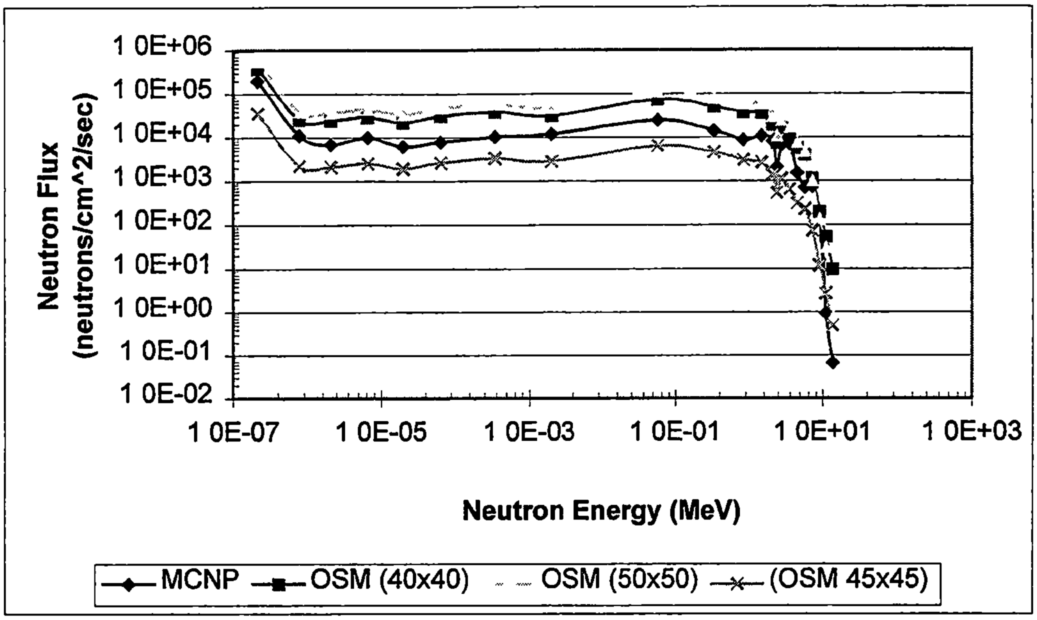

Figure 4-11 Comparison of Neutron Flux for Different Grid Sizes at (1200,1200,500) in Sample Problem 3

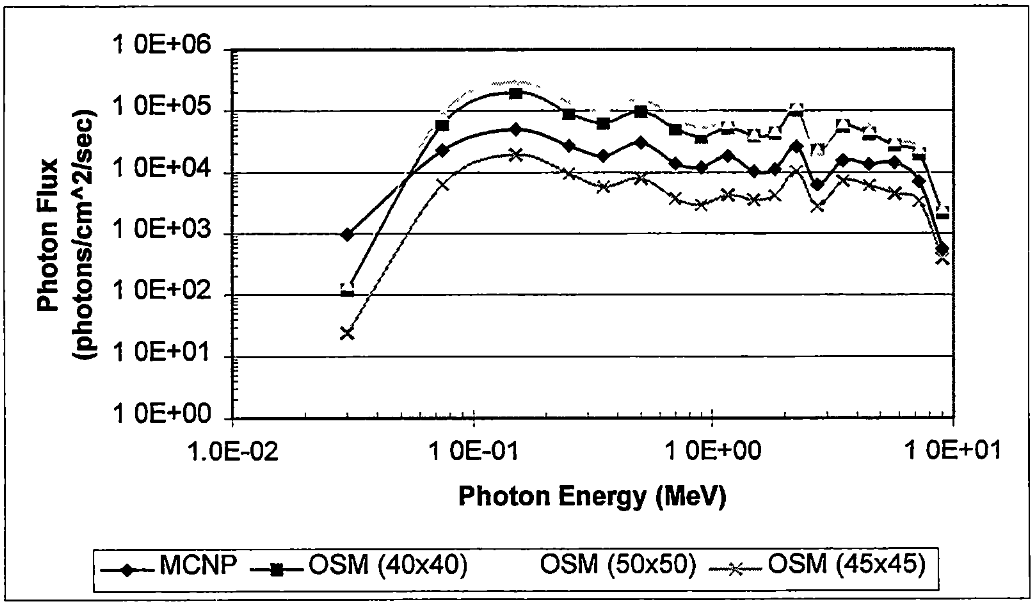

Figure 4-12 Comparison of Photon Flux for Different Grid Sizes at (1200,1200,500) in Sample Problem 3

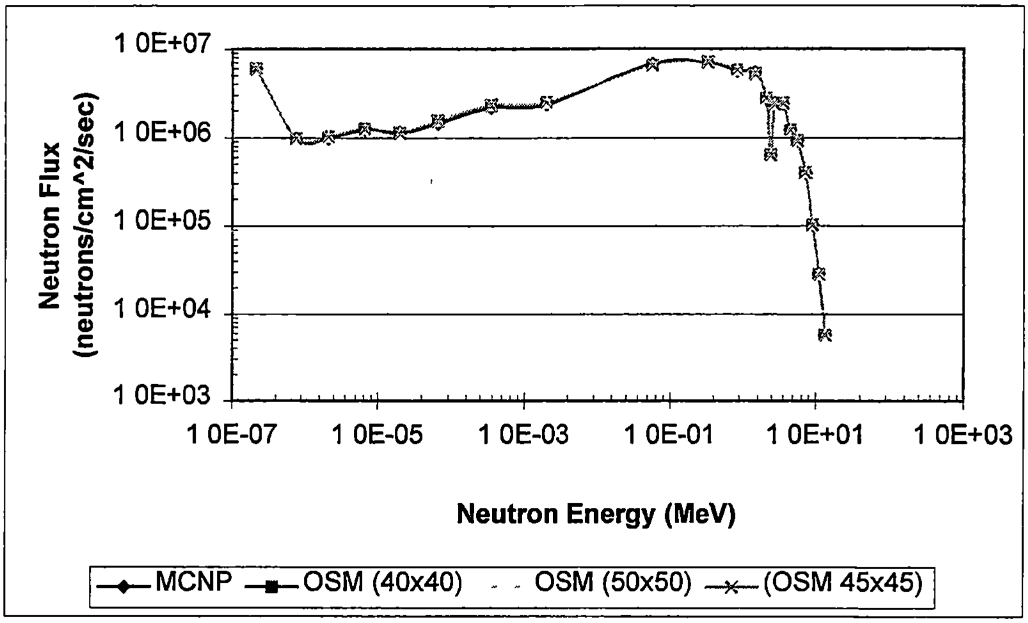

Figure 4-13 Comparison of Neutron Flux for Different Grid Sizes at (400,0,300) in Sample Problem 3

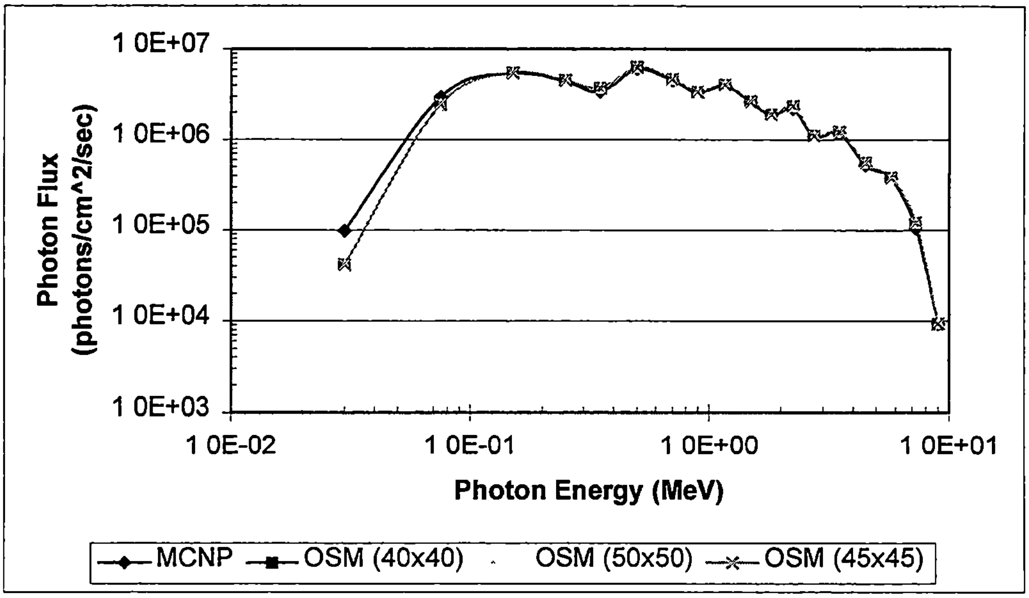

Figure 4-14 Comparison of Photon Flux for Different Grid Sizes at (400,0,300) in Sample Problem 3

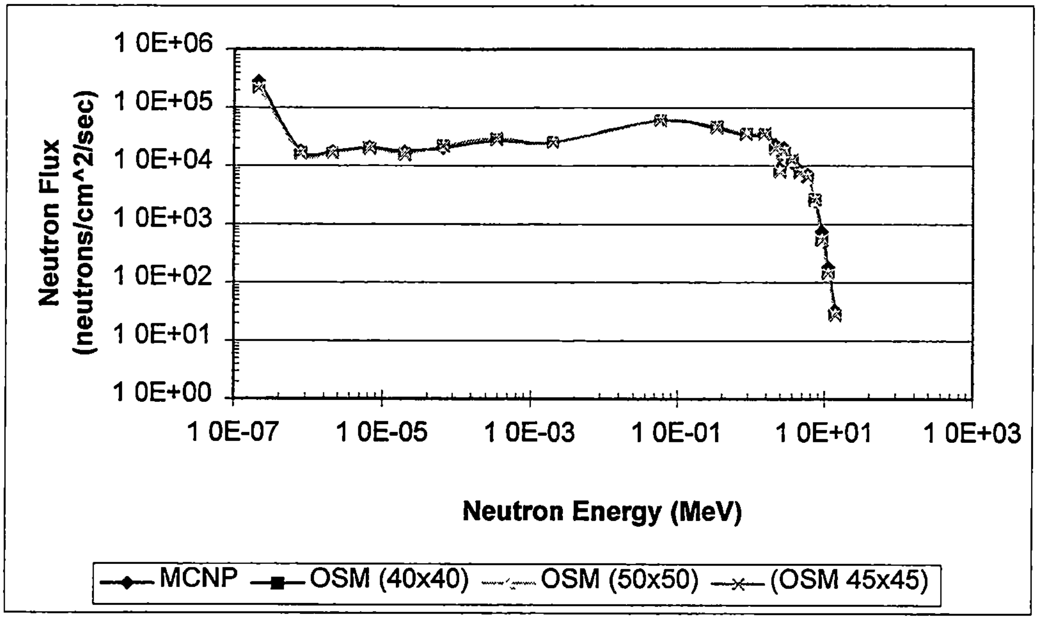

Figure 4-15 Comparison of Neutron Flux for Different Grid Sizes at (800,800,700) in Sample Problem 3

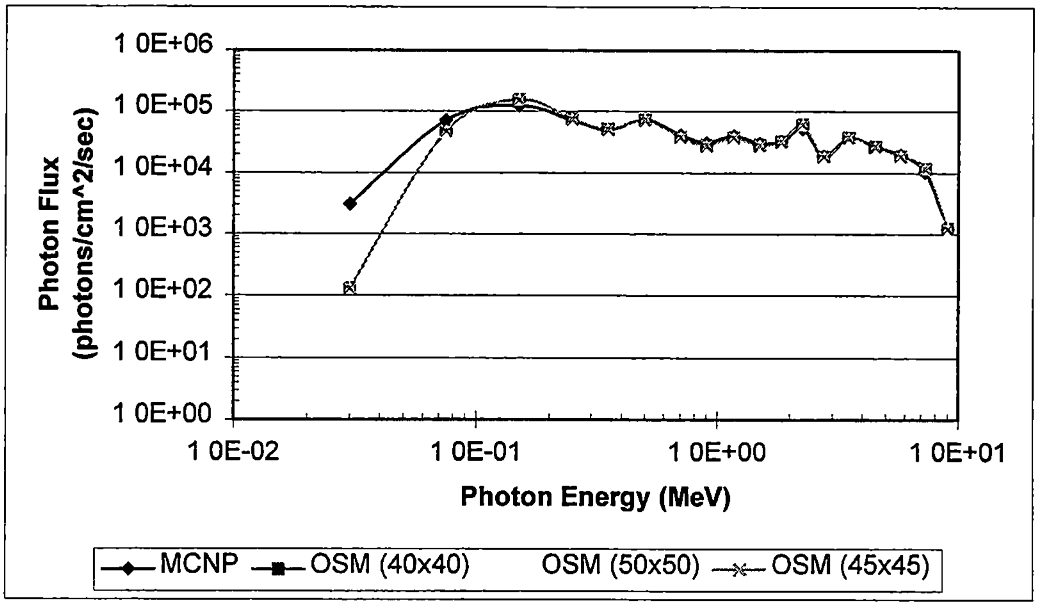

Figure 4-16 Comparison of Photon Flux for Different Grid Sizes at (800,800,700) in Sample Problem 3

5 CONCLUSIONS

5.1 Accuracy of Method

The "source-in-a-box" problem in Section 4 1 shows the basic utility of the OSM for very simple calculations The detector flux results agree very well with those obtained from MCNP, as seen in Figure 4-1, Figure 4-2, and Table 4-3, with the deviations easily accounted for by the assumptions inherent in the multi-group treatment.

The duct problem in Section 4.2 serves to present some of the limitations of the current version of the OSM code, while demonstrating the utility of the method for a system similar to many common shielding problems In particular, this problem shows that it is necessary for all six faces of each wall to be active for transmission and reflection in order to accurately model certain types of system Future versions of the code will address this problem However, this problem also shows that there are certain loopholes that can be exploited by users in order to work around this limitation of the code Users are advised to exercise caution in applying these methods of cheating the system.

The criticality source problem in Section 4 3 illustrates the applicability of the OSM methodology to a real-world situation However, this problem also revealed some of the limitations inherent in the code Users are advised to exercise caution when defining detector points, as any detectors placed within one to two patch characteristic lengths of any wall may produce highly inaccurate flux spectra For large systems, such as the one modeled for the criticality source problem, this is a very significant problem For smaller systems, it is a simple matter to create a fine patch grid, thus eliminating this concern

5.2 Speed of Method

Initially, the simple source-in-a-box problem in Section 4 1 gave quite a bit of encouragement with respect to the speed of the OSM code This problem ran in approximately 2 minutes, while the same problem took 4 hours to run in MCNP The speed of the MCNP run could be significantly increased through the use of variance reduction techniques However, even after accounting for this fact, the OSM code still seems to hold a significant advantage in terms of computational speed

The duct problem from Section 4 2 shows that the method may not provide quite as great a savings in computer time as the first sample problem initially indicated This problem more closely matches a real world radiation shielding situation, and the time savings are not as great, with the OSM requiring approximately 30 minutes while the MCNP model required four hours. Again, the use of variance reduction techniques in MCNP would significantly reduce the calculation time needed, which could seriously reduce the speed advantage of the OSM However, the OSM model can be set up quickly and easily, while implementing the variance reduction techniques in MCNP can require significant time and effort

The criticality source problem in Section 4 3 illustrates the speed advantage of the OSM with respect to MCNP for a real-world situation Even with the implementation of sophisticated variance reduction techniques in MCNP, the OSM should provide a significant speed advantage. In order to properly model a non-standard flux spectrum, as found in this problem, MCNP requires the neutron and photon sources to be run in separate cases, which greatly increases both the computational time and preparation time for each case In addition, MCNP limits the user to a rather small number of detector tallies, while the OSM allows an essentially unlimited number of detector points

This first version of the OSM has not been completely optimized, and further efforts in this area should serve to improve the speed and efficiency of the code This will increase the utility of the method for performing preliminary scoping calculations for large, complex systems

5.3 Other Conclusions

The sample problems and results reported here show the utility of the OSM for preliminary scoping calculations for radiation shielding problems involving room-like three-dimensional geometry with point sources However, the method does have several inherent limitations, and it is not meant as a replacement for established methods The OSM code is a tool that allows a quick, accurate preliminary assessment of a problem, giving the user a better "feel" for the system before applying more sophisticated Monte Carlo or Discrete Ordinates techniques

6 RECOMMENDATIONS FOR FUTURE WORK

6.1 Generalization and Optimization of the Code

Currently, there are quite a few limitations to the range of problems for which the OSM can be used Several modifications could be made in order to improve the method or to allow for a wider range of applicability Some of these modifications are as follows

- Improve the efficiency of the findpath and doincoming subroutines Currently, these two routines are responsible for over 70% of the CPU time required for a given problem Streamlining of these subroutines would create significant time savings
- Allow walls that are not normal to one of the three Cartesian axes This modification would allow for more accurate representation of many structures
- Allow all six faces of each wall to be active (i.e , perform transmission and reflection calculations in all three dimensions) This would eliminate potential errors caused by the dead faces for certain geometries and source-detector configurations
- Allow cylindrical, spherical, or hemispherical 'walls ' This would allow the user to model fuel storage casks, waste tanks, and other structures that do not fit the 'room-like' requirements of the current code
- Integrate the OSM1 and OSM2 modules into a single code The initial version of the OSM code separated these two modules to alleviate memory-usage concerns However, integrating the two modules would simplify the user's operating procedures and could possibly improve the speed of the code
- Add the ability to handle anisotropic sources, surface sources, and volumetric sources
- Streamline the process for the generation of response matrices Currently, this process is somewhat tedious This streamlining might be achieved via a batch processor or through an entirely new process This portion of the OSM was kept separate from the other two modules in order to allow for later modifications to the response matrix generation process
- Implement azimuthally dependent response matrices This would eliminate one of the main limiting assumptions in the method and would allow for more accurate

modeling of many different types of system, at the expense of much larger response matrix files

- Implement correction factors for the solid angle approximation This would allow a coarser division of the walls (i e , allow larger patch sizes), which could significantly reduce computation time.
- Allow for spatial diffusion of radiation inside the walls This would improve the accuracy of the method for 'skyshine' problems and other problems involving low density materials or thick walls
- Converge on outgoing patch fluxes, rather than detector response/flux This would allow the user to save the outgoing flux matrix and apply it to different detector configurations without having to re-run the entire calculation.

6.2 Additional Features

Several additional features or modifications may improve the utility of the OSM, without any changes to the methodology. Some of these modifications are as follows

- Implementation of a graphical user interface (GUI) This GUI would allow the user to "walk through" the problem geometry Not only would this aid in checking the geometry for errors, it would also allow the user to view flux maps in two or three dimensions
- It may be preferable to create the response matrices using MCNP, rather than the MAKERT system As seen in Appendix C, these two codes give comparable results, and the continuous cross-sections used by MCNP would allow the user to create customized energy group structures for a given problem A translation code would be necessary to convert the MCNP tally results to the proper format for the response matrices, and some means must be provided to remove the uncollided flux from the MCNP results
- Allow coupling to a limited subset of MCNP geometry. This would allow users to run the OSM using the geometry specifications from an MCNP input deck. This would eliminate translation errors between the two codes and allow for significant reductions in preparation time for each problem
- A Monte Carlo version of the OSM should also be considered The random walk process would be fairly simple, and the application of variance reduction techniques to the method would be an interesting exercise

BIBLIOGRAPHY

Bibliography

1 ANSI/ANS-6 1 1-1991, *Amencan Natıonal Standard for Neutron and Gamma-Ray Fluence to Dose Factors*

2 ANS-8 3-1979, *Criticalıty Accıdent Alarm System.*

3 Lewıs, E E , Mıller, W F , *Computatıonal Methods of Neutron Transport.*

4 *SCALE: A Modular Code System for Performing Standardized Computer Analyses for Licensıng Evaluation*, RSICC Computer Code Collectıon, CCC-545, NUREG/CR-0200, Rev 4, ORNL/NUREG/CSD-2/R4, Oak Ridge Natıonal Laboratory

5 Scott, C. Tyler, "Dose Response Functıon Justıfication and Conversıon for the BUGLE-96 Group Structure," ınternal UT memo, January 2000.

6 Scott, C Tyler, et al , "Uranyl Nıtrate Source Characterızatıon for Cntıcalıty Alarm Placement Analysıs "

7 Scott, C Tyler, "Source Characterızation for Y-12 Buıldıng 9818 F-604 Uranyl Nıtrate Tank "

8 Shultis, J Kenneth and Faw, Rıchard E , *Radıatıon Shielding*, Prentice Hall, Inc , 1996.

APPENDICES

A. The Solid Angle Approximation

In the coding of the OSM, we found it necessary to make an approximation when determining the solid angle subtended by a given patch in reference to a particular point. The fractional solid angle (i.e , solid angle in steradians, divided by 4π) of a body relative to a point at the origin is given by equation A-1

$$\Omega = \int_{dA} \frac{dA}{4\pi R(\vec{r})} \qquad \text{A-1}$$

To avoid the complications that would come about as a result of this integral, we have simplified this relation to the form shown in equation *A-2* In order to make this simplification, we must assume that the distance, *r*, between the patch and detector is a constant for the entire surface of the patch and that the angle θ is also a constant When the detector is close to the patch, these two assumption will clearly break down, resulting in a highly inaccurate prediction of the solid angle subtended by the patch

$$\Omega \cong \frac{A_p}{4\pi r^2} \qquad \text{A-2}$$

where A_p is the projected area of the patch, given by $A_p = A^*\cos\theta$, and r is the distance between the reference point and the center point of the patch. This approximation is quite good, provided that the reference point is some distance from the patch center point

The accuracy of this approximation is dependent upon the size and shape of the patch, the distance *r*, and the cosine of the angle between the reference point and the patch center. In addition to these quantities, we define the *characteristic length* as the average of the patch length and width

The solid angle subtended by a rectangular area at a point distance *z* from the center of the area on a line perpendicular to the surface (See Figure A) is given by the equation *A-3* [8]

$$\Omega = 4^*\tan^{-1}\left(\frac{W/L}{2z/L\sqrt{1+\left(W/L\right)^2+\left(2z/L\right)^2}} \right) \qquad \text{A-3}$$

where W and L are the length and width of the rectangular area A series of calculations was performed to determine the accuracy of our simplified equation in representing the solid angle of a rectangular surface The results of these calculations are shown on the following pages

As seen in Figure A-, for a square patch and μ=1, the percent error drops below one percent at about five characteristic lengths This figure also shows that the approximation breaks down when the reference point is too close to the segment, as expected Figure A- and Figure A- show the variations with μ for a square patch at a distance of five characteristic lengths Figure A and Figure A- show the variations with μ for a patch with a 3:1 aspect ratio at a distance of five characteristic lengths Figure A- and Figure A- show that the approximation is quite good at this distance As shown in these two figures, the approximation works best when μ is approximately 0.75, and it grows steadily worse as μ increases or decreases from that point, with the worst errors occurring as μ approaches zero.

In general, the inaccuracies created by the solid angle approximation will only be significant when the source or detector is placed close to a wall and between patches in room corners Thus, the user is cautioned in such analyses that placing the source or detector too close to a wall may result in inaccurate results Unfortunately, there is no way to eliminate corners from problems, so these inaccuracies can not be completely avoided Future versions of the code will implement a correction for these errors, in which the outgoing patch will be further subdivided for this single transport, with the assumption that each patch subdivision has the same outgoing flux as the whole patch This correction should conserve the outgoing flux and greatly reduce errors caused by the solid angle approximation

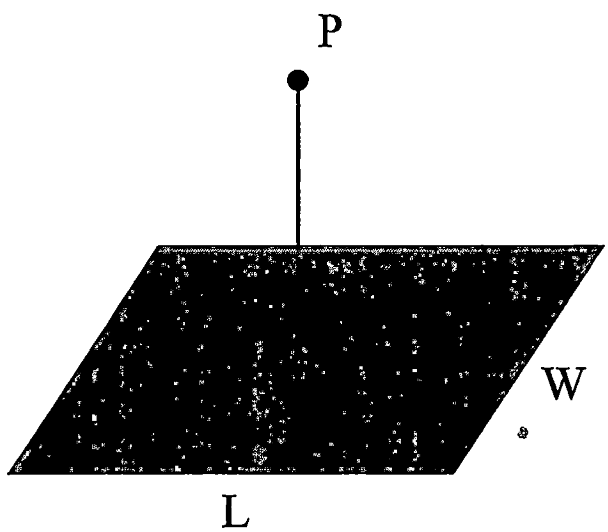

Figure A-1 Diagram of System for which Equation A-3 is Valid

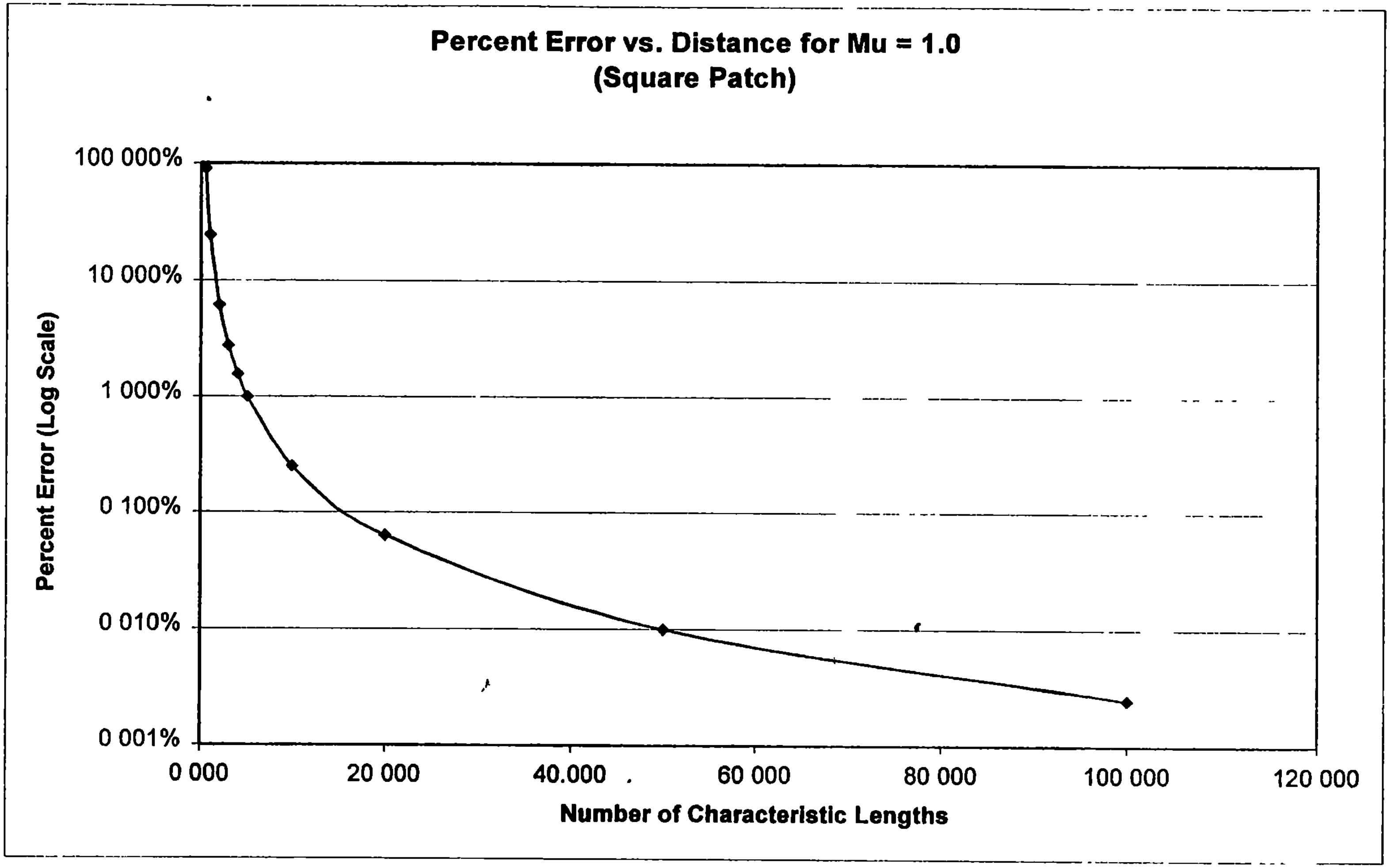

Figure A-2 Percent Error vs Distance for Mu = 1.0 (Square Patch)

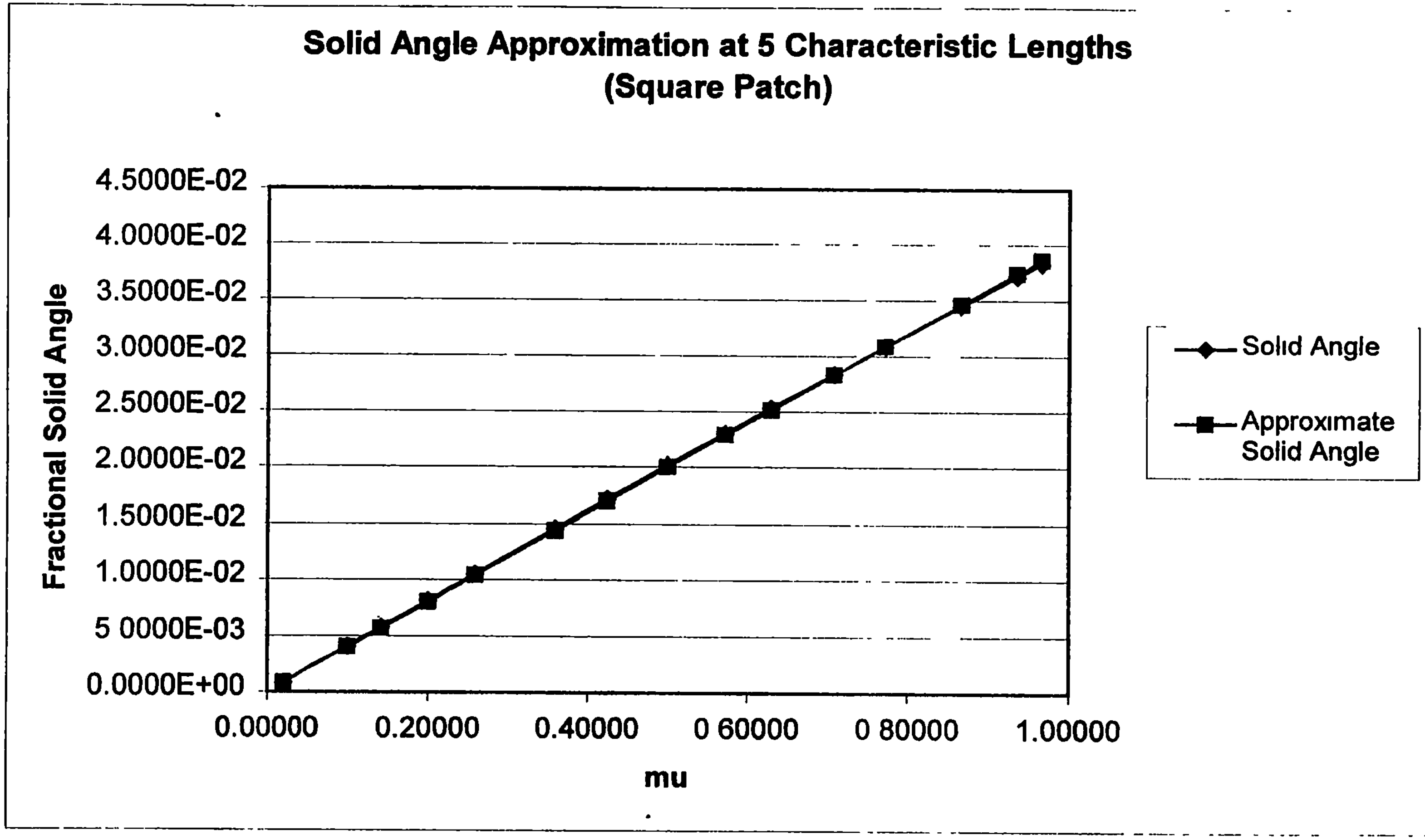

Figure A-3 Solid Angle Approximation at 5 Characteristic Lengths (Square Patch)

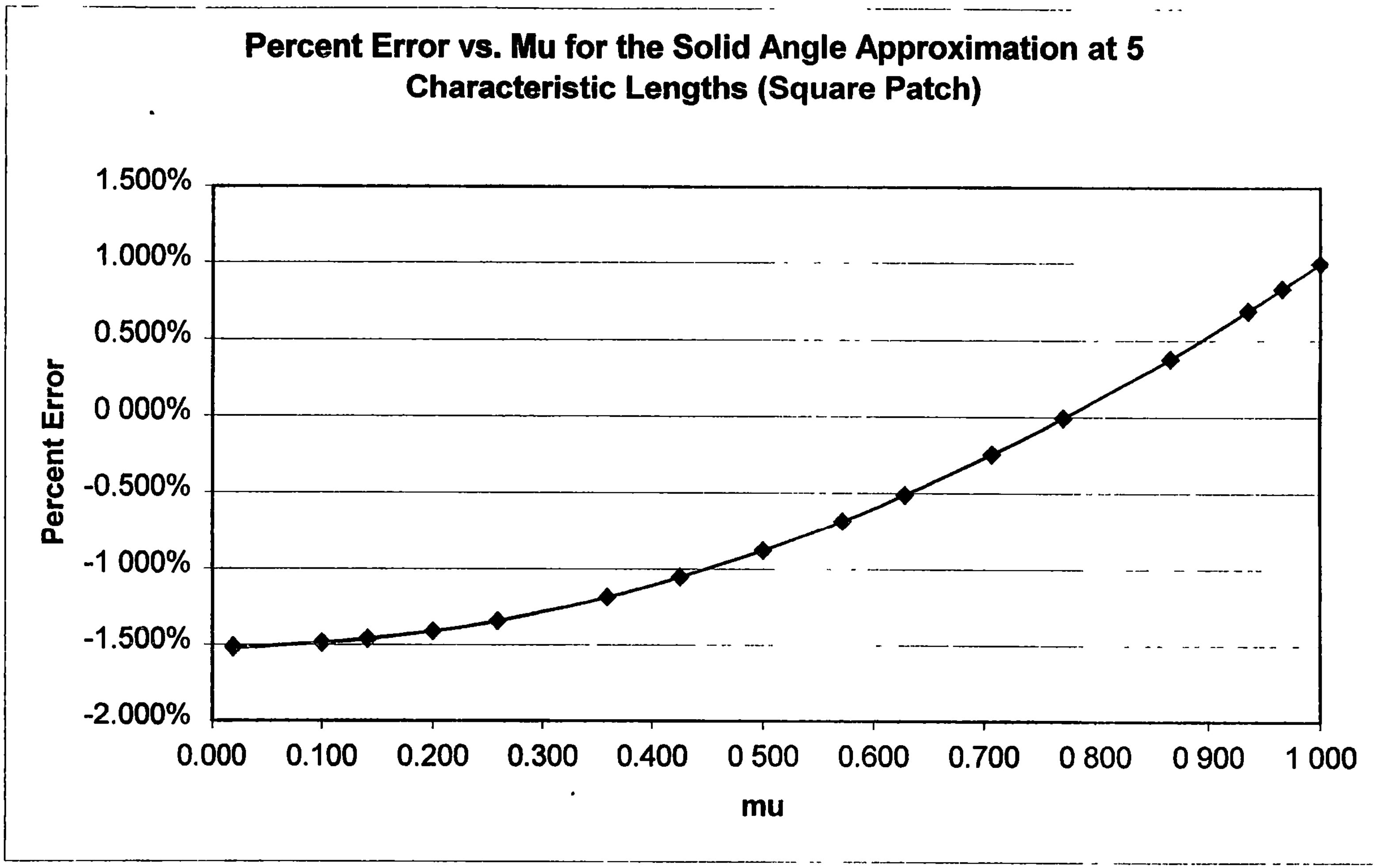

Figure A-4 Percent Error vs. Mu at 5 Characteristic Lengths (Square Patch)

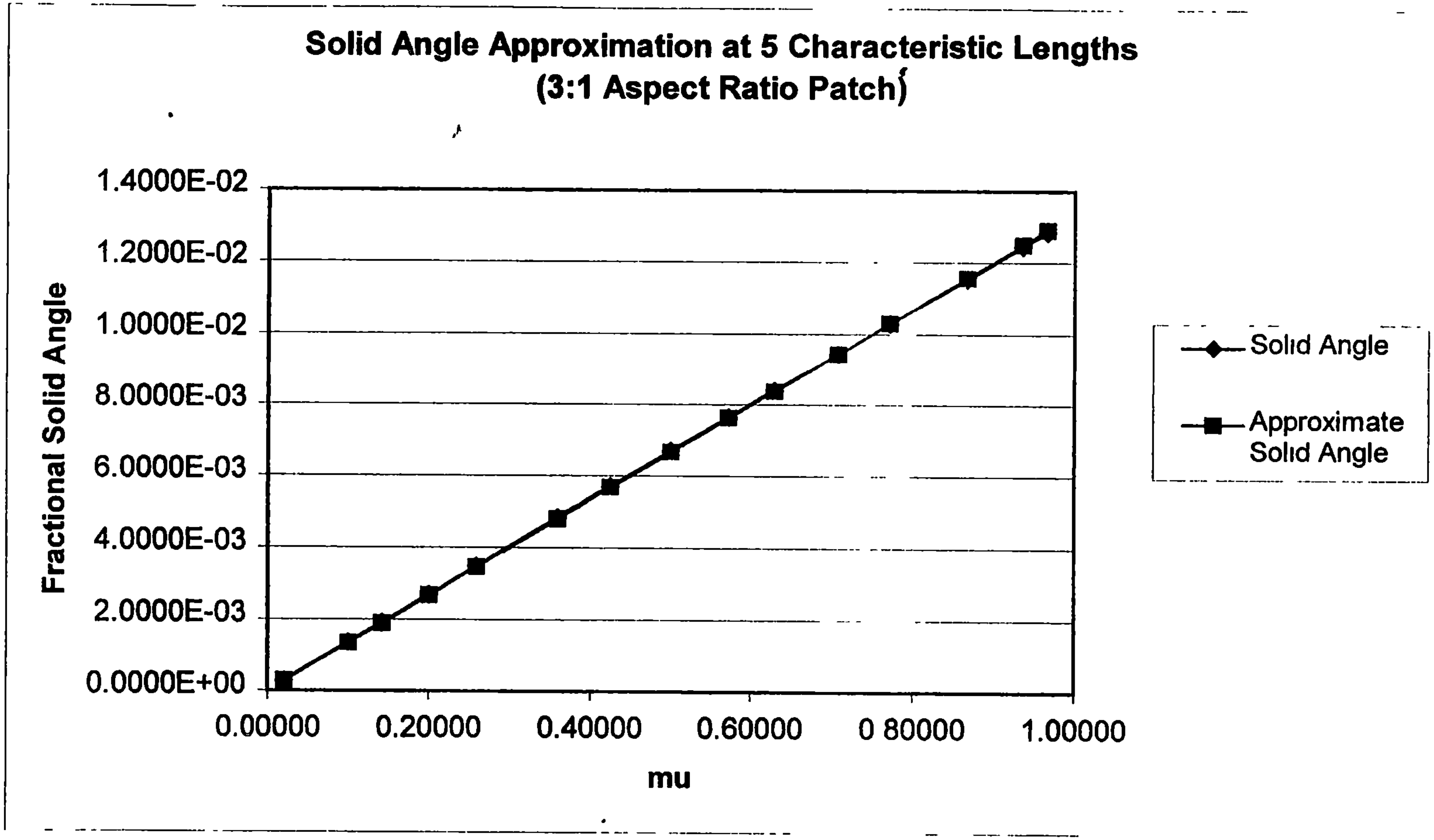

Figure A-5 Solid Angle Approximation at 5 Characteristic Lengths (3 1 Aspect Ratio Patch)

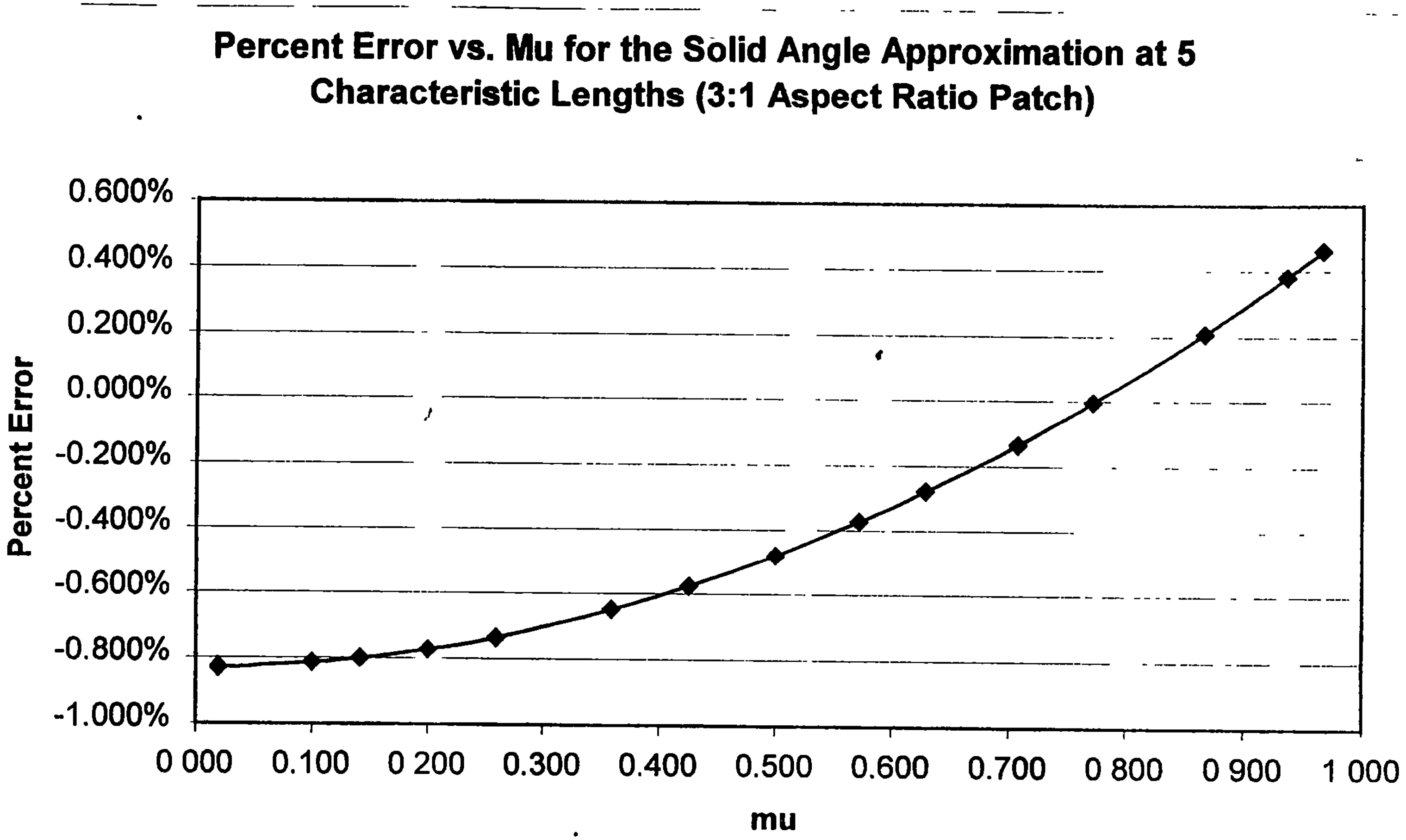

Figure A-6 Percent Error vs. Mu at 5 Characteristic Lengths (3:1 Aspect Ratio Patch

B. Comparison of MAKERT to MCNP

As part of the code validation and testing process for the OSM, a series of MCNP calculations were run, and the results compared to those obtained from the MAKERT code. The specifications for the test runs are compiled in Table B-1

Table B-1 Specifications for MAKERT/MCNP Comparison Runs

Specification	MAKERT	MCNP
Geometry	15 cm H_2O slab	15 cm H_2O slab
Source	Group 1, μ= 0.861136	14 MeV neutrons, μ= 0.861136
Cross Sections	22N-18G Coupled Library (from SCALE4 3)	ENDF-V Continuous Cross Sections
Quadrature	S4	N/A
Tallies	N/A	Current tallies divided into the 22N-18G energy structure and into cosine bins matching the S4 Gaussian quadrature
Results Processing	Balance code	N/A

In order to properly compare the results from the two codes, the flux values given by MAKERT had to be converted to current values, as given by MCNP. This was achieved using the *balance* code. This code reads the values from the response matrix file, converts the values from flux to current, and outputs the group-wise outgoing currents for each angular bin. The equation used to angular flux values to current is as follows.

$$J = \varphi\mu * wt \qquad \text{B-1}$$

where J is the current, φ is the angular flux, μ is the cosine of the angle, and wt is the weight associated with that μ value. Note that this code only reads in the values corresponding to incoming fluxes in energy group 1 and angular bin 4 Plots showing the results of the comparisons are given in Figure B-1 through Figure B-4

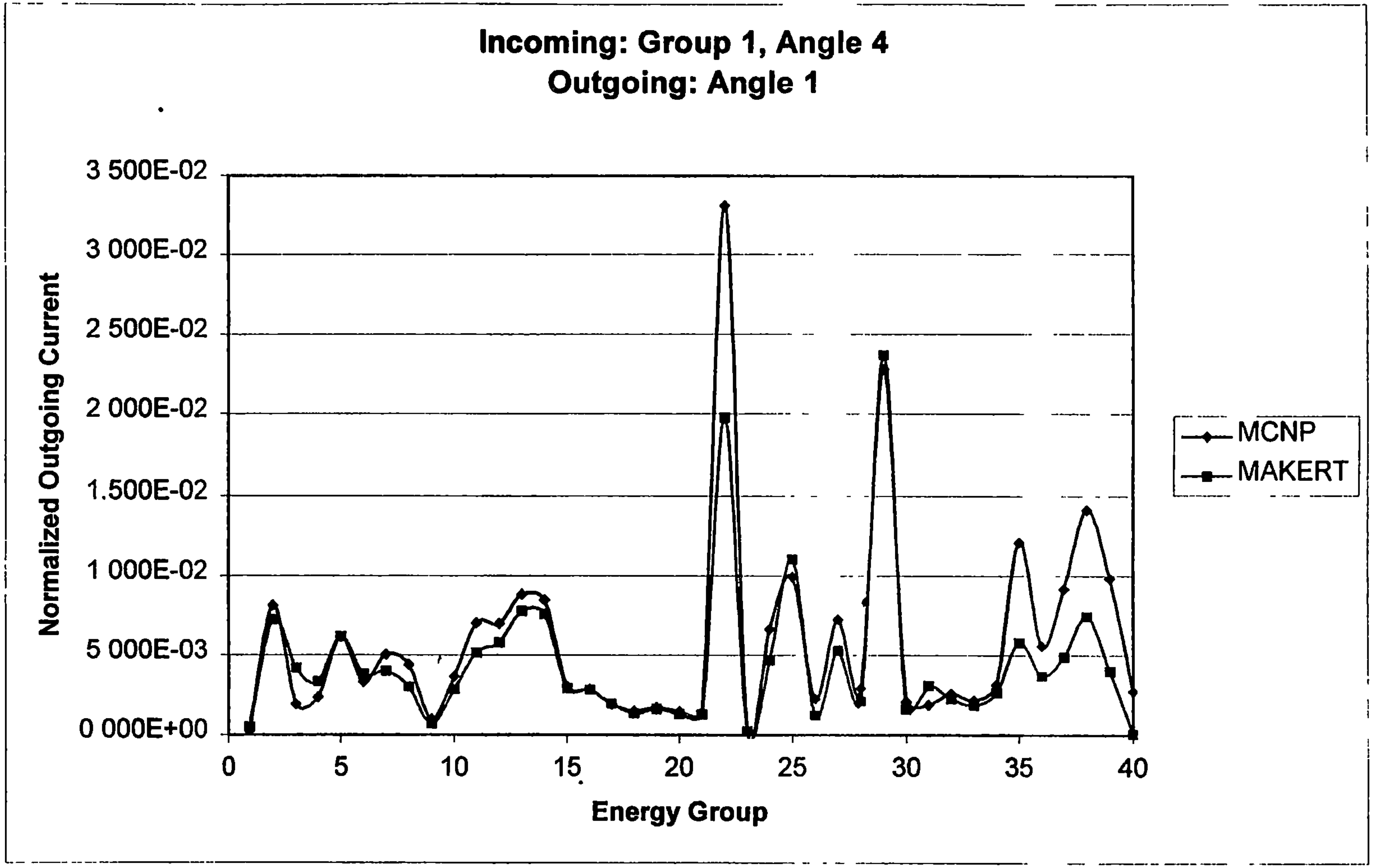

Figure B-1 Comparison of Outgoing Currents in Angular Bin 1

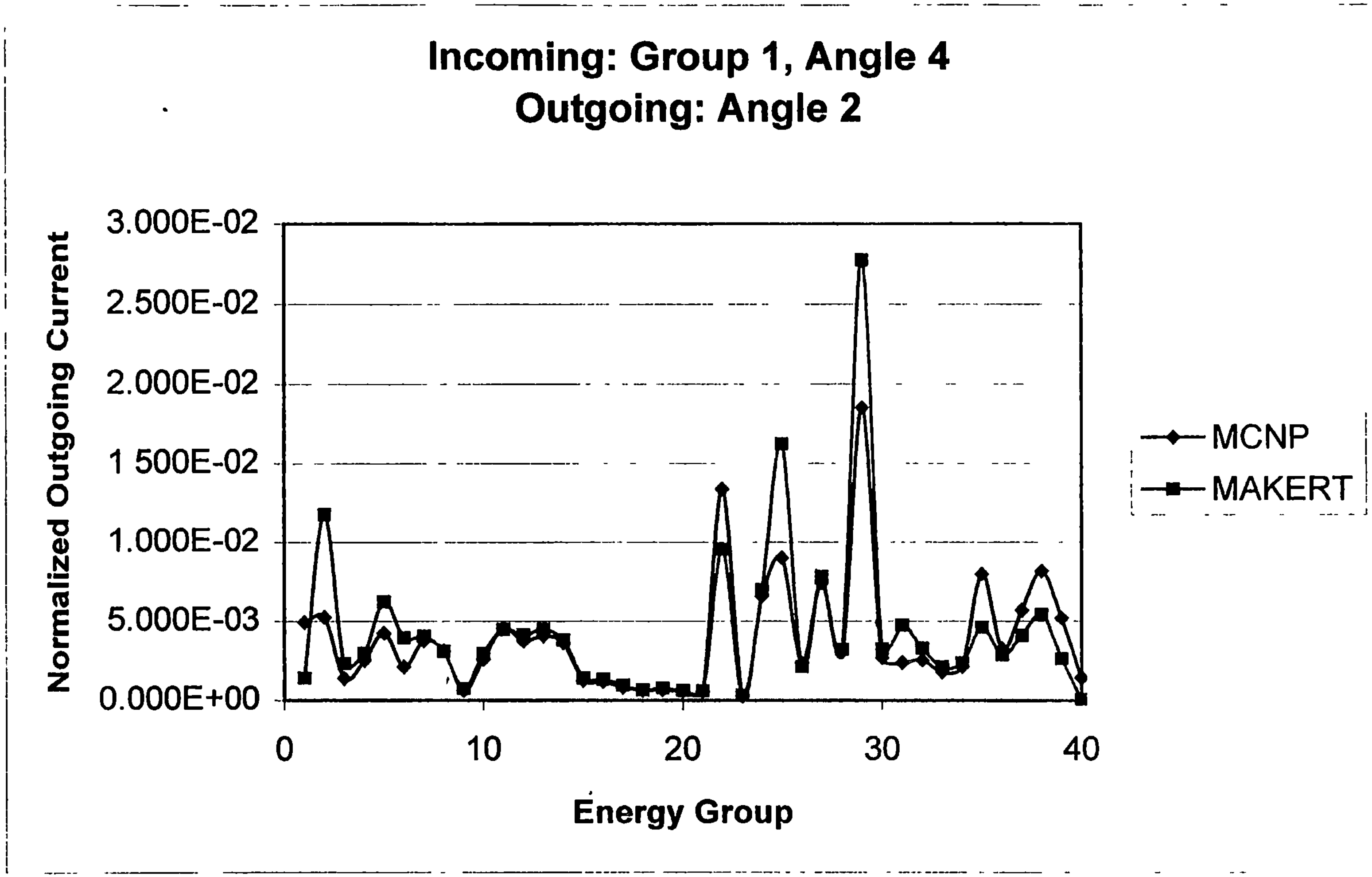

Figure B-2 Comparison of Outgoing Currents in Angular Bin 2

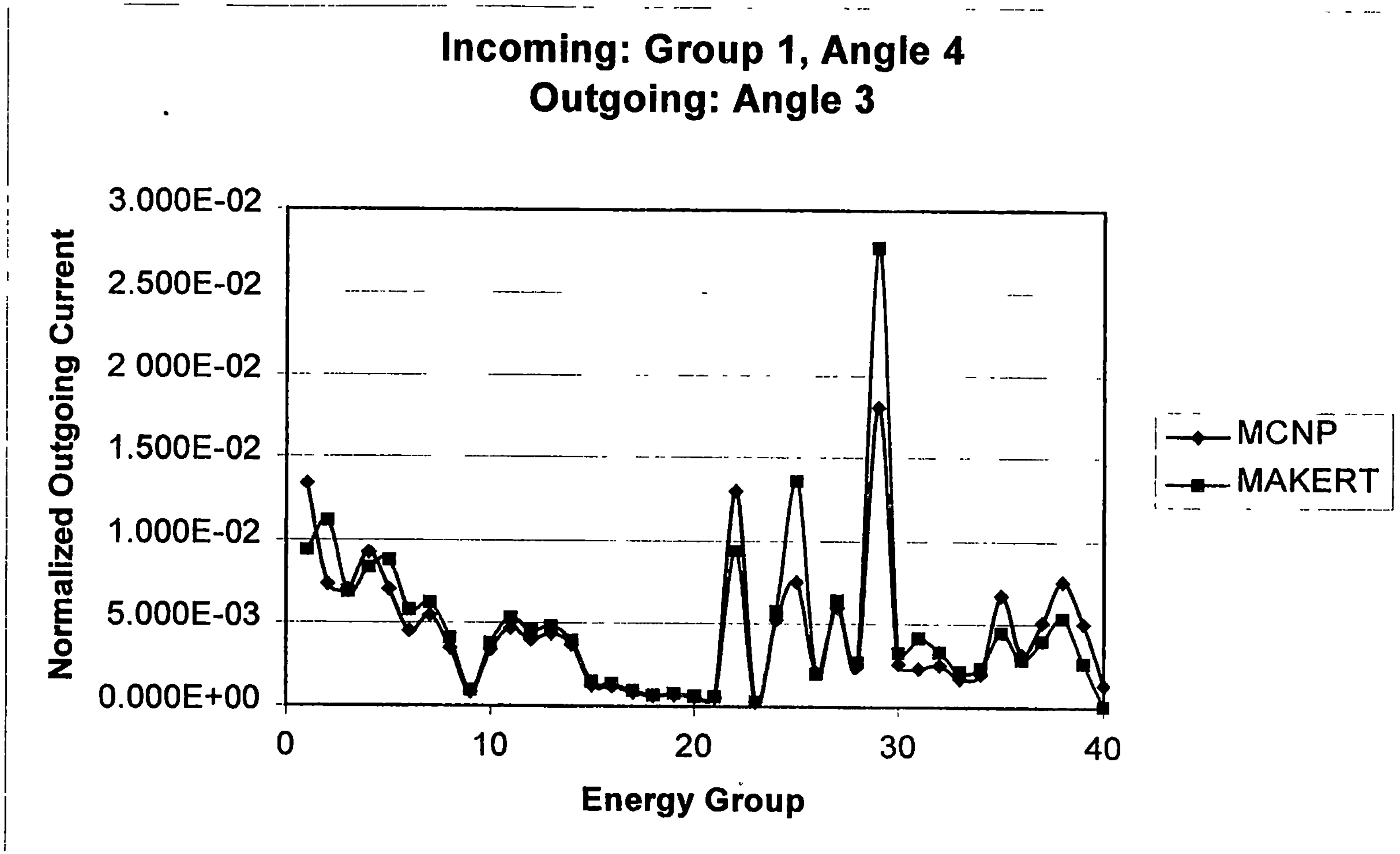

Figure B-3 Comparison of Outgoing Currents in Angular Bin 3

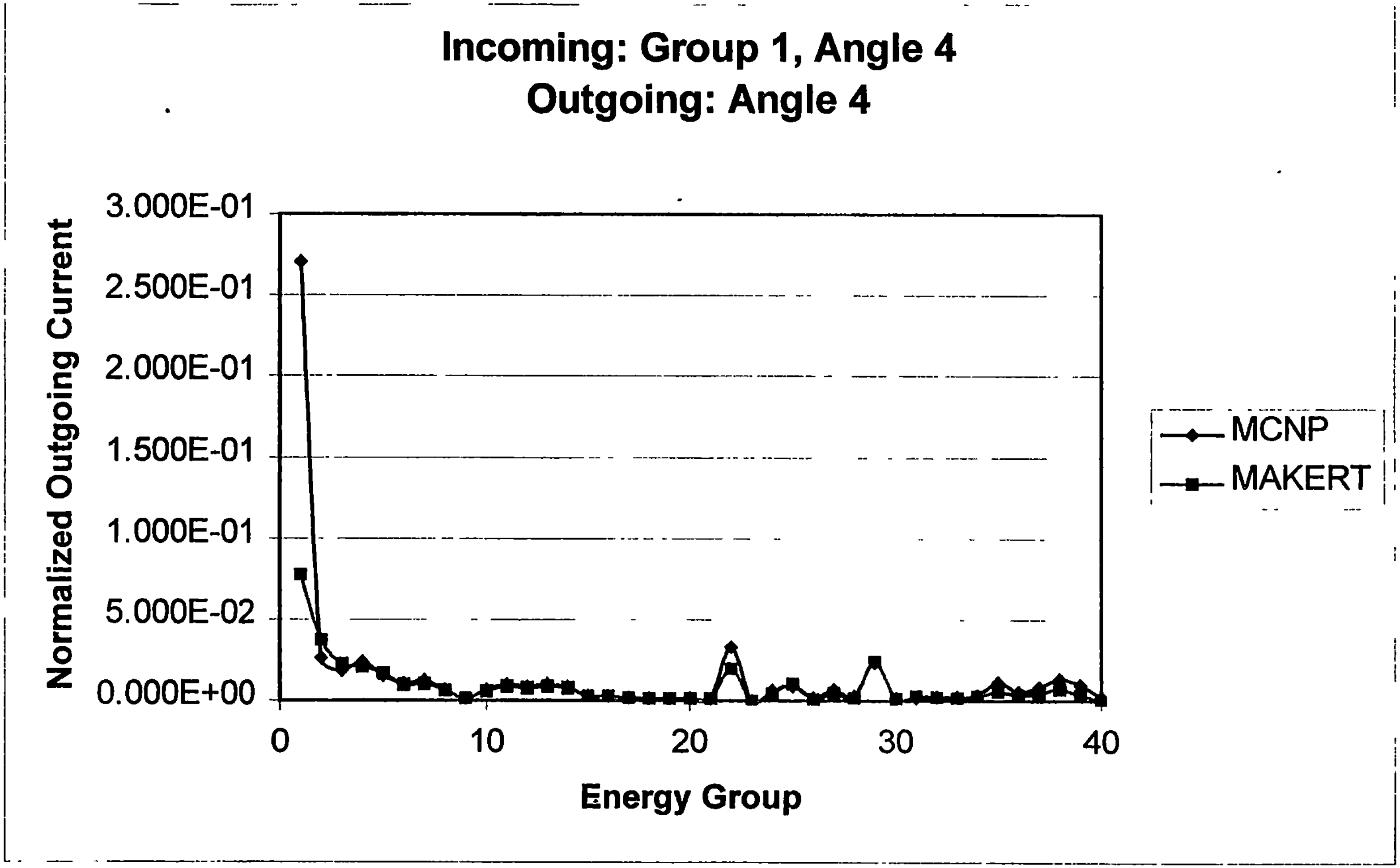

Figure B-4 Comparison of Outgoing Currents in Angular Bin 4

As seen in the four plots, the two codes produce results that agree quite well for most energies However, there are some differences that need to be addressed. For all four angular bins, the outgoing current predicted by MCNP is much greater than that predicted by MAKERT for energy group 22. This is the lowest neutron energy group, with energies from 0 01 eV up to 0 414 eV This single thermal group will not represent the cross sections as accurately as the continuous cross sections used by MCNP, resulting in large differences in the results Similar discrepancies can be seen in several other energy groups, these can also be accounted for by differences in the cross section data used in the two calculations A much more striking difference is seen in the outgoing current for energy group 1 and angular bin 4 (in Figure B-4) The value predicted by MCNP is approximately three times as large as that predicted by MAKERT This is easily explained when one takes into account that MAKERT subtracts out the uncollided portion of the flux With our source in group 1 and angular bin 4, we expect the MCNP result to be much higher than the value given by MAKERT, if we were to similarly edit the results given by MCNP, the curves would show much closer agreement at this point

For all angles, the two highest energy groups (group 1 and 2) differ This can be explained by the fact that the MCNP source is monoenergetic, while the MAKERT source is distributed over the range of group 1 One would physically expect that the resulting scatter would differ for these at energies close to 14 MeV and that the fluxes would begin to converge for lower energies

The results of this comparison give us confidence that the MAKERT code will accurately predict the outgoing fluxes from a one-dimensional slab, limited by the accuracy of the cross section data and the assumptions inherent in the discrete ordinates treatment

The input files used by each of the codes are included on the following pages

MCNP INPUT – h2o3 ın

```
test problem
c cells
1 1 -1.0 1 -4
10 0 -1 10
99 0 -10:4

c surfaces
1 px 0
4 px 15
10 px -101

c all other cards
mode n p
ımp·n 1 1 0
ımp.p 1 1 0
m1      1001 50c 2 8016.50c 1
SDEF PAR=1 ERG=14 x=-100.0 y=0 z=0 DIR=0.861136 VEC=1 0 0
f11:n 1
f111:p 1
f21:n 4
f121:p 4
c f12:n 1
c f112:p 1
c f22·n 4
c f122:p 4
c0 -.60056 0 .60056 1
e11  1.0E-8 4.14E-7 1 12E-6 3 06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
     3.35E-3 1.11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
     10 12.2 14.92
e21  1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5 83E-4
     3 35E-3 1.11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
     10 12.2 14.92
e111  1.0E-2 5.0E-2 1.0E-1 2.0E-1 3 0E-1 4.0E-1 6.0E-1 8.0E-1 1.0 1.33
      1 66 2 0 2.5 3 0 4.0 5.0 6.5 8 0 10
e121  1.0E-2 5 0E-2 1.0E-1 2.0E-1 3 0E-1 4.0E-1 6 0E-1 8.0E-1 1.0 1.33
      1.66 2.0 2.5 3.0 4.0 5.0 6.5 8 0 10
nps 1000000
```

SCALE4 3 INPUT – th1

```
=SAS1
'===========================================================
'   MATERIAL SPECIFICATION
'===========================================================
Take Home test
'  Library       Spatial treatment
22N-18COUPLE    INFHOMMEDIUM
'
' Mat  Mixture Density
  H2O     1       1.0    END
END COMP
END
LAST
'===========================================================
'   TRANSPORT CALCULATION
'===========================================================
Take home -- Above ground meat irradiation
'   Type
'  SPHERICAL
   SLAB VACUUM
' Mixture  Dimension #Meshes Source Other_mixture  Neutrons  Photons
     1      9.9       99       0
     1      10         1      -1      0   0        1.         0.
END ZONE
'===========================================================
'   SOURCE SPECIFICATION
'===========================================================
'  Neutron source spectrum
 1. 21Z
'  Photon source spectrum
 18Z
'===========================================================
'   DOSE CALCULATION
'===========================================================
READ XSDOSE
10. 10.
END
END
```

WORKING INPUT – working.inp

```
options = nosearch nolinear run
ratio = 0 8
spacing = 16
order = 2
left = 1
right = 0
outers = 100
inners = 4
groups = 40
working_library = ft04f001
materials = water
legendre = 3
quadrature = 16
convergence = 0 00001
dimension = 1
regions = water
thickness =  15.00
water =
                     1001      6.67692E-02
                     8016      3.33846E-02
```

MAKERT INPUT – makert in

```
groups = 40
legendre = 3
materials = h2o
map = 1
thickness = 15
nx = 15
h2o =
         1001     6.67692E-02
         8016     3.33846E-02
working_library = ft04f001
include s4.qad
```

C. Sample Problem Inputs and Outputs

Sample Problem 1 Input samples8 inp

```
ngroups=40
nang=8
isosource=
0. 0  0  1 1.0E20
material=
h2o15s8.rt
wallx=
1  100 -100 -100  115 100 100 1 10 10 0
2 -100 -100 -100 -115 100 100 1 10 10 0
wally=
3 -115  100 -100 115  115 100 1 11 10 0
4 -115 -100 -100 115 -115 100 1 11 10 0
wallz=
5 -115 -115  100 115 115  115 1 11 11 0
6 -115 -115 -100 115 115 -115 1 11 11 0
dosepoint=
300  0. 0  0
mu=
 183434642
.52553241
 796666477
 960289856
wt =
.050614268
.1111905172
.1568533229
.1813418917
.1813418917
.1568533229
.1111905172
 0506142681
```

Sample Problem 1 MCNP input sam1 in

```
First Sample Problem
c cells
c 1-6 = walls corresponding to the walls in sample.inp
c 98  = everything inside the box
c 99  = outside the box, but the relevant part of the universe
c 100 = the rest of the universe
1 1 -1.0 9 -10 12 -13 16 -17
2 1 -1.0 7 -8 12 -13 16 -17
3 1 -1.0 7 -10 13 -14 16 -17
4 1 -1.0 7 -10 11 -12 16 -17
5 1 -1.0 7 -10 11 -14 17 -18
6 1 -1.0 7 -10 11 -14 15 -16
98 0 8 -9 12 -13 16 -17
99 0 (-7 10:-11:14.-15:18) (1 -2 3 -4 5 -6)
100 0 -1.2:-3 4:-5:6

c surfaces
c outer edges of the problem area
1 px -120
2 px 305
3 py -120
4 py 120
5 pz -120
6 pz 120
c wall boundaries
```

```
7  px -115
8  px -100
9  px 100
10 px 115
11 py -115
12 py -100
13 py 100
14 py 115
15 pz -115
16 pz -100
17 pz 100
18 pz 115

c other cards
mode n p
ımp:n 1 1 1 1 1 1 1 1 0
ımp:p 1 1 1 1 1 1 1 1 0
m1      1001.50c 2 8016 50c 1
SDEF PAR=1 ERG=14 x=0 y=0 z=0
f5:n 300 0 0 0
f15:p 300 0 0 0
e5   1.0E-8 4.14E-7 1.12E-6 3 06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
     3 35E-3 1.11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
     10 12.2 14.92
e15  1.0E-2 5.0E-2 1 0E-1 2.0E-1 3.0E-1 4.0E-1 6.0E-1 8.0E-1 1.0 1.33
     1.66 2.0 2 5 3.0 4.0 5.0 6.5 8.0 10
nps 1000000
```

Sample Problem 2 Input duct1s8.inp

```
ngroups=40
nang=8
mu=
.183434642
.52553241
.796666477
.960289856
wt =
.050614268
 1111905172
.1568533229
.1813418917
.1813418917
.1568533229
 1111905172
.0506142681
ısosource=
-400. 0  50. 1 1 0E20
materıal=
regconc30s8 rt
regconc60s8 rt
regconc181s8 rt
wallx=
1 -30 -200 0 30 200 180 2 10 5 0
2 -30 -200 220 30 200 400 2 10 5 0
3 -30 -200 180 30 -20 220 2 9 2 0
4 -30 20 180 30 200 220 2 9 2 0
5 -530 -200 0 -500 200 400 1 10 10 0
6 500 -200 0 530 200 400 1 10 10 0
wally=
7 -530 -230 0 530 -200 400 1 26 10 0
```

```
8 -530 200 0 530 230 400 1 26 10 0
9 -30 19 180 30 20 220 3 6 4 0
10 -30 -20 180 30 -19 220 3 6 4 0
wallz=
11 -530 -230 0 530 230 -30 1 26 26 0
12 -530 -230 400 530 230 430 1 26 26 0
13 -30 -19 180 30 19 181 3 6 4 0
14 -30 -19 219 39 19 220 3 6 4 0
dosemesh=
50 0 50 450 200 200 5 5 4 1
respfcn=
1
include ftd.dat
```

Sample Problem 2 MCNP Input: dux1 in

```
First Sample Problem
c cells
c 1 = outer walls
c 2 = inner wall
c 3 = left room
c 4 = right room
c 5 = duct liner
c 6 = duct
c 999 = rest of universe
1 1 -2.3 (1 -2 3 -4 5 -6) (-7:8:-9:10:-11:12)
2 1 -2.3 (13 -14 9 -10 11 -12) (-15:18:-19:22)
3 0 7 -13 9 -10 11 -12
4 0 14 -8 9 -10 11 -12
5 1 -2.3 13 -14 15 -18 19 -22 (-16:17:-20:21)
6 0 13 -14 16 -17 20 -21
999 0 -1:2:-3:4:-5:6

c surfaces
c outer edges of the problem area
1 px -530
2 px 530
3 py -230
4 py 230
5 pz -30
6 pz 430
```

```
c ınner edges of building
7 px -500
8 px 500
9 py -200
10 py 200
11 pz 0
12 pz 400
c ınsıde wall edges
13 px -30
14 px 30
c duct lining edges
15 py -20
16 py -19
17 py 19
18 py 20
19 pz 180
20 pz 181
21 pz 219
22 pz 220

c other cards
mode n p
ımp·n 1 1 1 1 1 1 0
ımp.p 1 1 1 1 1 1 0
m1   26000 50c -.014 1001 50c -.01 13027.50c -.034 20000.50c -.044
     8016.50c -.532 14000.50c -.337 11023.50c -.029
SDEF PAR=1 ERG=14 x=-400 y=0 z=50
f5·n 50 50 50 0
f15·p 50 50 50 0
f25:n 250 0 100 0
f35:p 250 0 100 0
f45:n 250 100 100 0
f55:p 250 100 100 0
e5    1 0E-8 4.14E-7 1 12E-6 3 06E-6 1 01E-5 2 9E-5 1 01E-4 5 83E-4
      3.35E-3 1 11E-1 5 5E-1 1 11 1 83 2.35 2.46 3 01 4.06 4 96 6.36 8.18
      10 12.2 14.92
e15   1 0E-2 5.0E-2 1.0E-1 2.0E-1 3 0E-1 4.0E-1 6.0E-1 8 0E-1 1.0 1 33
      1 66 2.0 2.5 3 0 4 0 5.0 6 5 8 0 10
e25    1.0E-8 4.14E-7 1.12E-6 3 06E-6 1.01E-5 2 9E-5 1 01E-4 5.83E-4
      3 35E-3 1 11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4 06 4.96 6.36 8.18
      10 12 2 14.92
e35   1.0E-2 5.0E-2 1 0E-1 2 0E-1 3 0E-1 4 0E-1 6.0E-1 8 0E-1 1.0 1 33
      1 66 2.0 2.5 3 0 4 0 5 0 6 5 8.0 10
e45    1.0E-8 4 14E-7 1.12E-6 3 06E-6 1.01E-5 2 9E-5 1.01E-4 5.83E-4
```

```
      3.35E-3 1.11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
      10 12.2 14 92
e55   1.0E-2 5 0E-2 1.0E-1 2 0E-1 3.0E-1 4.0E-1 6.0E-1 8.0E-1 1.0 1.33
      1.66 2.0 2 5 3.0 4.0 5 0 6 5 8 0 10
nps 5000000
```

Sample Problem 3 Input wellflux ınp

```
ngroups=40
nang=8
ısosource=
0 0 0 40 1.062E+11
0 0 0 39 3.552E+12
0 0 0 38 3.529E+12
0 0 0 37 7.003E+12
0 0 0 36 9.409E+12
0 0 0 35 1.784E+13
0 0 0 34 1 394E+13
0 0 0 33 1.012E+13
0 0 0 32 1.201E+13
0 0 0 31 7.907E+12
0 0 0 30 5.129E+12
0 0 0 29 5.926E+12
0 0 0 28 3.191E+12
0 0 0 27 3.123E+12
0 0 0 26 1.189E+12
0 0 0 25 8 200E+11
0 0 0 24 1 106E+11
0 0 0 23 7.905E+08
0 0 0 22 5 368E+12
0 0 0 21 1.572E+12
0 0 0 20 1.685E+12
0 0 0 19 2.051E+12
0 0 0 18 1.931E+12
0 0 0 17 2 485E+12
0 0 0 16 3 849E+12
0 0 0 15 4.243E+12
0 0 0 14 1 208E+13
0 0 0 13 1 413E+13
0 0 0 12 1.286E+13
0 0 0 11 1.286E+13
0 0 0 10 7.307E+12
0 0 0  9 1.622E+12
0 0 0  8 6.289E+12
0 0 0  7 6.730E+12
0 0 0  6 3 473E+12
0 0 0  5 2 734E+12
0 0 0  4 1 223E+12
0 0 0  3 3 172E+11
0 0 0  2 8 784E+10
0 0 0  1 1 802E+10
materıal=
regconc20p32s8 rt
lamconch2o3060s8 rt
wallx=
1 1463 04 -1463 04 0 1554 48 1463.04 487.68 2 15 40 0
2 -1554.48 -1463.04 0 -1463 04 1463.04 487.68 2 15 40 1
wally=
3 -1554.48 -1554 48 0 1554.48 -1463.04 487 68 2 15 40 1
4 -1554.48 1463 04 0 1554.48 1554.48 487.68 2 15 40 0
```

```
wallz=
5 -1463.04 -1463 04 467.36 1463.04 1463.04 487 68 1 40 40 0
dosemesh=
0 0 100 1400 1400 900 8 8 5 0
respfcn=
1
include ftd.dat
mu=
 183434642
 52553241
.796666477
.960289856
wt =
.050614268
.1111905172
.1568533229
 1813418917
.1813418917
.1568533229
.1111905172
.0506142681
```

Sample Problem 3 MCNP Input: wn1 in

```
Criticality Source Problem (Neutrons)
c cells
c 1 = stuff above well
c 2 = interior of well
c 3 = concrete walls
c 4 = concrete roof/floor
c 100 = soil (water)
c 101 = rest of universe
1 0 1 -2 3 -4 7 -6
2 0 8 -9 10 -11 5 -16
3 1 -2.3 (12 -13 14 -15 5 -7) (-8.9:-10:11)
4 1 -2.3 8 -9 10 -11 16 -17
5 1 -2.3 8 -9 10 -11 17 -18
6 1 -2.3 8 -9 10 -11 18 -19
7 1 -2.3 8 -9 10 -11 19 -7
100 2 -1.0 (1 -2 3 -4 5 -7) (-12:13 -14:15)
101 0 -1:2:-3:4:-5:6

c surfaces
c outer edges of the problem area
1 px -1554 48
2 px 1554.48
3 py -1554 48
4 py 1554.48
5 pz 0
6 pz 945
c top of well
7 pz 487.68
c inner walls of well
8 px -1463.04
9 px 1463.05
10 py -1463.04
11 py 1463.04
c concrete-soil boundary
12 px -1493.52
13 px 1493 52
14 py -1493.52
```

```
15 py 1493.52
16 pz 467.36
17 pz 473
18 pz 478
19 pz 483

c other cards
mode n p
imp n 1 1 1 1 2 4 8 1 0
imp.p 1 1 1 1 1.5 2 25 3.38 1 0
m1   26000 50c -.014 1001.50c -.01 13027.50c - 034 20000.50c -.044
     8016.50c -.532 14000 50c -.337 11023.50c - 029
m2   8016.50c 1 1001 50c 2
SDEF PAR=1 ERG=D1 x=0 y=0 z=0 01
SI1  L 2.1200E-07 7 6700E-07 2.0900E-06 6.5800E-06 1.9550E-05
     6.5000E-05 3 4200E-04 1.9665E-03 5 7175E-02 3.3050E-01
     8 3000E-01 1 4700E+00 2.0900E+00 2.4050E+00 2.7350E+00
     3.5350E+00 4 5100E+00 5.6600E+00 7 2700E+00 9.0900E+00
     1.1100E+01 1.3560E+01
SP1  D 5.117E-02 1.499E-02 1.606E-02 1.955E-02 1.840E-02 2.369E-02
     3.669E-02 4.044E-02 1.152E-01 1 347E-01 1.226E-01 1.226E-01
     6.964E-02 1.546E-02 5.994E-02 6 415E-02 3.310E-02 2.606E-02
     1.165E-02 3.024E-03 8.372E-04 1.717E-04
f5:n 0 0 100 0
f15:p 0 0 100 0
f25:n 0 0 300 0
f35:p 0 0 300 0
f45·n 0 0 500 0
f55:p 0 0 500 0
f65·n 0 0 700 0
f75:p 0 0 700 0
f85:n 0 0 900 0
f95:p 0 0 900 0
f205:n 200 200 300 0
f215:p 200 200 300 0
f225:n 400 400 300 0
f235:p 400 400 300 0
f245:n 800 800 300 0
f255:p 800 800 300 0
f265:n 1200 1200 300 0
f275:p 1200 1200 300 0
f285:n 400 0 500 0
f295:p 400 0 500 0
e5    1.0E-8 4.14E-7 1 12E-6 3.06E-6 1.01E-5 2.9E-5 1 01E-4 5.83E-4
      3.35E-3 1 11E-1 5.5E-1 1.11 1.83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
      10 12.2 14.92
e15   1.0E-2 5 0E-2 1.0E-1 2.0E-1 3.0E-1 4.0E-1 6.0E-1 8 0E-1 1.0 1.33
      1.66 2.0 2.5 3.0 4.0 5.0 6 5 8.0 10
e25   1.0E-8 4 14E-7 1 12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
      3.35E-3 1 11E-1 5 5E-1 1.11 1.83 2 35 2 46 3.01 4.06 4.96 6.36 8.18
      10 12.2 14.92
e35   1.0E-2 5.0E-2 1.0E-1 2.0E-1 3 0E-1 4 0E-1 6.0E-1 8.0E-1 1.0 1.33
      1.66 2.0 2 5 3.0 4.0 5.0 6 5 8 0 10
e45   1.0E-8 4 14E-7 1 12E-6 3.06E-6 1.01E-5 2 9E-5 1.01E-4 5.83E-4
      3.35E-3 1 11E-1 5.5E-1 1 11 1 83 2.35 2 46 3.01 4 06 4.96 6 36 8.18
      10 12.2 14.92
e55   1 0E-2 5.0E-2 1.0E-1 2.0E-1 3.0E-1 4.0E-1 6.0E-1 8 0E-1 1.0 1.33
      1 66 2.0 2.5 3.0 4 0 5 0 6 5 8 0 10
e65   1 0E-8 4 14E-7 1.12E-6 3.06E-6 1 01E-5 2.9E-5 1 01E-4 5.83E-4
      3 35E-3 1 11E-1 5.5E-1 1 11 1.83 2.35 2.46 3 01 4 06 4.96 6.36 8 18
      10 12.2 14.92
e75   1.0E-2 5 0E-2 1.0E-1 2 0E-1 3.0E-1 4 0E-1 6 0E-1 8.0E-1 1.0 1.33
```

```
        1.66 2 0 2 5 3 0 4.0 5 0 6 5 8.0 10
e85     1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2 9E-5 1.01E-4 5.83E-4
        3.35E-3 1 11E-1 5.5E-1 1 11 1 83 2.35 2.46 3.01 4 06 4.96 6.36 8.18
        10 12.2 14.92
e95     1 0E-2 5.0E-2 1.0E-1 2.0E-1 3 0E-1 4.0E-1 6.0E-1 8.0E-1 1 0 1.33
        1 66 2 0 2.5 3 0 4.0 5.0 6 5 8.0 10
e205    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
        3.35E-3 1.11E-1 5.5E-1 1.11 1.83 2 35 2 46 3.01 4.06 4.96 6 36 8 18
        10 12.2 14 92
e215    1 0E-2 5.0E-2 1 0E-1 2 0E-1 3 0E-1 4 0E-1 6.0E-1 8.0E-1 1.0 1.33
        1.66 2.0 2.5 3.0 4.0 5 0 6.5 8 0 10
e225    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2 9E-5 1.01E-4 5.83E-4
        3.35E-3 1.11E-1 5.5E-1 1 11 1 83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
        10 12.2 14.92
e235    1.0E-2 5.0E-2 1.0E-1 2 0E-1 3.0E-1 4 0E-1 6.0E-1 8.0E-1 1.0 1.33
        1.66 2.0 2.5 3.0 4.0 5.0 6.5 8 0 10
e245    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2 9E-5 1.01E-4 5.83E-4
        3.35E-3 1.11E-1 5.5E-1 1 11 1 83 2.35 2.46 3.01 4.06 4 96 6.36 8 18
        10 12.2 14.92
e255    1.0E-2 5.0E-2 1.0E-1 2 0E-1 3.0E-1 4 0E-1 6.0E-1 8.0E-1 1.0 1.33
        1.66 2.0 2.5 3.0 4.0 5 0 6.5 8 0 10
e265    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
        3.35E-3 1.11E-1 5.5E-1 1.11 1 83 2.35 2.46 3.01 4.06 4 96 6.36 8.18
        10 12.2 14.92
e275    1.0E-2 5.0E-2 1.0E-1 2.0E-1 3.0E-1 4 0E-1 6.0E-1 8.0E-1 1.0 1.33
        1 66 2.0 2.5 3.0 4.0 5 0 6.5 8.0 10
e285    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
        3.35E-3 1.11E-1 5.5E-1 1.11 1 83 2.35 2.46 3.01 4.06 4.96 6.36 8.18
        10 12.2 14.92
e295    1.0E-2 5.0E-2 1.0E-1 2.0E-1 3.0E-1 4.0E-1 6.0E-1 8.0E-1 1 0 1.33
        1.66 2.0 2.5 3.0 4.0 5.0 6 5 8.0 10
nps 10000000
```

Note. wnp2 in is identical to wn1 in, except for the placement of the F5 (point detector) tallies

Sample Problem 3 MCNP Input wp1.in

```
Criticality Source Problem (photons)
c cells
c 1 = stuff above well
c 2 = interior of well
c 3 = concrete walls
c 4 = concrete roof/floor
c 5 = soil (water)
c 6 = rest of universe
1 0 1 -2 3 -4 7 -6
2 0 8 -9 10 -11 5 -16
3 1 -2 3 (12 -13 14 -15 5 -7) (-8:9 -10 11)
4 1 -2 3 8 -9 10 -11 16 -17
5 1 -2 3 8 -9 10 -11 17 -18
6 1 -2 3 8 -9 10 -11 18 -19
7 1 -2.3 8 -9 10 -11 19 -7
100 2 -1 0 (1 -2 3 -4 5 -7) (-12:13 -14 15)
101 0 -1 2 -3:4:-5:6

c surfaces
c outer edges of the problem area
```

```
1 px -1554.48
2 px 1554.48
3 py -1554.48
4 py 1554.48
5 pz 0
6 pz 945
c top of well
7 pz 487 68
c ınner walls of well
8 px -1463.04
9 px 1463.05
10 py -1463.04
11 py 1463.04
c concrete-soıl boundary
12 px -1493.52
13 px 1493.52
14 py -1493.52
15 py 1493.52
16 pz 467.36
17 pz 473
18 pz 478
19 pz 483

c other cards
mode p
ımp:p 1 1 1 1 2 4 8 1 0
m1    26000.50c -.014 1001.50c -.01 13027.50c - 034 20000.50c -.044
      8016 50c -.532 14000.50c -.337 11023.50c -.029
m2    8016.50c 1 1001.50c 2
SDEF PAR=2 ERG=D2 x=0 y=0 z=0.01
SI2  L 3.0000E-02 7.5000E-02 1.5000E-01 2.5000E-01 3.5000E-01
      5.0000E-01 7.0000E-01 9.0000E-01 1 1650E+00 1.4950E+00
      1.8300E+00 2.2500E+00 2.7500E+00 3.5000E+00 4.5000E+00
      5 7500E+00 7.2500E+00 9.0000E+00
SP2  D 1.012E-03 3.385E-02 3.364E-02 6.675E-02 8.969E-02
      1.700E-01 1.329E-01 9.651E-02 1.145E-01 7.537E-02
      4.889E-02 5.649E-02 3.041E-02 2.977E-02 1.133E-02
      7.816E-03 1.054E-03 7.535E-06
f15:p 0 0 100 0
f35:p 0 0 300 0
f55:p 0 0 500 0
f75.p 0 0 700 0
f95:p 0 0 900 0
f215 p 200 200 300 0
f235:p 400 400 300 0
f255:p 800 800 300 0
f275 p 1200 1200 300 0
f295 p 400 0 500 0
e0     1 0E-2 5 0E-2 1.0E-1 2.0E-1 3.0E-1 4.0E-1 6.0E-1 8.0E-1 1.0 1.33
       1.66 2.0 2.5 3 0 4 0 5.0 6.5 8 0 10
nps 10000000
```

Note wp2 ın ıs ıdentıcal to wp1 ın, except for the placement of the F5 (poınt detector) tallıes.

Sample Problem 3 Source Characterızatıon MCNP Input fın ın

```
.53 ft radıus 100 g/l
```

```
c cell cards
1 1 -1 0645 -1 imp:n 1 imp:p 1
2 0 1 imp:n 0 imp:p 0

c surface
1 so 16.1544

c other cards
mode n p
kcode 10000 1.0 3 1003 400 1
ksrc 0 0 0
m1 92235.50c 4.773e-4 92238.50c 3.466e-5 7014.50c 2.2465e-3
      8016.50c 3.693e-2 1001.50c 5.9547e-2
f1:n 1
f11:p 1
e1    1.0E-8 4.14E-7 1.12E-6 3.06E-6 1.01E-5 2.9E-5 1.01E-4 5.83E-4
      3.35E-3 1.11E-1 5.5E-1 1.11 1.83 2.35 2.46 3 01 4.06 4.96 6.36 8.18
      10 12.2 14 92
e11   1.0E-2 5.0E-2 1.0E-1 2.0E-1 3 0E-1 4.0E-1 6.0E-1 8.0E-1 1.0 1.33
      1.66 2.0 2.5 3.0 4.0 5.0 6 5 8 0 10
```

Sample Problem 1 OSM Output samples8 out

```
Number of energy groups is     40

     2 wallx's were defined.

     2 wally's were defined.

     2 wallz's were defined.

     6 total walls were defined.

     1 isotropic sources were defined

     1 dose calculation points were defined individually.

     0 different dose point meshes were defined.

     0 response functions were defined.

POSITIVE MU VALUES FOR S 8 QUADRATURE
 0.1834346420
 0.5255324100
 0.7966664770
 0.9602898560

WEIGHTS FOR FOR S 8 QUADRATURE
 0 0506142680
 0.1111905172
 0.1568533229
 0.1813418917
 0.1813418917
 0.1568533229
 0.1111905172
 0.0506142681

WALLX INFORMATION
```

ID	x1	y1	z1	x2	y2	z2	gridy	gridz
1	100.0	-100.0	-100 0	115.0	100 0	100 0	10	10
2	-115.0	-100.0	-100.0	-100.0	100.0	100.0	10	10

Wall segments (wallx)

ID#	x1	y1	z1	x2	y2	z2	WID	SENSE
1	100.00	-100.00	-100.00	100 00	-80.00	-80 00	1	0
2	100.00	-100.00	-80.00	100.00	-80.00	-60.00	1	0
3	100 00	-100 00	-60 00	100 00	-80.00	-40.00	1	0
4	100 00	-100.00	-40.00	100 00	-80.00	-20.00	1	0
5	100 00	-100.00	-20.00	100 00	-80 00	0.00	1	0
6	100.00	-100.00	0.00	100 00	-80 00	20 00	1	0
7	100.00	-100.00	20 00	100 00	-80 00	40 00	1	0
8	100.00	-100.00	40 00	100 00	-80 00	60 00	1	0
9	100.00	-100.00	60.00	100 00	-80 00	80 00	1	0
10	100.00	-100.00	80.00	100 00	-80 00	100 00	1	0
11	100.00	-80.00	-100.00	100 00	-60 00	-80 00	1	0
12	100.00	-80 00	-80 00	100 00	-60 00	-60.00	1	0
13	100.00	-80.00	-60.00	100 00	-60 00	-40.00	1	0
14	100 00	-80 00	-40.00	100 00	-60.00	-20.00	1	0
15	100 00	-80 00	-20.00	100 00	-60.00	0 00	1	0

16	100.00	-80.00	0.00	100.00	-60.00	20.00	1	0
17	100.00	-80.00	20.00	100.00	-60.00	40.00	1	0
18	100.00	-80.00	40.00	100.00	-60.00	60.00	1	0
19	100.00	-80.00	60 00	100.00	-60.00	80 00	1	0
20	100 00	-80.00	80 00	100.00	-60 00	100 00	1	0
21	100 00	-60 00	-100 00	100 00	-40 00	-80 00	1	0
22	100 00	-60.00	-80.00	100 00	-40.00	-60.00	1	0
23	100 00	-60 00	-60.00	100 00	-40.00	-40.00	1	0
24	100 00	-60.00	-40.00	100 00	-40.00	-20.00	1	0
25	100.00	-60 00	-20.00	100 00	-40.00	0.00	1	0
26	100 00	-60 00	0.00	100.00	-40.00	20.00	1	0
27	100 00	-60.00	20 00	100.00	-40.00	40.00	1	0
28	100.00	-60.00	40.00	100.00	-40.00	60.00	1	0
29	100.00	-60.00	60.00	100.00	-40.00	80.00	1	0
30	100.00	-60.00	80.00	100.00	-40.00	100.00	1	0
31	100 00	-40.00	-100.00	100.00	-20.00	-80.00	1	0
32	100.00	-40 00	-80.00	100 00	-20 00	-60.00	1	0
33	100 00	-40 00	-60.00	100 00	-20.00	-40.00	1	0
34	100.00	-40.00	-40.00	100.00	-20.00	-20.00	1	0
35	100 00	-40 00	-20.00	100.00	-20.00	0 00	1	0
36	100.00	-40.00	0.00	100.00	-20.00	20.00	1	0
37	100.00	-40.00	20.00	100.00	-20 00	40.00	1	0
38	100.00	-40.00	40.00	100.00	-20.00	60.00	1	0
39	100.00	-40.00	60.00	100.00	-20.00	80.00	1	0
40	100.00	-40 00	80.00	100.00	-20.00	100.00	1	0
41	100.00	-20 00	-100.00	100 00	0.00	-80.00	1	0
42	100.00	-20 00	-80.00	100 00	0.00	-60.00	1	0
43	100.00	-20.00	-60.00	100.00	0.00	-40.00	1	0
44	100 00	-20.00	-40.00	100.00	0.00	-20.00	1	0
45	100 00	-20.00	-20.00	100.00	0.00	0.00	1	0
46	100 00	-20.00	0.00	100.00	0.00	20.00	1	0
47	100.00	-20.00	20.00	100.00	0.00	40.00	1	0
48	100 00	-20.00	40.00	100.00	0.00	60.00	1	0
49	100.00	-20.00	60.00	100.00	0.00	80.00	1	0
50	100.00	-20.00	80.00	100.00	0.00	100.00	1	0
51	100.00	0.00	-100.00	100 00	20.00	-80.00	1	0
52	100.00	0 00	-80.00	100 00	20.00	-60.00	1	0
53	100.00	0 00	-60.00	100.00	20.00	-40.00	1	0
54	100 00	0 00	-40.00	100.00	20.00	-20.00	1	0
55	100 00	0.00	-20.00	100.00	20.00	0.00	1	0
56	100.00	0 00	0.00	100.00	20.00	20.00	1	0
57	100.00	0 00	20.00	100.00	20 00	40.00	1	0
58	100 00	0 00	40.00	100.00	20.00	60.00	1	0
59	100.00	0 00	60.00	100.00	20.00	80.00	1	0
60	100.00	0.00	80.00	100.00	20.00	100.00	1	0
61	100 00	20.00	-100.00	100.00	40.00	-80.00	1	0
62	100 00	20.00	-80.00	100.00	40.00	-60.00	1	0
63	100.00	20.00	-60.00	100.00	40.00	-40.00	1	0
64	100 00	20 00	-40 00	100.00	40.00	-20.00	1	0
65	100.00	20 00	-20 00	100 00	40.00	0.00	1	0
66	100.00	20 00	0 00	100 00	40.00	20.00	1	0
67	100.00	20 00	20 00	100 00	40 00	40 00	1	0
68	100 00	20 00	40 00	100 00	40 00	60 00	1	0
69	100 00	20 00	60 00	100.00	40.00	80 00	1	0
70	100 00	20 00	80 00	100 00	40 00	100 00	1	0
71	100.00	40 00	-100 00	100 00	60 00	-80.00	1	0
72	100 00	40 00	-80 00	100.00	60 00	-60.00	1	0
73	100 00	40 00	-60 00	100.00	60.00	-40 00	1	0
74	100.00	40 00	-40 00	100 00	60.00	-20 00	1	0
75	100.00	40 00	-20 00	100 00	60.00	0 00	1	0
76	100.00	40 00	0 00	100 00	60.00	20 00	1	0
77	100.00	40 00	20.00	100 00	60.00	40 00	1	0

78	100.00	40.00	40.00	100 00	60.00	60 00	1	0
79	100.00	40.00	60.00	100 00	60 00	80.00	1	0
80	100.00	40.00	80.00	100 00	60 00	100.00	1	0
81	100.00	60 00	-100.00	100.00	80.00	-80.00	1	0
82	100.00	60 00	-80.00	100 00	80.00	-60.00	1	0
83	100.00	60 00	-60.00	100 00	80 00	-40.00	1	0
84	100.00	60.00	-40.00	100 00	80 00	-20.00	1	0
85	100.00	60 00	-20 00	100 00	80 00	0.00	1	0
86	100.00	60.00	0.00	100 00	80 00	20.00	1	0
87	100.00	60.00	20 00	100.00	80.00	40.00	1	0
88	100.00	60.00	40.00	100 00	80.00	60.00	1	0
89	100.00	60.00	60.00	100 00	80.00	80.00	1	0
90	100 00	60.00	80.00	100 00	80.00	100 00	1	0
91	100.00	80.00	-100.00	100 00	100.00	-80.00	1	0
92	100.00	80.00	-80.00	100 00	100.00	-60.00	1	0
93	100.00	80.00	-60.00	100 00	100.00	-40.00	1	0
94	100 00	80.00	-40.00	100 00	100 00	-20.00	1	0
95	100.00	80.00	-20.00	100 00	100 00	0.00	1	0
96	100.00	80.00	0.00	100.00	100 00	20.00	1	0
97	100.00	80.00	20.00	100 00	100 00	40.00	1	0
98	100.00	80.00	40.00	100 00	100 00	60.00	1	0
99	100.00	80.00	60 00	100 00	100 00	80 00	1	0
100	100.00	80.00	80 00	100 00	100.00	100.00	1	0
101	-115.00	-100.00	-100 00	-115 00	-80 00	-80.00	2	0
102	-115.00	-100.00	-80.00	-115 00	-80 00	-60.00	2	0
103	-115.00	-100.00	-60.00	-115 00	-80.00	-40.00	2	0
104	-115.00	-100.00	-40.00	-115 00	-80.00	-20.00	2	0
105	-115.00	-100.00	-20.00	-115 00	-80.00	0.00	2	0
106	-115.00	-100.00	0.00	-115 00	-80.00	20.00	2	0
107	-115.00	-100.00	20.00	-115 00	-80.00	40.00	2	0
108	-115.00	-100.00	40 00	-115 00	-80.00	60.00	2	0
109	-115.00	-100.00	60 00	-115 00	-80 00	80 00	2	0
110	-115.00	-100.00	80 00	-115 00	-80.00	100.00	2	0
111	-115.00	-80.00	-100.00	-115 00	-60.00	-80.00	2	0
112	-115.00	-80.00	-80.00	-115 00	-60.00	-60.00	2	0
113	-115.00	-80.00	-60.00	-115 00	-60 00	-40.00	2	0
114	-115.00	-80.00	-40.00	-115 00	-60 00	-20.00	2	0
115	-115.00	-80 00	-20.00	-115.00	-60.00	0.00	2	0
116	-115.00	-80.00	0 00	-115 00	-60.00	20.00	2	0
117	-115.00	-80.00	20 00	-115 00	-60.00	40.00	2	0
118	-115.00	-80.00	40 00	-115 00	-60.00	60.00	2	0
119	-115.00	-80.00	60.00	-115 00	-60.00	80.00	2	0
120	-115 00	-80.00	80.00	-115 00	-60.00	100.00	2	0
121	-115.00	-60 00	-100.00	-115 00	-40 00	-80.00	2	0
122	-115.00	-60.00	-80 00	-115 00	-40 00	-60.00	2	0
123	-115.00	-60.00	-60.00	-115 00	-40.00	-40.00	2	0
124	-115.00	-60.00	-40.00	-115 00	-40 00	-20.00	2	0
125	-115 00	-60.00	-20.00	-115 00	-40 00	0.00	2	0
126	-115 00	-60.00	0.00	-115 00	-40 00	20.00	2	0
127	-115.00	-60.00	20 00	-115 00	-40 00	40.00	2	0
128	-115.00	-60 00	40 00	-115 00	-40 00	60.00	2	0
129	-115 00	-60 00	60 00	-115 00	-40.00	80.00	2	0
130	-115 00	-60 00	80 00	-115 00	-40 00	100.00	2	0
131	-115 00	-40.00	-100.00	-115 00	-20 00	-80.00	2	0
132	-115.00	-40.00	-80 00	-115 00	-20 00	-60.00	2	0
133	-115 00	-40 00	-60 00	-115 00	-20 00	-40.00	2	0
134	-115 00	-40 00	-40 00	-115 00	-20.00	-20.00	2	0
135	-115 00	-40 00	-20.00	-115 00	-20 00	0.00	2	0
136	-115.00	-40.00	0 00	-115 00	-20 00	20.00	2	0
137	-115.00	-40 00	20.00	-115 00	-20 00	40.00	2	0
138	-115.00	-40.00	40 00	-115 00	-20 00	60.00	2	0
139	-115 00	-40 00	60 00	-115 00	-20 00	80.00	2	0

140	-115 00	-40 00	80.00	-115.00	-20 00	100 00	2	0
141	-115 00	-20 00	-100.00	-115.00	0 00	-80 00	2	0
142	-115 00	-20 00	-80 00	-115.00	0.00	-60.00	2	0
143	-115.00	-20 00	-60 00	-115 00	0.00	-40.00	2	0
144	-115.00	-20.00	-40.00	-115.00	0.00	-20.00	2	0
145	-115.00	-20.00	-20.00	-115 00	0.00	0.00	2	0
146	-115 00	-20 00	0.00	-115 00	0.00	20 00	2	0
147	-115 00	-20 00	20.00	-115.00	0 00	40 00	2	0
148	-115 00	-20 00	40.00	-115.00	0 00	60 00	2	0
149	-115 00	-20.00	60.00	-115.00	0.00	80 00	2	0
150	-115.00	-20.00	80.00	-115.00	0.00	100.00	2	0
151	-115.00	0 00	-100.00	-115 00	20.00	-80.00	2	0
152	-115 00	0.00	-80.00	-115.00	20.00	-60 00	2	0
153	-115 00	0.00	-60.00	-115 00	20.00	-40 00	2	0
154	-115.00	0.00	-40.00	-115.00	20.00	-20.00	2	0
155	-115.00	0 00	-20.00	-115 00	20.00	0.00	2	0
156	-115 00	0 00	0 00	-115.00	20.00	20.00	2	0
157	-115.00	0.00	20.00	-115.00	20.00	40.00	2	0
158	-115.00	0.00	40 00	-115.00	20.00	60 00	2	0
159	-115.00	0.00	60.00	-115.00	20.00	80 00	2	0
160	-115 00	0.00	80.00	-115.00	20.00	100.00	2	0
161	-115 00	20.00	-100.00	-115 00	40.00	-80 00	2	0
162	-115.00	20.00	-80.00	-115.00	40.00	-60.00	2	0
163	-115.00	20.00	-60.00	-115.00	40.00	-40.00	2	0
164	-115.00	20.00	-40.00	-115 00	40.00	-20.00	2	0
165	-115 00	20 00	-20.00	-115.00	40.00	0.00	2	0
166	-115 00	20 00	0.00	-115.00	40.00	20.00	2	0
167	-115 00	20.00	20.00	-115 00	40.00	40.00	2	0
168	-115 00	20.00	40.00	-115.00	40.00	60.00	2	0
169	-115.00	20.00	60.00	-115 00	40.00	80.00	2	0
170	-115.00	20.00	80.00	-115 00	40.00	100.00	2	0
171	-115.00	40 00	-100.00	-115 00	60.00	-80.00	2	0
172	-115.00	40.00	-80.00	-115 00	60.00	-60.00	2	0
173	-115 00	40.00	-60.00	-115.00	60.00	-40.00	2	0
174	-115.00	40.00	-40.00	-115.00	60.00	-20.00	2	0
175	-115.00	40.00	-20.00	-115.00	60.00	0.00	2	0
176	-115.00	40 00	0.00	-115.00	60.00	20.00	2	0
177	-115 00	40 00	20.00	-115 00	60.00	40.00	2	0
178	-115 00	40 00	40.00	-115.00	60.00	60.00	2	0
179	-115.00	40.00	60 00	-115 00	60.00	80.00	2	0
180	-115.00	40.00	80.00	-115 00	60.00	100 00	2	0
181	-115.00	60.00	-100.00	-115 00	80.00	-80.00	2	0
182	-115.00	60.00	-80.00	-115 00	80.00	-60.00	2	0
183	-115 00	60.00	-60.00	-115.00	80.00	-40.00	2	0
184	-115 00	60.00	-40.00	-115.00	80.00	-20.00	2	0
185	-115.00	60.00	-20.00	-115 00	80 00	0.00	2	0
186	-115 00	60 00	0.00	-115 00	80.00	20.00	2	0
187	-115.00	60.00	20 00	-115 00	80.00	40.00	2	0
188	-115.00	60.00	40.00	-115 00	80.00	60.00	2	0
189	-115.00	60 00	60.00	-115 00	80.00	80 00	2	0
190	-115.00	60 00	80.00	-115 00	80 00	100 00	2	0
191	-115.00	80 00	-100.00	-115 00	100 00	-80.00	2	0
192	-115.00	80 00	-80.00	-115 00	100.00	-60.00	2	0
193	-115.00	80 00	-60.00	-115 00	100 00	-40.00	2	0
194	-115 00	80 00	-40.00	-115 00	100 00	-20.00	2	0
195	-115.00	80 00	-20.00	-115 00	100 00	0.00	2	0
196	-115.00	80 00	0.00	-115 00	100.00	20.00	2	0
197	-115.00	80.00	20 00	-115 00	100.00	40 00	2	0
198	-115 00	80.00	40.00	-115 00	100.00	60 00	2	0
199	-115 00	80.00	60.00	-115 00	100.00	80 00	2	0
200	-115 00	80 00	80.00	-115 00	100 00	100.00	2	0
201	115.00	-100 00	-100.00	115 00	-80 00	-80.00	1	4

202	115.00	-100.00	-80.00	115.00	-80 00	-60.00	1	4
203	115.00	-100.00	-60 00	115.00	-80 00	-40 00	1	4
204	115 00	-100.00	-40.00	115.00	-80.00	-20 00	1	4
205	115 00	-100 00	-20 00	115.00	-80.00	0 00	1	4
206	115 00	-100.00	0.00	115.00	-80 00	20 00	1	4
207	115 00	-100 00	20.00	115.00	-80 00	40 00	1	4
208	115 00	-100 00	40.00	115.00	-80 00	60 00	1	4
209	115 00	-100 00	60.00	115.00	-80 00	80 00	1	4
210	115.00	-100 00	80.00	115 00	-80 00	100.00	1	4
211	115.00	-80 00	-100.00	115.00	-60 00	-80.00	1	4
212	115.00	-80.00	-80.00	115 00	-60 00	-60 00	1	4
213	115 00	-80 00	-60.00	115.00	-60 00	-40 00	1	4
214	115.00	-80.00	-40.00	115.00	-60 00	-20 00	1	4
215	115.00	-80 00	-20.00	115.00	-60.00	0.00	1	4
216	115.00	-80.00	0 00	115.00	-60.00	20 00	1	4
217	115.00	-80.00	20.00	115.00	-60.00	40.00	1	4
218	115 00	-80 00	40.00	115.00	-60.00	60 00	1	4
219	115 00	-80 00	60.00	115.00	-60.00	80 00	1	4
220	115 00	-80.00	80.00	115.00	-60.00	100.00	1	4
221	115.00	-60.00	-100 00	115.00	-40.00	-80.00	1	4
222	115.00	-60.00	-80.00	115.00	-40.00	-60.00	1	4
223	115.00	-60.00	-60.00	115.00	-40.00	-40 00	1	4
224	115 00	-60.00	-40.00	115.00	-40.00	-20.00	1	4
225	115.00	-60.00	-20 00	115.00	-40.00	0.00	1	4
226	115 00	-60.00	0.00	115.00	-40.00	20 00	1	4
227	115.00	-60.00	20 00	115.00	-40.00	40.00	1	4
228	115.00	-60.00	40.00	115.00	-40.00	60 00	1	4
229	115.00	-60.00	60.00	115.00	-40.00	80.00	1	4
230	115.00	-60.00	80.00	115.00	-40.00	100.00	1	4
231	115.00	-40.00	-100.00	115.00	-20 00	-80.00	1	4
232	115.00	-40.00	-80.00	115.00	-20 00	-60.00	1	4
233	115.00	-40.00	-60.00	115.00	-20 00	-40.00	1	4
234	115.00	-40.00	-40.00	115.00	-20.00	-20.00	1	4
235	115.00	-40.00	-20.00	115.00	-20.00	0.00	1	4
236	115.00	-40.00	0.00	115.00	-20 00	20 00	1	4
237	115.00	-40.00	20.00	115.00	-20 00	40 00	1	4
238	115.00	-40.00	40.00	115.00	-20 00	60.00	1	4
239	115.00	-40.00	60.00	115.00	-20 00	80.00	1	4
240	115.00	-40 00	80.00	115.00	-20.00	100.00	1	4
241	115 00	-20 00	-100 00	115.00	0.00	-80 00	1	4
242	115.00	-20 00	-80.00	115.00	0.00	-60.00	1	4
243	115.00	-20.00	-60 00	115.00	0.00	-40.00	1	4
244	115.00	-20 00	-40.00	115.00	0.00	-20 00	1	4
245	115.00	-20 00	-20 00	115.00	0 00	0.00	1	4
246	115.00	-20 00	0.00	115.00	0.00	20.00	1	4
247	115.00	-20.00	20.00	115.00	0.00	40 00	1	4
248	115.00	-20 00	40 00	115.00	0.00	60.00	1	4
249	115 00	-20 00	60 00	115.00	0.00	80 00	1	4
250	115 00	-20 00	80.00	115.00	0.00	100 00	1	4
251	115 00	0 00	-100 00	115.00	20.00	-80 00	1	4
252	115 00	0 00	-80.00	115 00	20 00	-60 00	1	4
253	115.00	0 00	-60.00	115 00	20 00	-40 00	1	4
254	115.00	0 00	-40.00	115.00	20 00	-20 00	1	4
255	115.00	0 00	-20.00	115.00	20 00	0.00	1	4
256	115.00	0 00	0.00	115.00	20 00	20 00	1	4
257	115.00	0 00	20.00	115.00	20.00	40.00	1	4
258	115 00	0 00	40 00	115.00	20 00	60 00	1	4
259	115 00	0.00	60 00	115.00	20.00	80 00	1	4
260	115 00	0.00	80 00	115.00	20.00	100 00	1	4
261	115 00	20.00	-100 00	115.00	40.00	-80 00	1	4
262	115 00	20 00	-80 00	115.00	40.00	-60 00	1	4
263	115.00	20.00	-60 00	115.00	40.00	-40 00	1	4

264	115.00	20.00	-40 00	115 00	40.00	-20 00	1	4
265	115.00	20 00	-20.00	115 00	40.00	0.00	1	4
266	115.00	20 00	0 00	115.00	40.00	20 00	1	4
267	115.00	20 00	20.00	115.00	40.00	40.00	1	4
268	115 00	20 00	40.00	115.00	40 00	60 00	1	4
269	115.00	20.00	60 00	115.00	40 00	80.00	1	4
270	115 00	20.00	80.00	115.00	40 00	100.00	1	4
271	115 00	40.00	-100.00	115.00	60.00	-80.00	1	4
272	115.00	40.00	-80.00	115 00	60.00	-60 00	1	4
273	115.00	40 00	-60 00	115.00	60.00	-40 00	1	4
274	115.00	40 00	-40 00	115.00	60.00	-20 00	1	4
275	115.00	40 00	-20 00	115.00	60 00	0 00	1	4
276	115.00	40 00	0 00	115 00	60.00	20.00	1	4
277	115.00	40 00	20 00	115.00	60 00	40 00	1	4
278	115.00	40 00	40 00	115.00	60.00	60.00	1	4
279	115.00	40.00	60 00	115.00	60 00	80.00	1	4
280	115 00	40 00	80.00	115.00	60.00	100 00	1	4
281	115 00	60 00	-100 00	115.00	80.00	-80 00	1	4
282	115 00	60 00	-80 00	115.00	80.00	-60 00	1	4
283	115.00	60 00	-60 00	115.00	80.00	-40 00	1	4
284	115 00	60 00	-40 00	115.00	80.00	-20.00	1	4
285	115.00	60 00	-20 00	115.00	80.00	0.00	1	4
286	115.00	60.00	0.00	115.00	80.00	20 00	1	4
287	115.00	60.00	20 00	115.00	80.00	40.00	1	4
288	115.00	60.00	40.00	115.00	80 00	60 00	1	4
289	115.00	60.00	60.00	115.00	80.00	80 00	1	4
290	115.00	60.00	80.00	115.00	80 00	100.00	1	4
291	115.00	80 00	-100.00	115.00	100.00	-80.00	1	4
292	115.00	80 00	-80.00	115.00	100.00	-60.00	1	4
293	115.00	80 00	-60.00	115.00	100.00	-40.00	1	4
294	115.00	80 00	-40.00	115.00	100.00	-20.00	1	4
295	115.00	80 00	-20 00	115.00	100.00	0.00	1	4
296	115.00	80.00	0.00	115.00	100.00	20.00	1	4
297	115.00	80.00	20.00	115.00	100.00	40.00	1	4
298	115.00	80.00	40.00	115.00	100.00	60.00	1	4
299	115.00	80.00	60.00	115.00	100.00	80.00	1	4
300	115.00	80.00	80.00	115.00	100 00	100.00	1	4
301	-100.00	-100.00	-100.00	-100.00	-80.00	-80.00	2	4
302	-100.00	-100.00	-80.00	-100.00	-80 00	-60.00	2	4
303	-100.00	-100 00	-60.00	-100.00	-80.00	-40.00	2	4
304	-100 00	-100 00	-40.00	-100.00	-80.00	-20 00	2	4
305	-100.00	-100 00	-20.00	-100.00	-80.00	0 00	2	4
306	-100.00	-100.00	0.00	-100.00	-80.00	20.00	2	4
307	-100.00	-100.00	20.00	-100.00	-80.00	40.00	2	4
308	-100.00	-100.00	40.00	-100.00	-80.00	60.00	2	4
309	-100.00	-100.00	60.00	-100.00	-80.00	80.00	2	4
310	-100.00	-100 00	80.00	-100.00	-80 00	100.00	2	4
311	-100 00	-80 00	-100.00	-100.00	-60.00	-80.00	2	4
312	-100.00	-80 00	-80.00	-100.00	-60.00	-60.00	2	4
313	-100.00	-80 00	-60 00	-100.00	-60.00	-40.00	2	4
314	-100.00	-80 00	-40 00	-100.00	-60 00	-20.00	2	4
315	-100.00	-80.00	-20 00	-100.00	-60 00	0.00	2	4
316	-100 00	-80.00	0 00	-100 00	-60.00	20 00	2	4
317	-100 00	-80.00	20 00	-100 00	-60.00	40 00	2	4
318	-100 00	-80.00	40.00	-100.00	-60.00	60 00	2	4
319	-100.00	-80 00	60 00	-100.00	-60.00	80.00	2	4
320	-100.00	-80 00	80 00	-100.00	-60.00	100.00	2	4
321	-100 00	-60 00	-100.00	-100 00	-40 00	-80.00	2	4
322	-100 00	-60 00	-80 00	-100.00	-40.00	-60 00	2	4
323	-100 00	-60 00	-60 00	-100.00	-40 00	-40 00	2	4
324	-100.00	-60 00	-40.00	-100.00	-40.00	-20 00	2	4
325	-100.00	-60 00	-20.00	-100.00	-40.00	0 00	2	4

326	-100 00	-60 00	0.00	-100.00	-40.00	20.00	2	4
327	-100 00	-60 00	20.00	-100.00	-40.00	40 00	2	4
328	-100 00	-60 00	40.00	-100 00	-40 00	60 00	2	4
329	-100 00	-60 00	60.00	-100.00	-40 00	80 00	2	4
330	-100 00	-60 00	80.00	-100.00	-40.00	100.00	2	4
331	-100 00	-40.00	-100.00	-100.00	-20 00	-80.00	2	4
332	-100 00	-40.00	-80.00	-100 00	-20.00	-60 00	2	4
333	-100 00	-40.00	-60 00	-100.00	-20.00	-40.00	2	4
334	-100 00	-40.00	-40 00	-100.00	-20.00	-20.00	2	4
335	-100 00	-40.00	-20.00	-100.00	-20.00	0 00	2	4
336	-100.00	-40.00	0.00	-100.00	-20.00	20 00	2	4
337	-100.00	-40 00	20.00	-100.00	-20.00	40.00	2	4
338	-100.00	-40 00	40.00	-100.00	-20 00	60.00	2	4
339	-100.00	-40 00	60.00	-100.00	-20.00	80.00	2	4
340	-100 00	-40.00	80 00	-100.00	-20.00	100.00	2	4
341	-100 00	-20.00	-100 00	-100.00	0.00	-80 00	2	4
342	-100 00	-20.00	-80.00	-100.00	0.00	-60 00	2	4
343	-100 00	-20.00	-60.00	-100.00	0.00	-40 00	2	4
344	-100 00	-20 00	-40.00	-100.00	0.00	-20.00	2	4
345	-100 00	-20 00	-20.00	-100.00	0.00	0.00	2	4
346	-100 00	-20 00	0.00	-100.00	0.00	20.00	2	4
347	-100 00	-20 00	20 00	-100.00	0.00	40.00	2	4
348	-100 00	-20.00	40 00	-100.00	0.00	60.00	2	4
349	-100.00	-20.00	60.00	-100.00	0.00	80.00	2	4
350	-100 00	-20.00	80.00	-100.00	0.00	100.00	2	4
351	-100 00	0.00	-100.00	-100.00	20.00	-80.00	2	4
352	-100 00	0.00	-80.00	-100.00	20 00	-60.00	2	4
353	-100 00	0.00	-60.00	-100 00	20.00	-40.00	2	4
354	-100.00	0.00	-40.00	-100.00	20.00	-20.00	2	4
355	-100.00	0 00	-20.00	-100.00	20.00	0.00	2	4
356	-100.00	0.00	0 00	-100.00	20.00	20.00	2	4
357	-100 00	0 00	20.00	-100.00	20.00	40.00	2	4
358	-100 00	0.00	40.00	-100.00	20.00	60.00	2	4
359	-100 00	0.00	60.00	-100.00	20.00	80.00	2	4
360	-100.00	0.00	80.00	-100.00	20.00	100.00	2	4
361	-100 00	20.00	-100.00	-100.00	40.00	-80.00	2	4
362	-100 00	20.00	-80.00	-100.00	40.00	-60.00	2	4
363	-100 00	20 00	-60.00	-100.00	40 00	-40.00	2	4
364	-100 00	20 00	-40.00	-100.00	40 00	-20.00	2	4
365	-100.00	20.00	-20.00	-100 00	40.00	0 00	2	4
366	-100 00	20 00	0.00	-100.00	40.00	20 00	2	4
367	-100.00	20.00	20.00	-100.00	40.00	40 00	2	4
368	-100 00	20 00	40.00	-100.00	40.00	60.00	2	4
369	-100 00	20.00	60.00	-100.00	40.00	80.00	2	4
370	-100 00	20 00	80.00	-100.00	40.00	100.00	2	4
371	-100 00	40 00	-100.00	-100.00	60.00	-80.00	2	4
372	-100 00	40 00	-80.00	-100.00	60.00	-60.00	2	4
373	-100 00	40.00	-60.00	-100.00	60 00	-40.00	2	4
374	-100 00	40.00	-40.00	-100.00	60.00	-20.00	2	4
375	-100 00	40.00	-20 00	-100.00	60 00	0.00	2	4
376	-100 00	40.00	0 00	-100.00	60.00	20.00	2	4
377	-100 00	40 00	20 00	-100.00	60.00	40.00	2	4
378	-100 00	40 00	40.00	-100.00	60 00	60.00	2	4
379	-100 00	40.00	60 00	-100.00	60.00	80.00	2	4
380	-100 00	40.00	80 00	-100.00	60 00	100.00	2	4
381	-100.00	60.00	-100 00	-100.00	80.00	-80.00	2	4
382	-100 00	60.00	-80 00	-100.00	80 00	-60.00	2	4
383	-100.00	60.00	-60.00	-100.00	80.00	-40.00	2	4
384	-100 00	60.00	-40 00	-100 00	80 00	-20.00	2	4
385	-100 00	60.00	-20.00	-100 00	80.00	0.00	2	4
386	-100 00	60.00	0.00	-100.00	80.00	20.00	2	4
387	-100.00	60.00	20.00	-100.00	80.00	40.00	2	4

388	-100 00	60.00	40.00	-100.00	80.00	60 00	2	4
389	-100.00	60.00	60.00	-100 00	80.00	80.00	2	4
390	-100 00	60.00	80.00	-100.00	80.00	100.00	2	4
391	-100.00	80.00	-100.00	-100 00	100.00	-80.00	2	4
392	-100 00	80.00	-80.00	-100 00	100 00	-60 00	2	4
393	-100.00	80.00	-60 00	-100 00	100.00	-40 00	2	4
394	-100.00	80.00	-40.00	-100 00	100.00	-20 00	2	4
395	-100.00	80.00	-20.00	-100.00	100.00	0.00	2	4
396	-100.00	80.00	0 00	-100 00	100.00	20.00	2	4
397	-100 00	80.00	20.00	-100 00	100.00	40 00	2	4
398	-100.00	80.00	40.00	-100 00	100 00	60.00	2	4
399	-100 00	80.00	60.00	-100 00	100.00	80.00	2	4
400	-100 00	80.00	80.00	-100 00	100.00	100.00	2	4

WALLY INFORMATION

ID	x1	y1	z1	x2	y2	z2	gridx	gridz
3	-115.0	100.0	-100 0	115.0	115.0	100.0	11	10
4	-115.0	-115.0	-100.0	115.0	-100.0	100.0	11	10

Wall segments (wally)

ID#	x1	y1	z1	x2	y2	z2	WID	SENSE
1	-115.00	100.00	-100.00	-94 09	100.00	-80.00	3	0
2	-115.00	100.00	-80.00	-94 09	100.00	-60.00	3	0
3	-115.00	100.00	-60.00	-94 09	100.00	-40.00	3	0
4	-115.00	100.00	-40.00	-94 09	100.00	-20.00	3	0
5	-115.00	100.00	-20 00	-94 09	100 00	0.00	3	0
6	-115.00	100.00	0.00	-94 09	100 00	20.00	3	0
7	-115 00	100.00	20.00	-94 09	100.00	40.00	3	0
8	-115.00	100.00	40.00	-94.09	100.00	60.00	3	0
9	-115.00	100.00	60 00	-94 09	100.00	80.00	3	0
10	-115.00	100.00	80.00	-94 09	100.00	100 00	3	0
11	-94.09	100.00	-100.00	-73 18	100.00	-80.00	3	0
12	-94.09	100.00	-80.00	-73 18	100.00	-60.00	3	0
13	-94.09	100.00	-60 00	-73 18	100.00	-40.00	3	0
14	-94.09	100.00	-40.00	-73 18	100 00	-20.00	3	0
15	-94.09	100.00	-20.00	-73 18	100.00	0 00	3	0
16	-94.09	100.00	0.00	-73 18	100.00	20.00	3	0
17	-94.09	100.00	20 00	-73 18	100.00	40.00	3	0
18	-94.09	100.00	40.00	-73 18	100.00	60.00	3	0
19	-94.09	100.00	60.00	-73 18	100.00	80.00	3	0
20	-94.09	100.00	80.00	-73 18	100 00	100.00	3	0
21	-73.18	100.00	-100.00	-52 27	100 00	-80 00	3	0
22	-73.18	100.00	-80.00	-52 27	100.00	-60.00	3	0
23	-73.18	100.00	-60.00	-52 27	100.00	-40.00	3	0
24	-73.18	100.00	-40.00	-52 27	100.00	-20.00	3	0
25	-73.18	100.00	-20.00	-52 27	100.00	0 00	3	0
26	-73.18	100.00	0 00	-52 27	100 00	20 00	3	0
27	-73.18	100.00	20 00	-52 27	100 00	40.00	3	0
28	-73 18	100.00	40.00	-52 27	100 00	60.00	3	0
29	-73 18	100.00	60.00	-52 27	100 00	80.00	3	0
30	-73 18	100.00	80.00	-52 27	100.00	100.00	3	0
31	-52 27	100.00	-100.00	-31 36	100.00	-80.00	3	0
32	-52.27	100.00	-80.00	-31 36	100.00	-60.00	3	0
33	-52.27	100.00	-60.00	-31 36	100.00	-40 00	3	0
34	-52.27	100.00	-40.00	-31 36	100 00	-20 00	3	0
35	-52 27	100.00	-20.00	-31 36	100 00	0.00	3	0
36	-52 27	100.00	0.00	-31 36	100 00	20.00	3	0
37	-52 27	100.00	20.00	-31 36	100.00	40 00	3	0

38	-52 27	100.00	40.00	-31.36	100.00	60.00	3	0
39	-52.27	100.00	60.00	-31 36	100.00	80.00	3	0
40	-52.27	100.00	80.00	-31 36	100.00	100 00	3	0
41	-31 36	100.00	-100.00	-10 45	100.00	-80.00	3	0
42	-31.36	100.00	-80.00	-10 45	100.00	-60 00	3	0
43	-31.36	100.00	-60.00	-10 45	100.00	-40.00	3	0
44	-31.36	100.00	-40.00	-10 45	100.00	-20.00	3	0
45	-31.36	100.00	-20.00	-10 45	100.00	0.00	3	0
46	-31.36	100.00	0 00	-10 45	100.00	20 00	3	0
47	-31 36	100.00	20 00	-10 45	100.00	40.00	3	0
48	-31.36	100.00	40 00	-10 45	100.00	60 00	3	0
49	-31.36	100 00	60.00	-10.45	100.00	80.00	3	0
50	-31.36	100 00	80 00	-10 45	100.00	100.00	3	0
51	-10 45	100 00	-100.00	10 45	100.00	-80.00	3	0
52	-10 45	100 00	-80.00	10 45	100.00	-60 00	3	0
53	-10.45	100.00	-60.00	10 45	100.00	-40.00	3	0
54	-10 45	100.00	-40.00	10 45	100.00	-20.00	3	0
55	-10 45	100 00	-20.00	10.45	100.00	0.00	3	0
56	-10.45	100.00	0.00	10 45	100.00	20.00	3	0
57	-10.45	100 00	20.00	10 45	100.00	40.00	3	0
58	-10.45	100 00	40.00	10 45	100.00	60 00	3	0
59	-10.45	100 00	60 00	10.45	100.00	80.00	3	0
60	-10.45	100.00	80.00	10 45	100.00	100.00	3	0
61	10 45	100.00	-100.00	31.36	100.00	-80.00	3	0
62	10 45	100.00	-80.00	31.36	100.00	-60.00	3	0
63	10.45	100 00	-60.00	31.36	100.00	-40.00	3	0
64	10.45	100 00	-40.00	31 36	100.00	-20 00	3	0
65	10.45	100.00	-20 00	31 36	100.00	0.00	3	0
66	10.45	100.00	0.00	31 36	100.00	20.00	3	0
67	10 45	100.00	20.00	31 36	100.00	40.00	3	0
68	10.45	100.00	40.00	31 36	100.00	60.00	3	0
69	10.45	100.00	60.00	31 36	100.00	80.00	3	0
70	10.45	100 00	80.00	31 36	100 00	100.00	3	0
71	31.36	100 00	-100.00	52.27	100.00	-80.00	3	0
72	31.36	100 00	-80 00	52 27	100.00	-60.00	3	0
73	31.36	100.00	-60 00	52 27	100.00	-40 00	3	0
74	31 36	100 00	-40 00	52.27	100 00	-20.00	3	0
75	31.36	100.00	-20.00	52.27	100 00	0.00	3	0
76	31.36	100 00	0.00	52.27	100.00	20.00	3	0
77	31.36	100.00	20.00	52 27	100 00	40.00	3	0
78	31.36	100 00	40.00	52 27	100 00	60.00	3	0
79	31.36	100 00	60.00	52.27	100.00	80.00	3	0
80	31.36	100 00	80 00	52 27	100 00	100.00	3	0
81	52.27	100 00	-100.00	73 18	100.00	-80.00	3	0
82	52.27	100.00	-80 00	73 18	100.00	-60 00	3	0
83	52.27	100.00	-60 00	73 18	100.00	-40 00	3	0
84	52.27	100.00	-40 00	73 18	100 00	-20 00	3	0
85	52.27	100.00	-20 00	73 18	100 00	0 00	3	0
86	52.27	100 00	0 00	73 18	100.00	20 00	3	0
87	52.27	100.00	20 00	73 18	100.00	40 00	3	0
88	52.27	100 00	40.00	73 18	100.00	60.00	3	0
89	52 27	100 00	60.00	73 18	100 00	80.00	3	0
90	52 27	100 00	80.00	73 18	100 00	100.00	3	0
91	73.18	100 00	-100.00	94 09	100 00	-80 00	3	0
92	73 18	100 00	-80.00	94 09	100 00	-60.00	3	0
93	73.18	100 00	-60.00	94 09	100 00	-40.00	3	0
94	73.18	100 00	-40.00	94 09	100.00	-20 00	3	0
95	73.18	100 00	-20 00	94 09	100.00	0 00	3	0
96	73.18	100 00	0 00	94 09	100.00	20 00	3	0
97	73.18	100 00	20.00	94 09	100.00	40 00	3	0
98	73.18	100 00	40 00	94 09	100.00	60 00	3	0
99	73.18	100.00	60 00	94 09	100.00	80 00	3	0

100	73.18	100.00	80.00	94 09	100.00	100 00	3	0
101	94.09	100.00	-100.00	115 00	100.00	-80.00	3	0
102	94.09	100.00	-80 00	115.00	100.00	-60 00	3	0
103	94.09	100.00	-60.00	115.00	100 00	-40 00	3	0
104	94.09	100 00	-40 00	115.00	100 00	-20.00	3	0
105	94.09	100.00	-20.00	115 00	100.00	0.00	3	0
106	94.09	100.00	0.00	115 00	100.00	20.00	3	0
107	94.09	100 00	20.00	115 00	100.00	40.00	3	0
108	94 09	100.00	40 00	115.00	100.00	60.00	3	0
109	94.09	100.00	60 00	115.00	100.00	80.00	3	0
110	94.09	100.00	80.00	115.00	100.00	100.00	3	0
111	-115.00	-115.00	-100.00	-94 09	-115.00	-80.00	4	0
112	-115.00	-115 00	-80.00	-94 09	-115.00	-60 00	4	0
113	-115.00	-115.00	-60 00	-94.09	-115 00	-40.00	4	0
114	-115.00	-115 00	-40 00	-94.09	-115.00	-20.00	4	0
115	-115.00	-115.00	-20.00	-94.09	-115.00	0 00	4	0
116	-115.00	-115.00	0.00	-94 09	-115.00	20.00	4	0
117	-115.00	-115.00	20.00	-94 09	-115.00	40.00	4	0
118	-115.00	-115.00	40.00	-94 09	-115.00	60.00	4	0
119	-115.00	-115.00	60.00	-94 09	-115.00	80.00	4	0
120	-115.00	-115.00	80.00	-94 09	-115.00	100.00	4	0
121	-94.09	-115.00	-100.00	-73.18	-115.00	-80.00	4	0
122	-94.09	-115.00	-80 00	-73 18	-115.00	-60.00	4	0
123	-94.09	-115.00	-60.00	-73 18	-115.00	-40.00	4	0
124	-94.09	-115 00	-40.00	-73 18	-115.00	-20.00	4	0
125	-94.09	-115.00	-20.00	-73 18	-115.00	0.00	4	0
126	-94.09	-115.00	0.00	-73 18	-115.00	20.00	4	0
127	-94.09	-115.00	20.00	-73 18	-115.00	40.00	4	0
128	-94.09	-115 00	40.00	-73 18	-115.00	60.00	4	0
129	-94.09	-115 00	60 00	-73 18	-115.00	80.00	4	0
130	-94.09	-115.00	80.00	-73 18	-115.00	100.00	4	0
131	-73.18	-115.00	-100.00	-52 27	-115.00	-80 00	4	0
132	-73.18	-115.00	-80.00	-52 27	-115.00	-60.00	4	0
133	-73 18	-115.00	-60 00	-52 27	-115.00	-40.00	4	0
134	-73.18	-115 00	-40.00	-52 27	-115.00	-20.00	4	0
135	-73.18	-115.00	-20.00	-52 27	-115.00	0.00	4	0
136	-73.18	-115 00	0.00	-52.27	-115.00	20.00	4	0
137	-73.18	-115.00	20.00	-52 27	-115.00	40.00	4	0
138	-73.18	-115.00	40.00	-52 27	-115.00	60.00	4	0
139	-73.18	-115.00	60 00	-52.27	-115.00	80.00	4	0
140	-73.18	-115.00	80.00	-52 27	-115.00	100.00	4	0
141	-52.27	-115.00	-100.00	-31 36	-115.00	-80.00	4	0
142	-52.27	-115.00	-80.00	-31.36	-115.00	-60.00	4	0
143	-52.27	-115 00	-60.00	-31 36	-115.00	-40.00	4	0
144	-52.27	-115.00	-40.00	-31 36	-115.00	-20.00	4	0
145	-52.27	-115.00	-20 00	-31 36	-115.00	0 00	4	0
146	-52.27	-115.00	0 00	-31 36	-115.00	20 00	4	0
147	-52.27	-115.00	20 00	-31 36	-115 00	40.00	4	0
148	-52.27	-115.00	40.00	-31 36	-115.00	60.00	4	0
149	-52.27	-115.00	60 00	-31 36	-115 00	80.00	4	0
150	-52.27	-115 00	80.00	-31 36	-115.00	100.00	4	0
151	-31.36	-115.00	-100 00	-10 45	-115.00	-80 00	4	0
152	-31.36	-115.00	-80.00	-10 45	-115 00	-60 00	4	0
153	-31 36	-115.00	-60.00	-10 45	-115 00	-40 00	4	0
154	-31 36	-115.00	-40 00	-10 45	-115 00	-20 00	4	0
155	-31.36	-115.00	-20 00	-10 45	-115 00	0.00	4	0
156	-31 36	-115 00	0 00	-10 45	-115 00	20.00	4	0
157	-31.36	-115 00	20.00	-10 45	-115 00	40.00	4	0
158	-31.36	-115 00	40.00	-10 45	-115.00	60.00	4	0
159	-31.36	-115.00	60.00	-10 45	-115 00	80 00	4	0
160	-31 36	-115.00	80.00	-10 45	-115 00	100 00	4	0
161	-10 45	-115.00	-100.00	10 45	-115 00	-80 00	4	0

162	-10.45	-115.00	-80.00	10 45	-115.00	-60.00	4	0
163	-10.45	-115.00	-60.00	10 45	-115.00	-40.00	4	0
164	-10.45	-115.00	-40.00	10 45	-115.00	-20 00	4	0
165	-10 45	-115 00	-20 00	10 45	-115.00	0 00	4	0
166	-10 45	-115.00	0 00	10 45	-115 00	20.00	4	0
167	-10 45	-115 00	20 00	10 45	-115.00	40.00	4	0
168	-10.45	-115 00	40 00	10 45	-115.00	60 00	4	0
169	-10.45	-115 00	60 00	10 45	-115 00	80 00	4	0
170	-10.45	-115 00	80.00	10 45	-115 00	100 00	4	0
171	10.45	-115 00	-100 00	31.36	-115.00	-80.00	4	0
172	10.45	-115 00	-80.00	31 36	-115 00	-60 00	4	0
173	10.45	-115 00	-60 00	31 36	-115.00	-40 00	4	0
174	10.45	-115.00	-40.00	31 36	-115 00	-20 00	4	0
175	10.45	-115 00	-20 00	31.36	-115.00	0 00	4	0
176	10.45	-115 00	0.00	31.36	-115.00	20.00	4	0
177	10.45	-115 00	20 00	31 36	-115.00	40.00	4	0
178	10.45	-115 00	40 00	31 36	-115.00	60 00	4	0
179	10.45	-115 00	60 00	31 36	-115.00	80 00	4	0
180	10.45	-115 00	80 00	31 36	-115.00	100.00	4	0
181	31.36	-115 00	-100 00	52 27	-115.00	-80.00	4	0
182	31.36	-115 00	-80 00	52 27	-115.00	-60.00	4	0
183	31.36	-115.00	-60.00	52.27	-115.00	-40 00	4	0
184	31.36	-115.00	-40.00	52 27	-115.00	-20.00	4	0
185	31.36	-115 00	-20.00	52 27	-115.00	0 00	4	0
186	31.36	-115.00	0 00	52.27	-115.00	20.00	4	0
187	31.36	-115.00	20.00	52 27	-115.00	40 00	4	0
188	31.36	-115.00	40.00	52.27	-115 00	60 00	4	0
189	31.36	-115.00	60.00	52.27	-115.00	80.00	4	0
190	31.36	-115.00	80.00	52 27	-115.00	100.00	4	0
191	52.27	-115.00	-100.00	73 18	-115 00	-80.00	4	0
192	52.27	-115.00	-80.00	73.18	-115.00	-60.00	4	0
193	52.27	-115.00	-60.00	73 18	-115 00	-40 00	4	0
194	52.27	-115.00	-40.00	73.18	-115.00	-20.00	4	0
195	52.27	-115 00	-20.00	73 18	-115.00	0.00	4	0
196	52.27	-115.00	0.00	73.18	-115.00	20.00	4	0
197	52.27	-115 00	20.00	73 18	-115.00	40.00	4	0
198	52.27	-115.00	40 00	73 18	-115.00	60.00	4	0
199	52 27	-115.00	60.00	73 18	-115.00	80.00	4	0
200	52.27	-115.00	80.00	73.18	-115.00	100 00	4	0
201	73.18	-115.00	-100 00	94.09	-115.00	-80 00	4	0
202	73.18	-115.00	-80.00	94 09	-115.00	-60 00	4	0
203	73.18	-115.00	-60.00	94 09	-115.00	-40.00	4	0
204	73.18	-115.00	-40.00	94.09	-115.00	-20.00	4	0
205	73.18	-115.00	-20.00	94 09	-115.00	0.00	4	0
206	73.18	-115 00	0.00	94.09	-115.00	20.00	4	0
207	73.18	-115 00	20 00	94.09	-115.00	40.00	4	0
208	73.18	-115 00	40 00	94 09	-115 00	60.00	4	0
209	73 18	-115.00	60 00	94 09	-115.00	80 00	4	0
210	73.18	-115.00	80 00	94 09	-115.00	100 00	4	0
211	94.09	-115.00	-100 00	115 00	-115.00	-80 00	4	0
212	94.09	-115.00	-80.00	115 00	-115.00	-60 00	4	0
213	94 09	-115 00	-60.00	115 00	-115 00	-40.00	4	0
214	94.09	-115 00	-40 00	115 00	-115 00	-20.00	4	0
215	94 09	-115 00	-20.00	115 00	-115 00	0.00	4	0
216	94 09	-115 00	0 00	115 00	-115 00	20 00	4	0
217	94 09	-115 00	20 00	115 00	-115 00	40 00	4	0
218	94.09	-115.00	40 00	115 00	-115.00	60 00	4	0
219	94.09	-115.00	60 00	115 00	-115.00	80 00	4	0
220	94 09	-115.00	80.00	115 00	-115 00	100.00	4	0
221	-115 00	115 00	-100.00	-94 09	115 00	-80 00	3	4
222	-115.00	115 00	-80 00	-94 09	115 00	-60.00	3	4
223	-115 00	115 00	-60 00	-94 09	115 00	-40.00	3	4

224	-115 00	115 00	-40 00	-94 09	115 00	-20.00	3	4
225	-115.00	115.00	-20.00	-94.09	115.00	0.00	3	4
226	-115.00	115 00	0.00	-94 09	115.00	20.00	3	4
227	-115.00	115 00	20.00	-94.09	115.00	40.00	3	4
228	-115.00	115 00	40 00	-94 09	115.00	60.00	3	4
229	-115.00	115 00	60 00	-94 09	115.00	80.00	3	4
230	-115.00	115 00	80.00	-94.09	115.00	100.00	3	4
231	-94.09	115.00	-100 00	-73.18	115 00	-80.00	3	4
232	-94.09	115 00	-80 00	-73 18	115.00	-60.00	3	4
233	-94.09	115 00	-60.00	-73.18	115.00	-40.00	3	4
234	-94.09	115 00	-40 00	-73.18	115.00	-20 00	3	4
235	-94.09	115 00	-20 00	-73 18	115 00	0.00	3	4
236	-94 09	115 00	0.00	-73 18	115.00	20.00	3	4
237	-94.09	115 00	20 00	-73.18	115.00	40.00	3	4
238	-94.09	115.00	40.00	-73 18	115.00	60.00	3	4
239	-94.09	115 00	60.00	-73.18	115.00	80.00	3	4
240	-94.09	115 00	80 00	-73.18	115.00	100.00	3	4
241	-73.18	115 00	-100.00	-52 27	115.00	-80.00	3	4
242	-73 18	115 00	-80.00	-52.27	115.00	-60.00	3	4
243	-73.18	115 00	-60 00	-52 27	115.00	-40.00	3	4
244	-73.18	115.00	-40.00	-52.27	115.00	-20.00	3	4
245	-73.18	115 00	-20.00	-52.27	115.00	0.00	3	4
246	-73.18	115.00	0 00	-52.27	115.00	20.00	3	4
247	-73.18	115.00	20.00	-52.27	115.00	40.00	3	4
248	-73.18	115.00	40 00	-52.27	115.00	60.00	3	4
249	-73.18	115 00	60.00	-52.27	115.00	80.00	3	4
250	-73.18	115.00	80.00	-52.27	115.00	100.00	3	4
251	-52.27	115.00	-100.00	-31.36	115.00	-80.00	3	4
252	-52.27	115 00	-80.00	-31.36	115.00	-60.00	3	4
253	-52.27	115 00	-60.00	-31 36	115 00	-40.00	3	4
254	-52.27	115.00	-40 00	-31.36	115.00	-20.00	3	4
255	-52.27	115 00	-20.00	-31.36	115 00	0.00	3	4
256	-52.27	115 00	0 00	-31.36	115.00	20.00	3	4
257	-52.27	115.00	20 00	-31.36	115.00	40.00	3	4
258	-52.27	115.00	40.00	-31.36	115.00	60.00	3	4
259	-52.27	115.00	60.00	-31.36	115.00	80.00	3	4
260	-52.27	115 00	80 00	-31.36	115.00	100.00	3	4
261	-31.36	115.00	-100.00	-10.45	115.00	-80.00	3	4
262	-31.36	115.00	-80.00	-10.45	115 00	-60.00	3	4
263	-31.36	115 00	-60.00	-10 45	115.00	-40 00	3	4
264	-31.36	115 00	-40.00	-10.45	115.00	-20.00	3	4
265	-31.36	115.00	-20.00	-10.45	115.00	0.00	3	4
266	-31.36	115.00	0.00	-10.45	115.00	20.00	3	4
267	-31.36	115.00	20.00	-10 45	115.00	40.00	3	4
268	-31.36	115.00	40 00	-10.45	115 00	60.00	3	4
269	-31.36	115.00	60 00	-10.45	115.00	80.00	3	4
270	-31.36	115.00	80.00	-10.45	115.00	100 00	3	4
271	-10 45	115 00	-100.00	10 45	115.00	-80.00	3	4
272	-10 45	115.00	-80.00	10 45	115.00	-60.00	3	4
273	-10 45	115.00	-60 00	10.45	115.00	-40.00	3	4
274	-10.45	115.00	-40.00	10.45	115.00	-20.00	3	4
275	-10.45	115 00	-20.00	10 45	115.00	0 00	3	4
276	-10.45	115 00	0 00	10 45	115.00	20.00	3	4
277	-10 45	115 00	20 00	10 45	115.00	40.00	3	4
278	-10 45	115 00	40 00	10 45	115 00	60 00	3	4
279	-10.45	115 00	60.00	10 45	115 00	80 00	3	4
280	-10.45	115 00	80 00	10 45	115.00	100 00	3	4
281	10.45	115 00	-100 00	31 36	115.00	-80.00	3	4
282	10.45	115.00	-80.00	31 36	115 00	-60 00	3	4
283	10.45	115.00	-60 00	31 36	115 00	-40 00	3	4
284	10.45	115 00	-40.00	31 36	115.00	-20 00	3	4
285	10.45	115 00	-20 00	31 36	115 00	0.00	3	4

286	10.45	115 00	0 00	31 36	115.00	20.00	3	4
287	10.45	115.00	20 00	31.36	115.00	40.00	3	4
288	10 45	115.00	40.00	31.36	115.00	60 00	3	4
289	10.45	115.00	60.00	31 36	115.00	80.00	3	4
290	10.45	115.00	80 00	31 36	115 00	100.00	3	4
291	31.36	115 00	-100 00	52 27	115.00	-80.00	3	4
292	31.36	115 00	-80 00	52 27	115.00	-60.00	3	4
293	31.36	115.00	-60 00	52 27	115.00	-40.00	3	4
294	31.36	115.00	-40.00	52 27	115 00	-20.00	3	4
295	31 36	115 00	-20 00	52 27	115 00	0.00	3	4
296	31 36	115.00	0.00	52 27	115.00	20.00	3	4
297	31.36	115.00	20 00	52 27	115 00	40.00	3	4
298	31.36	115.00	40 00	52.27	115.00	60.00	3	4
299	31.36	115.00	60.00	52 27	115.00	80.00	3	4
300	31.36	115.00	80.00	52 27	115 00	100.00	3	4
301	52.27	115.00	-100 00	73 18	115.00	-80 00	3	4
302	52 27	115 00	-80 00	73 18	115.00	-60.00	3	4
303	52.27	115.00	-60.00	73 18	115 00	-40.00	3	4
304	52.27	115.00	-40.00	73 18	115.00	-20.00	3	4
305	52 27	115 00	-20.00	73 18	115.00	0.00	3	4
306	52.27	115.00	0.00	73 18	115.00	20.00	3	4
307	52.27	115.00	20.00	73 18	115.00	40.00	3	4
308	52.27	115.00	40.00	73 18	115.00	60.00	3	4
309	52.27	115.00	60.00	73 18	115.00	80.00	3	4
310	52.27	115.00	80 00	73 18	115 00	100.00	3	4
311	73.18	115.00	-100 00	94 09	115.00	-80.00	3	4
312	73.18	115.00	-80.00	94 09	115.00	-60.00	3	4
313	73 18	115 00	-60.00	94 09	115.00	-40.00	3	4
314	73.18	115.00	-40.00	94 09	115.00	-20.00	3	4
315	73.18	115 00	-20.00	94 09	115.00	0.00	3	4
316	73.18	115.00	0.00	94.09	115 00	20.00	3	4
317	73.18	115.00	20.00	94 09	115 00	40.00	3	4
318	73.18	115.00	40.00	94 09	115.00	60 00	3	4
319	73.18	115.00	60.00	94 09	115.00	80 00	3	4
320	73.18	115 00	80.00	94 09	115 00	100.00	3	4
321	94.09	115.00	-100.00	115 00	115.00	-80.00	3	4
322	94.09	115.00	-80.00	115 00	115.00	-60 00	3	4
323	94.09	115.00	-60.00	115 00	115.00	-40 00	3	4
324	94.09	115.00	-40.00	115 00	115 00	-20.00	3	4
325	94.09	115.00	-20.00	115 00	115 00	0.00	3	4
326	94.09	115.00	0 00	115.00	115.00	20 00	3	4
327	94.09	115 00	20.00	115 00	115.00	40 00	3	4
328	94 09	115.00	40 00	115.00	115.00	60.00	3	4
329	94.09	115.00	60.00	115 00	115 00	80.00	3	4
330	94.09	115.00	80.00	115.00	115.00	100.00	3	4
331	-115.00	-100.00	-100 00	-94 09	-100.00	-80.00	4	4
332	-115 00	-100.00	-80.00	-94 09	-100.00	-60.00	4	4
333	-115.00	-100.00	-60.00	-94 09	-100.00	-40.00	4	4
334	-115.00	-100.00	-40.00	-94 09	-100 00	-20 00	4	4
335	-115.00	-100 00	-20.00	-94 09	-100 00	0 00	4	4
336	-115.00	-100.00	0 00	-94 09	-100.00	20 00	4	4
337	-115.00	-100.00	20 00	-94 09	-100.00	40.00	4	4
338	-115 00	-100 00	40.00	-94 09	-100.00	60.00	4	4
339	-115 00	-100 00	60.00	-94 09	-100.00	80 00	4	4
340	-115.00	-100 00	80.00	-94 09	-100.00	100 00	4	4
341	-94.09	-100 00	-100 00	-73 18	-100 00	-80 00	4	4
342	-94.09	-100 00	-80 00	-73 18	-100 00	-60 00	4	4
343	-94 09	-100 00	-60 00	-73 18	-100.00	-40.00	4	4
344	-94 09	-100 00	-40.00	-73 18	-100 00	-20 00	4	4
345	-94.09	-100 00	-20.00	-73 18	-100.00	0.00	4	4
346	-94.09	-100 00	0 00	-73 18	-100 00	20 00	4	4
347	-94.09	-100.00	20 00	-73 18	-100.00	40 00	4	4

348	-94.09	-100 00	40.00	-73.18	-100 00	60.00	4	4
349	-94.09	-100.00	60.00	-73.18	-100 00	80.00	4	4
350	-94 09	-100 00	80.00	-73.18	-100.00	100.00	4	4
351	-73.18	-100 00	-100.00	-52.27	-100.00	-80.00	4	4
352	-73.18	-100 00	-80 00	-52 27	-100.00	-60.00	4	4
353	-73.18	-100 00	-60.00	-52.27	-100.00	-40.00	4	4
354	-73 18	-100.00	-40 00	-52.27	-100.00	-20.00	4	4
355	-73.18	-100 00	-20.00	-52.27	-100.00	0.00	4	4
356	-73.18	-100 00	0.00	-52.27	-100 00	20.00	4	4
357	-73.18	-100 00	20.00	-52.27	-100.00	40.00	4	4
358	-73.18	-100.00	40 00	-52.27	-100.00	60.00	4	4
359	-73.18	-100.00	60 00	-52 27	-100.00	80.00	4	4
360	-73 18	-100 00	80 00	-52 27	-100.00	100.00	4	4
361	-52.27	-100 00	-100 00	-31.36	-100.00	-80.00	4	4
362	-52.27	-100.00	-80.00	-31.36	-100.00	-60.00	4	4
363	-52.27	-100 00	-60.00	-31.36	-100.00	-40.00	4	4
364	-52.27	-100.00	-40.00	-31.36	-100 00	-20.00	4	4
365	-52.27	-100.00	-20.00	-31.36	-100 00	0.00	4	4
366	-52 27	-100.00	0 00	-31.36	-100.00	20.00	4	4
367	-52.27	-100.00	20 00	-31.36	-100.00	40.00	4	4
368	-52.27	-100.00	40 00	-31.36	-100.00	60.00	4	4
369	-52.27	-100.00	60.00	-31.36	-100.00	80.00	4	4
370	-52.27	-100.00	80.00	-31.36	-100.00	100.00	4	4
371	-31 36	-100.00	-100.00	-10.45	-100.00	-80.00	4	4
372	-31 36	-100.00	-80.00	-10.45	-100.00	-60 00	4	4
373	-31 36	-100 00	-60.00	-10.45	-100.00	-40 00	4	4
374	-31.36	-100 00	-40.00	-10.45	-100.00	-20.00	4	4
375	-31.36	-100.00	-20.00	-10.45	-100.00	0.00	4	4
376	-31.36	-100.00	0.00	-10.45	-100.00	20 00	4	4
377	-31.36	-100.00	20.00	-10.45	-100.00	40 00	4	4
378	-31 36	-100.00	40.00	-10.45	-100 00	60.00	4	4
379	-31 36	-100 00	60.00	-10 45	-100.00	80.00	4	4
380	-31.36	-100 00	80.00	-10.45	-100.00	100.00	4	4
381	-10.45	-100.00	-100.00	10.45	-100.00	-80 00	4	4
382	-10.45	-100.00	-80 00	10.45	-100 00	-60.00	4	4
383	-10 45	-100.00	-60 00	10.45	-100 00	-40.00	4	4
384	-10.45	-100 00	-40 00	10.45	-100.00	-20.00	4	4
385	-10.45	-100.00	-20.00	10.45	-100.00	0.00	4	4
386	-10.45	-100.00	0.00	10.45	-100.00	20.00	4	4
387	-10.45	-100.00	20.00	10.45	-100 00	40.00	4	4
388	-10.45	-100.00	40 00	10 45	-100 00	60.00	4	4
389	-10.45	-100.00	60.00	10.45	-100.00	80.00	4	4
390	-10.45	-100.00	80.00	10.45	-100.00	100 00	4	4
391	10.45	-100.00	-100 00	31.36	-100 00	-80.00	4	4
392	10.45	-100.00	-80.00	31.36	-100.00	-60.00	4	4
393	10.45	-100.00	-60.00	31.36	-100.00	-40 00	4	4
394	10 45	-100 00	-40 00	31.36	-100 00	-20.00	4	4
395	10.45	-100.00	-20 00	31.36	-100 00	0.00	4	4
396	10 45	-100.00	0.00	31.36	-100 00	20.00	4	4
397	10 45	-100.00	20 00	31.36	-100 00	40 00	4	4
398	10 45	-100.00	40 00	31.36	-100 00	60.00	4	4
399	10 45	-100.00	60 00	31 36	-100 00	80.00	4	4
400	10 45	-100.00	80.00	31.36	-100 00	100 00	4	4
401	31 36	-100.00	-100 00	52.27	-100 00	-80.00	4	4
402	31.36	-100.00	-80 00	52 27	-100 00	-60.00	4	4
403	31 36	-100 00	-60 00	52.27	-100 00	-40.00	4	4
404	31 36	-100.00	-40.00	52.27	-100 00	-20 00	4	4
405	31 36	-100 00	-20 00	52 27	-100 00	0 00	4	4
406	31 36	-100 00	0 00	52.27	-100.00	20.00	4	4
407	31 36	-100.00	20 00	52.27	-100.00	40.00	4	4
408	31 36	-100.00	40.00	52.27	-100 00	60 00	4	4
409	31 36	-100 00	60 00	52.27	-100.00	80 00	4	4

410	31.36	-100.00	80.00	52 27	-100 00	100.00	4	4
411	52.27	-100.00	-100 00	73 18	-100 00	-80.00	4	4
412	52.27	-100.00	-80.00	73 18	-100.00	-60.00	4	4
413	52.27	-100.00	-60.00	73 18	-100.00	-40 00	4	4
414	52.27	-100.00	-40.00	73 18	-100.00	-20 00	4	4
415	52.27	-100.00	-20 00	73 18	-100 00	0 00	4	4
416	52.27	-100.00	0.00	73 18	-100 00	20.00	4	4
417	52.27	-100.00	20 00	73 18	-100.00	40.00	4	4
418	52.27	-100.00	40 00	73 18	-100 00	60.00	4	4
419	52 27	-100.00	60.00	73 18	-100.00	80.00	4	4
420	52 27	-100.00	80.00	73 18	-100 00	100.00	4	4
421	73.18	-100.00	-100.00	94 09	-100 00	-80.00	4	4
422	73 18	-100.00	-80.00	94 09	-100.00	-60.00	4	4
423	73.18	-100.00	-60.00	94 09	-100.00	-40.00	4	4
424	73.18	-100.00	-40.00	94 09	-100.00	-20.00	4	4
425	73 18	-100.00	-20.00	94 09	-100.00	0.00	4	4
426	73 18	-100.00	0 00	94 09	-100 00	20.00	4	4
427	73.18	-100.00	20 00	94 09	-100 00	40.00	4	4
428	73.18	-100.00	40.00	94 09	-100 00	60.00	4	4
429	73.18	-100.00	60 00	94 09	-100.00	80.00	4	4
430	73.18	-100.00	80 00	94 09	-100.00	100.00	4	4
431	94.09	-100.00	-100 00	115 00	-100.00	-80 00	4	4
432	94.09	-100.00	-80.00	115 00	-100.00	-60.00	4	4
433	94.09	-100.00	-60.00	115 00	-100.00	-40.00	4	4
434	94.09	-100.00	-40.00	115 00	-100.00	-20.00	4	4
435	94.09	-100.00	-20.00	115 00	-100.00	0.00	4	4
436	94.09	-100.00	0.00	115 00	-100.00	20.00	4	4
437	94.09	-100.00	20.00	115.00	-100.00	40.00	4	4
438	94.09	-100.00	40.00	115 00	-100 00	60.00	4	4
439	94.09	-100.00	60.00	115 00	-100.00	80.00	4	4
440	94.09	-100.00	80 00	115 00	-100.00	100.00	4	4

WALLZ INFORMATION

ID	x1	y1	z1	x2	y2	z2	gridx	gridy
5	-115.0	-115.0	100.0	115 0	115.0	115.0	11	11
6	-115.0	-115.0	-115.0	115.0	115.0	-100.0	11	11

Wall segments (wallz)

ID#	x1	y1	z1	x2	y2	z2	WID	SENSE
1	-115.00	-115.00	100.00	-94 09	-94.09	100.00	5	0
2	-115 00	-94.09	100.00	-94 09	-73.18	100 00	5	0
3	-115.00	-73 18	100.00	-94 09	-52.27	100.00	5	0
4	-115.00	-52 27	100 00	-94 09	-31.36	100 00	5	0
5	-115.00	-31.36	100.00	-94 09	-10.45	100.00	5	0
6	-115.00	-10 45	100.00	-94 09	10.45	100.00	5	0
7	-115.00	10.45	100 00	-94 09	31 36	100.00	5	0
8	-115.00	31.36	100.00	-94 09	52 27	100.00	5	0
9	-115.00	52.27	100 00	-94 09	73 18	100 00	5	0
10	-115 00	73.18	100.00	-94 09	94.09	100 00	5	0
11	-115 00	94.09	100 00	-94 09	115 00	100 00	5	0
12	-94 09	-115.00	100 00	-73 18	-94 09	100.00	5	0
13	-94.09	-94.09	100 00	-73 18	-73 18	100.00	5	0
14	-94 09	-73.18	100.00	-73 18	-52 27	100.00	5	0
15	-94.09	-52 27	100 00	-73 18	-31.36	100.00	5	0
16	-94 09	-31 36	100 00	-73 18	-10.45	100 00	5	0
17	-94 09	-10.45	100 00	-73 18	10.45	100 00	5	0
18	-94 09	10.45	100 00	-73 18	31 36	100 00	5	0
19	-94 09	31 36	100 00	-73 18	52 27	100.00	5	0

20	-94.09	52.27	100.00	-73.18	73 18	100.00	5	0
21	-94.09	73.18	100.00	-73.18	94 09	100.00	5	0
22	-94.09	94.09	100.00	-73.18	115.00	100.00	5	0
23	-73.18	-115.00	100 00	-52.27	-94.09	100.00	5	0
24	-73.18	-94.09	100 00	-52 27	-73.18	100 00	5	0
25	-73.18	-73.18	100.00	-52 27	-52.27	100 00	5	0
26	-73.18	-52.27	100.00	-52 27	-31.36	100 00	5	0
27	-73 18	-31.36	100.00	-52.27	-10.45	100 00	5	0
28	-73.18	-10 45	100.00	-52.27	10.45	100.00	5	0
29	-73.18	10 45	100.00	-52.27	31.36	100 00	5	0
30	-73 18	31 36	100.00	-52.27	52.27	100.00	5	0
31	-73.18	52 27	100.00	-52.27	73 18	100.00	5	0
32	-73.18	73 18	100.00	-52.27	94.09	100.00	5	0
33	-73.18	94 09	100.00	-52.27	115.00	100.00	5	0
34	-52.27	-115 00	100.00	-31.36	-94.09	100.00	5	0
35	-52.27	-94 09	100.00	-31.36	-73.18	100.00	5	0
36	-52.27	-73 18	100.00	-31.36	-52.27	100.00	5	0
37	-52.27	-52.27	100.00	-31.36	-31 36	100.00	5	0
38	-52.27	-31 36	100.00	-31.36	-10 45	100.00	5	0
39	-52.27	-10.45	100.00	-31.36	10 45	100.00	5	0
40	-52.27	10.45	100.00	-31.36	31.36	100.00	5	0
41	-52 27	31.36	100.00	-31.36	52.27	100.00	5	0
42	-52.27	52.27	100.00	-31.36	73.18	100.00	5	0
43	-52.27	73.18	100.00	-31.36	94.09	100.00	5	0
44	-52.27	94.09	100 00	-31.36	115.00	100.00	5	0
45	-31.36	-115.00	100.00	-10 45	-94.09	100.00	5	0
46	-31.36	-94.09	100.00	-10.45	-73.18	100.00	5	0
47	-31.36	-73.18	100.00	-10.45	-52.27	100.00	5	0
48	-31.36	-52.27	100.00	-10.45	-31.36	100.00	5	0
49	-31.36	-31 36	100.00	-10.45	-10.45	100.00	5	0
50	-31.36	-10 45	100.00	-10.45	10.45	100.00	5	0
51	-31.36	10.45	100.00	-10.45	31.36	100 00	5	0
52	-31.36	31.36	100.00	-10.45	52.27	100.00	5	0
53	-31.36	52.27	100.00	-10.45	73.18	100.00	5	0
54	-31 36	73.18	100.00	-10 45	94.09	100 00	5	0
55	-31.36	94.09	100.00	-10.45	115.00	100.00	5	0
56	-10.45	-115.00	100.00	10.45	-94.09	100.00	5	0
57	-10.45	-94.09	100.00	10.45	-73.18	100.00	5	0
58	-10 45	-73.18	100.00	10.45	-52.27	100.00	5	0
59	-10 45	-52.27	100.00	10.45	-31.36	100 00	5	0
60	-10 45	-31.36	100.00	10.45	-10.45	100.00	5	0
61	-10.45	-10 45	100 00	10.45	10.45	100.00	5	0
62	-10.45	10 45	100.00	10 45	31.36	100.00	5	0
63	-10.45	31 36	100 00	10 45	52.27	100.00	5	0
64	-10.45	52.27	100.00	10.45	73.18	100.00	5	0
65	-10.45	73.18	100.00	10.45	94.09	100 00	5	0
66	-10.45	94.09	100.00	10.45	115.00	100 00	5	0
67	10.45	-115.00	100.00	31.36	-94.09	100.00	5	0
68	10.45	-94.09	100.00	31 36	-73.18	100.00	5	0
69	10.45	-73.18	100.00	31 36	-52.27	100 00	5	0
70	10.45	-52.27	100.00	31.36	-31.36	100 00	5	0
71	10.45	-31 36	100.00	31.36	-10.45	100 00	5	0
72	10.45	-10 45	100.00	31.36	10.45	100 00	5	0
73	10 45	10.45	100 00	31.36	31.36	100 00	5	0
74	10 45	31.36	100.00	31.36	52 27	100.00	5	0
75	10.45	52 27	100.00	31.36	73 18	100.00	5	0
76	10.45	73 18	100.00	31.36	94.09	100 00	5	0
77	10.45	94 09	100.00	31.36	115.00	100 00	5	0
78	31.36	-115 00	100.00	52.27	-94.09	100 00	5	0
79	31 36	-94 09	100.00	52.27	-73 18	100 00	5	0
80	31.36	-73.18	100.00	52 27	-52.27	100 00	5	0
81	31.36	-52.27	100.00	52 27	-31.36	100.00	5	0

82	31.36	-31 36	100.00	52 27	-10.45	100.00	5	0
83	31.36	-10.45	100.00	52 27	10 45	100.00	5	0
84	31.36	10.45	100.00	52 27	31.36	100.00	5	0
85	31.36	31.36	100.00	52 27	52.27	100.00	5	0
86	31.36	52 27	100.00	52 27	73.18	100.00	5	0
87	31.36	73.18	100.00	52.27	94.09	100.00	5	0
88	31.36	94.09	100.00	52 27	115.00	100.00	5	0
89	52.27	-115.00	100 00	73 18	-94 09	100.00	5	0
90	52.27	-94 09	100 00	73 18	-73.18	100.00	5	0
91	52.27	-73 18	100.00	73.18	-52.27	100.00	5	0
92	52.27	-52.27	100.00	73 18	-31.36	100.00	5	0
93	52 27	-31.36	100 00	73 18	-10.45	100.00	5	0
94	52.27	-10 45	100.00	73 18	10.45	100.00	5	0
95	52.27	10.45	100.00	73 18	31.36	100.00	5	0
96	52.27	31.36	100 00	73 18	52.27	100.00	5	0
97	52.27	52.27	100.00	73.18	73.18	100.00	5	0
98	52.27	73.18	100.00	73.18	94.09	100 00	5	0
99	52 27	94.09	100 00	73 18	115 00	100.00	5	0
100	73.18	-115.00	100 00	94 09	-94.09	100.00	5	0
101	73.18	-94.09	100.00	94.09	-73.18	100.00	5	0
102	73.18	-73.18	100.00	94.09	-52.27	100.00	5	0
103	73.18	-52.27	100.00	94 09	-31.36	100.00	5	0
104	73.18	-31.36	100.00	94.09	-10.45	100.00	5	0
105	73.18	-10.45	100.00	94 09	10.45	100.00	5	0
106	73.18	10 45	100.00	94 09	31 36	100.00	5	0
107	73.18	31.36	100.00	94.09	52.27	100.00	5	0
108	73.18	52.27	100.00	94.09	73.18	100.00	5	0
109	73.18	73.18	100.00	94.09	94 09	100.00	5	0
110	73.18	94 09	100 00	94.09	115.00	100.00	5	0
111	94.09	-115.00	100.00	115.00	-94.09	100.00	5	0
112	94.09	-94.09	100.00	115.00	-73.18	100.00	5	0
113	94.09	-73.18	100.00	115.00	-52.27	100.00	5	0
114	94.09	-52.27	100.00	115 00	-31.36	100.00	5	0
115	94.09	-31 36	100.00	115.00	-10.45	100.00	5	0
116	94.09	-10.45	100.00	115.00	10.45	100.00	5	0
117	94.09	10.45	100.00	115.00	31.36	100.00	5	0
118	94.09	31.36	100.00	115 00	52.27	100.00	5	0
119	94.09	52.27	100.00	115 00	73.18	100.00	5	0
120	94.09	73.18	100.00	115 00	94.09	100.00	5	0
121	94.09	94.09	100.00	115.00	115.00	100.00	5	0
122	-115.00	-115.00	-115 00	-94.09	-94.09	-115.00	6	0
123	-115 00	-94.09	-115 00	-94 09	-73.18	-115 00	6	0
124	-115.00	-73.18	-115 00	-94 09	-52.27	-115.00	6	0
125	-115.00	-52.27	-115.00	-94 09	-31.36	-115.00	6	0
126	-115.00	-31.36	-115.00	-94.09	-10.45	-115.00	6	0
127	-115.00	-10.45	-115.00	-94.09	10.45	-115.00	6	0
128	-115.00	10 45	-115.00	-94 09	31 36	-115 00	6	0
129	-115 00	31.36	-115.00	-94 09	52.27	-115 00	6	0
130	-115.00	52.27	-115 00	-94 09	73.18	-115.00	6	0
131	-115 00	73.18	-115 00	-94 09	94.09	-115.00	6	0
132	-115.00	94 09	-115.00	-94.09	115.00	-115.00	6	0
133	-94.09	-115 00	-115.00	-73.18	-94.09	-115 00	6	0
134	-94.09	-94.09	-115.00	-73 18	-73.18	-115.00	6	0
135	-94.09	-73 18	-115 00	-73 18	-52.27	-115 00	6	0
136	-94.09	-52 27	-115 00	-73 18	-31.36	-115.00	6	0
137	-94 09	-31.36	-115 00	-73 18	-10.45	-115.00	6	0
138	-94.09	-10 45	-115.00	-73.18	10.45	-115.00	6	0
139	-94.09	10 45	-115.00	-73.18	31 36	-115.00	6	0
140	-94.09	31 36	-115.00	-73 18	52.27	-115 00	6	0
141	-94.09	52.27	-115.00	-73 18	73.18	-115.00	6	0
142	-94.09	73.18	-115 00	-73 18	94.09	-115.00	6	0
143	-94.09	94.09	-115.00	-73 18	115.00	-115.00	6	0

144	-73.18	-115.00	-115.00	-52.27	-94 09	-115.00	6	0
145	-73.18	-94.09	-115.00	-52.27	-73.18	-115 00	6	0
146	-73.18	-73.18	-115.00	-52.27	-52 27	-115 00	6	0
147	-73.18	-52.27	-115.00	-52.27	-31.36	-115.00	6	0
148	-73.18	-31 36	-115 00	-52.27	-10 45	-115.00	6	0
149	-73 18	-10 45	-115 00	-52.27	10 45	-115 00	6	0
150	-73.18	10.45	-115.00	-52 27	31 36	-115 00	6	0
151	-73.18	31.36	-115.00	-52.27	52 27	-115.00	6	0
152	-73 18	52 27	-115.00	-52.27	73 18	-115.00	6	0
153	-73.18	73.18	-115.00	-52.27	94 09	-115.00	6	0
154	-73.18	94.09	-115.00	-52.27	115 00	-115.00	6	0
155	-52.27	-115.00	-115.00	-31.36	-94.09	-115 00	6	0
156	-52 27	-94.09	-115 00	-31.36	-73 18	-115.00	6	0
157	-52 27	-73.18	-115.00	-31 36	-52 27	-115 00	6	0
158	-52.27	-52.27	-115.00	-31.36	-31 36	-115.00	6	0
159	-52.27	-31.36	-115.00	-31 36	-10.45	-115.00	6	0
160	-52 27	-10.45	-115 00	-31 36	10 45	-115.00	6	0
161	-52 27	10 45	-115.00	-31 36	31 36	-115 00	6	0
162	-52.27	31.36	-115.00	-31 36	52 27	-115 00	6	0
163	-52.27	52.27	-115.00	-31 36	73 18	-115.00	6	0
164	-52.27	73.18	-115.00	-31 36	94 09	-115.00	6	0
165	-52.27	94.09	-115.00	-31 36	115.00	-115.00	6	0
166	-31.36	-115.00	-115 00	-10 45	-94 09	-115.00	6	0
167	-31.36	-94.09	-115.00	-10.45	-73.18	-115.00	6	0
168	-31.36	-73.18	-115.00	-10 45	-52.27	-115.00	6	0
169	-31.36	-52.27	-115.00	-10 45	-31 36	-115.00	6	0
170	-31.36	-31.36	-115.00	-10 45	-10 45	-115 00	6	0
171	-31.36	-10.45	-115.00	-10 45	10.45	-115.00	6	0
172	-31.36	10.45	-115.00	-10 45	31.36	-115.00	6	0
173	-31.36	31.36	-115.00	-10 45	52.27	-115.00	6	0
174	-31.36	52.27	-115.00	-10 45	73.18	-115.00	6	0
175	-31.36	73.18	-115 00	-10.45	94.09	-115.00	6	0
176	-31 36	94.09	-115 00	-10.45	115.00	-115.00	6	0
177	-10.45	-115.00	-115.00	10 45	-94.09	-115.00	6	0
178	-10.45	-94.09	-115.00	10 45	-73.18	-115 00	6	0
179	-10.45	-73.18	-115.00	10 45	-52.27	-115 00	6	0
180	-10 45	-52.27	-115.00	10 45	-31.36	-115.00	6	0
181	-10.45	-31.36	-115.00	10 45	-10 45	-115.00	6	0
182	-10.45	-10.45	-115.00	10 45	10 45	-115.00	6	0
183	-10 45	10.45	-115.00	10 45	31.36	-115 00	6	0
184	-10.45	31.36	-115.00	10 45	52.27	-115 00	6	0
185	-10.45	52.27	-115.00	10 45	73.18	-115.00	6	0
186	-10.45	73.18	-115.00	10 45	94.09	-115.00	6	0
187	-10.45	94.09	-115.00	10 45	115 00	-115.00	6	0
188	10.45	-115.00	-115 00	31.36	-94 09	-115.00	6	0
189	10.45	-94.09	-115.00	31 36	-73 18	-115 00	6	0
190	10 45	-73.18	-115 00	31 36	-52.27	-115 00	6	0
191	10.45	-52.27	-115 00	31 36	-31.36	-115 00	6	0
192	10.45	-31.36	-115.00	31 36	-10.45	-115.00	6	0
193	10 45	-10.45	-115.00	31 36	10.45	-115 00	6	0
194	10.45	10 45	-115.00	31 36	31.36	-115 00	6	0
195	10.45	31 36	-115.00	31 36	52.27	-115 00	6	0
196	10.45	52 27	-115 00	31 36	73 18	-115 00	6	0
197	10 45	73 18	-115 00	31 36	94.09	-115.00	6	0
198	10 45	94 09	-115 00	31 36	115 00	-115 00	6	0
199	31 36	-115 00	-115 00	52 27	-94 09	-115 00	6	0
200	31 36	-94.09	-115.00	52 27	-73 18	-115 00	6	0
201	31.36	-73.18	-115.00	52 27	-52 27	-115 00	6	0
202	31.36	-52.27	-115.00	52 27	-31.36	-115.00	6	0
203	31.36	-31.36	-115.00	52 27	-10.45	-115.00	6	0
204	31.36	-10 45	-115 00	52 27	10.45	-115.00	6	0
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206	31.36	31.36	-115.00	52 27	52.27	-115.00	6	0
207	31.36	52.27	-115 00	52 27	73.18	-115.00	6	0
208	31.36	73.18	-115.00	52 27	94 09	-115.00	6	0
209	31.36	94 09	-115.00	52.27	115 00	-115.00	6	0
210	52 27	-115.00	-115.00	73.18	-94.09	-115.00	6	0
211	52 27	-94 09	-115.00	73.18	-73.18	-115 00	6	0
212	52 27	-73.18	-115.00	73.18	-52.27	-115.00	6	0
213	52.27	-52 27	-115.00	73.18	-31.36	-115.00	6	0
214	52.27	-31.36	-115 00	73 18	-10.45	-115.00	6	0
215	52.27	-10 45	-115 00	73 18	10.45	-115.00	6	0
216	52.27	10 45	-115.00	73 18	31.36	-115 00	6	0
217	52.27	31.36	-115 00	73 18	52 27	-115.00	6	0
218	52 27	52 27	-115 00	73 18	73.18	-115.00	6	0
219	52 27	73 18	-115 00	73.18	94.09	-115.00	6	0
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221	73 18	-115.00	-115.00	94 09	-94.09	-115.00	6	0
222	73 18	-94.09	-115.00	94 09	-73 18	-115.00	6	0
223	73.18	-73.18	-115.00	94 09	-52.27	-115 00	6	0
224	73.18	-52.27	-115.00	94 09	-31.36	-115 00	6	0
225	73.18	-31.36	-115 00	94 09	-10.45	-115.00	6	0
226	73.18	-10.45	-115 00	94 09	10 45	-115.00	6	0
227	73.18	10.45	-115 00	94 09	31 36	-115.00	6	0
228	73.18	31.36	-115.00	94.09	52.27	-115.00	6	0
229	73.18	52.27	-115.00	94 09	73.18	-115.00	6	0
230	73 18	73 18	-115 00	94 09	94 09	-115.00	6	0
231	73.18	94.09	-115.00	94 09	115.00	-115.00	6	0
232	94.09	-115.00	-115.00	115 00	-94 09	-115.00	6	0
233	94.09	-94.09	-115.00	115 00	-73 18	-115.00	6	0
234	94.09	-73.18	-115.00	115.00	-52.27	-115.00	6	0
235	94.09	-52.27	-115.00	115.00	-31.36	-115.00	6	0
236	94.09	-31.36	-115.00	115.00	-10.45	-115.00	6	0
237	94 09	-10.45	-115.00	115 00	10.45	-115.00	6	0
238	94.09	10.45	-115.00	115.00	31.36	-115 00	6	0
239	94.09	31.36	-115 00	115.00	52.27	-115.00	6	0
240	94.09	52.27	-115.00	115.00	73.18	-115.00	6	0
241	94.09	73.18	-115.00	115.00	94.09	-115.00	6	0
242	94.09	94 09	-115 00	115 00	115.00	-115.00	6	0
243	-115.00	-115 00	115 00	-94.09	-94.09	115.00	5	4
244	-115.00	-94.09	115.00	-94 09	-73.18	115.00	5	4
245	-115.00	-73.18	115.00	-94.09	-52.27	115.00	5	4
246	-115.00	-52.27	115.00	-94.09	-31.36	115 00	5	4
247	-115.00	-31.36	115.00	-94.09	-10.45	115 00	5	4
248	-115.00	-10.45	115.00	-94.09	10.45	115 00	5	4
249	-115.00	10.45	115.00	-94.09	31.36	115.00	5	4
250	-115.00	31.36	115 00	-94.09	52.27	115.00	5	4
251	-115.00	52 27	115.00	-94 09	73 18	115.00	5	4
252	-115 00	73 18	115 00	-94 09	94.09	115.00	5	4
253	-115.00	94 09	115.00	-94 09	115.00	115 00	5	4
254	-94.09	-115 00	115 00	-73.18	-94.09	115 00	5	4
255	-94.09	-94.09	115.00	-73 18	-73.18	115 00	5	4
256	-94 09	-73 18	115 00	-73.18	-52 27	115 00	5	4
257	-94 09	-52 27	115 00	-73.18	-31.36	115 00	5	4
258	-94.09	-31 36	115 00	-73 18	-10 45	115.00	5	4
259	-94.09	-10.45	115.00	-73 18	10.45	115.00	5	4
260	-94.09	10.45	115 00	-73 18	31.36	115.00	5	4
261	-94.09	31 36	115.00	-73 18	52.27	115.00	5	4
262	-94 09	52 27	115.00	-73 18	73 18	115.00	5	4
263	-94 09	73 18	115.00	-73.18	94 09	115.00	5	4
264	-94 09	94 09	115 00	-73 18	115 00	115 00	5	4
265	-73 18	-115.00	115 00	-52 27	-94 09	115.00	5	4
266	-73.18	-94.09	115 00	-52 27	-73.18	115.00	5	4
267	-73 18	-73.18	115 00	-52.27	-52.27	115.00	5	4

268	-73.18	-52.27	115.00	-52.27	-31 36	115 00	5	4
269	-73.18	-31.36	115.00	-52.27	-10.45	115 00	5	4
270	-73.18	-10.45	115.00	-52.27	10 45	115 00	5	4
271	-73 18	10 45	115 00	-52.27	31.36	115.00	5	4
272	-73.18	31.36	115 00	-52.27	52.27	115 00	5	4
273	-73 18	52.27	115.00	-52.27	73.18	115 00	5	4
274	-73.18	73.18	115.00	-52.27	94 09	115 00	5	4
275	-73.18	94.09	115.00	-52.27	115.00	115 00	5	4
276	-52.27	-115.00	115.00	-31.36	-94.09	115 00	5	4
277	-52.27	-94.09	115.00	-31.36	-73.18	115 00	5	4
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279	-52.27	-52.27	115 00	-31.36	-31.36	115 00	5	4
280	-52.27	-31.36	115.00	-31.36	-10 45	115 00	5	4
281	-52.27	-10.45	115.00	-31.36	10 45	115 00	5	4
282	-52 27	10.45	115.00	-31.36	31 36	115.00	5	4
283	-52 27	31.36	115 00	-31.36	52 27	115.00	5	4
284	-52.27	52.27	115.00	-31.36	73 18	115.00	5	4
285	-52 27	73 18	115.00	-31.36	94 09	115 00	5	4
286	-52 27	94 09	115.00	-31 36	115.00	115 00	5	4
287	-31.36	-115 00	115 00	-10 45	-94 09	115 00	5	4
288	-31 36	-94.09	115.00	-10 45	-73.18	115 00	5	4
289	-31 36	-73.18	115.00	-10.45	-52.27	115 00	5	4
290	-31.36	-52.27	115.00	-10 45	-31.36	115 00	5	4
291	-31 36	-31.36	115 00	-10.45	-10.45	115 00	5	4
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293	-31 36	10.45	115.00	-10 45	31.36	115 00	5	4
294	-31 36	31.36	115 00	-10.45	52.27	115.00	5	4
295	-31 36	52.27	115.00	-10 45	73.18	115.00	5	4
296	-31 36	73.18	115.00	-10 45	94.09	115 00	5	4
297	-31 36	94.09	115.00	-10.45	115.00	115.00	5	4
298	-10 45	-115.00	115.00	10.45	-94.09	115 00	5	4
299	-10 45	-94.09	115.00	10 45	-73.18	115 00	5	4
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302	-10.45	-31.36	115.00	10.45	-10.45	115.00	5	4
303	-10 45	-10.45	115.00	10.45	10.45	115.00	5	4
304	-10 45	10.45	115.00	10.45	31 36	115.00	5	4
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306	-10 45	52.27	115.00	10 45	73 18	115 00	5	4
307	-10 45	73 18	115.00	10.45	94 09	115.00	5	4
308	-10 45	94 09	115.00	10.45	115.00	115.00	5	4
309	10.45	-115.00	115.00	31.36	-94 09	115 00	5	4
310	10.45	-94.09	115.00	31.36	-73.18	115 00	5	4
311	10.45	-73.18	115.00	31.36	-52.27	115.00	5	4
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313	10 45	-31.36	115.00	31.36	-10.45	115 00	5	4
314	10 45	-10.45	115.00	31.36	10.45	115 00	5	4
315	10 45	10.45	115.00	31 36	31.36	115.00	5	4
316	10 45	31 36	115.00	31.36	52 27	115.00	5	4
317	10.45	52.27	115.00	31 36	73 18	115 00	5	4
318	10 45	73 18	115.00	31 36	94 09	115 00	5	4
319	10 45	94 09	115.00	31.36	115 00	115.00	5	4
320	31 36	-115 00	115.00	52 27	-94 09	115 00	5	4
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326	31 36	10 45	115.00	52 27	31 36	115 00	5	4
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333	52.27	-73.18	115 00	73 18	-52.27	115.00	5	4
334	52.27	-52.27	115 00	73 18	-31.36	115 00	5	4
335	52.27	-31 36	115.00	73 18	-10 45	115.00	5	4
336	52 27	-10 45	115.00	73 18	10.45	115.00	5	4
337	52.27	10.45	115.00	73.18	31 36	115 00	5	4
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343	73.18	-94 09	115 00	94 09	-73.18	115.00	5	4
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352	73.18	94.09	115.00	94 09	115.00	115.00	5	4
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355	94.09	-73.18	115.00	115 00	-52 27	115.00	5	4
356	94.09	-52 27	115.00	115 00	-31.36	115.00	5	4
357	94.09	-31.36	115.00	115 00	-10.45	115.00	5	4
358	94.09	-10.45	115.00	115 00	10.45	115.00	5	4
359	94.09	10.45	115.00	115 00	31.36	115.00	5	4
360	94 09	31.36	115.00	115 00	52.27	115.00	5	4
361	94.09	52.27	115.00	115.00	73.18	115.00	5	4
362	94.09	73 18	115.00	115.00	94.09	115.00	5	4
363	94.09	94 09	115.00	115.00	115.00	115.00	5	4
364	-115.00	-115.00	-100.00	-94 09	-94.09	-100.00	6	4
365	-115 00	-94.09	-100.00	-94.09	-73.18	-100.00	6	4
366	-115.00	-73.18	-100.00	-94.09	-52.27	-100.00	6	4
367	-115.00	-52.27	-100.00	-94.09	-31.36	-100.00	6	4
368	-115.00	-31.36	-100.00	-94.09	-10.45	-100.00	6	4
369	-115 00	-10.45	-100.00	-94.09	10.45	-100.00	6	4
370	-115 00	10.45	-100.00	-94.09	31.36	-100.00	6	4
371	-115 00	31 36	-100.00	-94.09	52.27	-100.00	6	4
372	-115.00	52 27	-100.00	-94.09	73.18	-100.00	6	4
373	-115.00	73.18	-100.00	-94 09	94.09	-100.00	6	4
374	-115.00	94.09	-100.00	-94.09	115.00	-100.00	6	4
375	-94 09	-115 00	-100.00	-73.18	-94.09	-100.00	6	4
376	-94.09	-94.09	-100.00	-73.18	-73.18	-100.00	6	4
377	-94.09	-73.18	-100 00	-73.18	-52.27	-100.00	6	4
378	-94 09	-52.27	-100.00	-73.18	-31.36	-100.00	6	4
379	-94.09	-31 36	-100.00	-73.18	-10 45	-100.00	6	4
380	-94.09	-10 45	-100.00	-73.18	10.45	-100.00	6	4
381	-94 09	10 45	-100 00	-73 18	31.36	-100.00	6	4
382	-94 09	31 36	-100.00	-73.18	52.27	-100.00	6	4
383	-94.09	52 27	-100.00	-73.18	73 18	-100.00	6	4
384	-94.09	73 18	-100 00	-73.18	94.09	-100.00	6	4
385	-94 09	94 09	-100 00	-73.18	115.00	-100.00	6	4
386	-73.18	-115 00	-100.00	-52.27	-94.09	-100.00	6	4
387	-73.18	-94 09	-100.00	-52.27	-73 18	-100.00	6	4
388	-73 18	-73 18	-100 00	-52.27	-52 27	-100.00	6	4
389	-73 18	-52 27	-100.00	-52.27	-31.36	-100.00	6	4
390	-73.18	-31 36	-100.00	-52.27	-10.45	-100.00	6	4
391	-73.18	-10 45	-100 00	-52.27	10.45	-100 00	6	4

392	-73.18	10.45	-100.00	-52 27	31 36	-100.00	6	4
393	-73.18	31 36	-100.00	-52 27	52.27	-100 00	6	4
394	-73.18	52.27	-100.00	-52 27	73 18	-100 00	6	4
395	-73.18	73.18	-100.00	-52 27	94.09	-100 00	6	4
396	-73 18	94.09	-100.00	-52 27	115.00	-100 00	6	4
397	-52.27	-115.00	-100.00	-31 36	-94 09	-100 00	6	4
398	-52.27	-94.09	-100.00	-31.36	-73.18	-100.00	6	4
399	-52.27	-73.18	-100.00	-31 36	-52 27	-100.00	6	4
400	-52 27	-52.27	-100.00	-31 36	-31 36	-100 00	6	4
401	-52 27	-31 36	-100.00	-31 36	-10 45	-100 00	6	4
402	-52 27	-10 45	-100.00	-31 36	10.45	-100 00	6	4
403	-52.27	10.45	-100.00	-31.36	31 36	-100 00	6	4
404	-52 27	31.36	-100.00	-31 36	52.27	-100 00	6	4
405	-52.27	52.27	-100.00	-31.36	73.18	-100.00	6	4
406	-52.27	73.18	-100.00	-31 36	94.09	-100.00	6	4
407	-52.27	94.09	-100.00	-31.36	115.00	-100.00	6	4
408	-31.36	-115.00	-100.00	-10 45	-94.09	-100 00	6	4
409	-31.36	-94.09	-100.00	-10 45	-73 18	-100 00	6	4
410	-31 36	-73.18	-100 00	-10 45	-52 27	-100 00	6	4
411	-31.36	-52.27	-100 00	-10.45	-31 36	-100 00	6	4
412	-31.36	-31.36	-100.00	-10 45	-10.45	-100 00	6	4
413	-31.36	-10.45	-100.00	-10 45	10.45	-100.00	6	4
414	-31.36	10.45	-100.00	-10.45	31.36	-100.00	6	4
415	-31.36	31.36	-100.00	-10 45	52.27	-100.00	6	4
416	-31.36	52.27	-100.00	-10 45	73 18	-100.00	6	4
417	-31 36	73.18	-100.00	-10 45	94 09	-100.00	6	4
418	-31.36	94.09	-100.00	-10 45	115 00	-100 00	6	4
419	-10.45	-115.00	-100.00	10 45	-94.09	-100 00	6	4
420	-10.45	-94.09	-100.00	10 45	-73.18	-100.00	6	4
421	-10.45	-73.18	-100.00	10 45	-52.27	-100.00	6	4
422	-10.45	-52.27	-100.00	10.45	-31.36	-100.00	6	4
423	-10 45	-31.36	-100.00	10.45	-10.45	-100 00	6	4
424	-10 45	-10.45	-100.00	10.45	10 45	-100 00	6	4
425	-10 45	10 45	-100.00	10.45	31.36	-100.00	6	4
426	-10.45	31.36	-100.00	10 45	52.27	-100.00	6	4
427	-10.45	52.27	-100.00	10.45	73.18	-100 00	6	4
428	-10.45	73.18	-100.00	10.45	94.09	-100 00	6	4
429	-10.45	94.09	-100.00	10.45	115.00	-100.00	6	4
430	10 45	-115 00	-100.00	31.36	-94.09	-100.00	6	4
431	10 45	-94 09	-100.00	31.36	-73.18	-100 00	6	4
432	10.45	-73.18	-100.00	31 36	-52 27	-100 00	6	4
433	10.45	-52.27	-100.00	31.36	-31.36	-100 00	6	4
434	10 45	-31.36	-100.00	31.36	-10 45	-100.00	6	4
435	10.45	-10.45	-100.00	31.36	10 45	-100.00	6	4
436	10.45	10.45	-100.00	31.36	31.36	-100.00	6	4
437	10 45	31.36	-100.00	31 36	52 27	-100 00	6	4
438	10.45	52.27	-100 00	31.36	73.18	-100 00	6	4
439	10.45	73.18	-100 00	31.36	94.09	-100.00	6	4
440	10 45	94.09	-100.00	31 36	115.00	-100.00	6	4
441	31 36	-115 00	-100.00	52 27	-94.09	-100 00	6	4
442	31.36	-94 09	-100.00	52.27	-73 18	-100 00	6	4
443	31 36	-73 18	-100.00	52.27	-52.27	-100 00	6	4
444	31.36	-52.27	-100 00	52.27	-31.36	-100.00	6	4
445	31.36	-31 36	-100.00	52 27	-10 45	-100 00	6	4
446	31.36	-10 45	-100.00	52.27	10 45	-100 00	6	4
447	31 36	10.45	-100.00	52.27	31 36	-100 00	6	4
448	31 36	31.36	-100 00	52.27	52 27	-100.00	6	4
449	31.36	52 27	-100.00	52.27	73 18	-100 00	6	4
450	31.36	73 18	-100.00	52.27	94 09	-100 00	6	4
451	31 36	94.09	-100.00	52 27	115 00	-100.00	6	4
452	52 27	-115.00	-100 00	73.18	-94.09	-100.00	6	4
453	52.27	-94.09	-100 00	73 18	-73.18	-100.00	6	4

454	52.27	-73.18	-100.00	73 18	-52.27	-100 00	6	4
455	52.27	-52.27	-100 00	73 18	-31.36	-100 00	6	4
456	52.27	-31.36	-100 00	73 18	-10.45	-100 00	6	4
457	52.27	-10.45	-100.00	73 18	10.45	-100 00	6	4
458	52.27	10 45	-100.00	73 18	31.36	-100 00	6	4
459	52.27	31.36	-100.00	73 18	52.27	-100 00	6	4
460	52 27	52.27	-100.00	73 18	73.18	-100.00	6	4
461	52 27	73.18	-100 00	73.18	94 09	-100 00	6	4
462	52 27	94.09	-100.00	73 18	115.00	-100 00	6	4
463	73 18	-115.00	-100.00	94 09	-94.09	-100 00	6	4
464	73 18	-94.09	-100 00	94 09	-73.18	-100 00	6	4
465	73.18	-73.18	-100.00	94 09	-52.27	-100 00	6	4
466	73 18	-52.27	-100.00	94.09	-31.36	-100 00	6	4
467	73 18	-31.36	-100.00	94 09	-10.45	-100 00	6	4
468	73.18	-10.45	-100.00	94 09	10.45	-100.00	6	4
469	73 18	10.45	-100 00	94 09	31 36	-100 00	6	4
470	73 18	31.36	-100.00	94.09	52 27	-100 00	6	4
471	73.18	52.27	-100.00	94 09	73.18	-100 00	6	4
472	73.18	73 18	-100.00	94 09	94.09	-100.00	6	4
473	73.18	94.09	-100.00	94 09	115.00	-100.00	6	4
474	94.09	-115.00	-100.00	115.00	-94.09	-100.00	6	4
475	94.09	-94.09	-100.00	115 00	-73.18	-100.00	6	4
476	94.09	-73.18	-100.00	115 00	-52.27	-100.00	6	4
477	94.09	-52.27	-100.00	115.00	-31.36	-100.00	6	4
478	94.09	-31.36	-100.00	115 00	-10.45	-100 00	6	4
479	94 09	-10.45	-100.00	115.00	10.45	-100 00	6	4
480	94.09	10.45	-100 00	115 00	31 36	-100 00	6	4
481	94.09	31.36	-100.00	115 00	52.27	-100.00	6	4
482	94.09	52 27	-100.00	115.00	73.18	-100.00	6	4
483	94.09	73.18	-100.00	115 00	94.09	-100 00	6	4
484	94.09	94.09	-100.00	115 00	115.00	-100 00	6	4

ISOTROPIC SOURCE INFORMATION

x	y	z	group	strength
0.000	0.000	0.000	1	0 1000E+21

RESPONSE FUNCTION INFORMATION

DOSE POINT INFORMATION

x	y	z	Resp. Fcn.
300 00	0.00	0 00	0

DOSE POINT MESH INFORMATION

x1	y1	z1	x2	y2	z2	grid1	grid2	grid3	Resp. Fcn

MESH POINT INFORMATION

ID#	x	y	z	Resp. Fcn ID

Meshpoint data can be found in the meshpoints file

A comprehensive list of dose calculation points (defined invividually or as part of a mesh) can be found in the output file

0 dose points were defined as part of 0 meshes.

LIST OF DOSE CALCULATION POINTS

ID#	X	Y	Z	Resp Fcn
1	300 00	0.00	0.00	0

UNCOLLIDED FLUX VALUES FOR EACH DETECTOR POINT
FOR GROUPS NOT SHOWN, UNCOLLIDED FLUXES ARE EQUAL TO ZERO.

DET. POINT	X	Y	Z	ENERGY GROUP	UNCOLLIDED FLUX
1	300.00	0 00	0.00	1	0 191798748E+14

Detector Flux Values

IDP	GROUP	FLUX VALUE	PREV. FLUX
1	1	0.38244180E+14	0.38244180E+14
1	2	0.92603752E+13	0.92603752E+13
1	3	0.55267384E+13	0.55267384E+13
1	4	0.48205073E+13	0.48205073E+13
1	5	0.39085977E+13	0.39085977E+13
1	6	0.23326590E+13	0.23326590E+13
1	7	0 24418268E+13	0.24418268E+13
1	8	0 14902639E+13	0.14902639E+13
1	9	0 35303663E+12	0.35303663E+12
1	10	0.14173898E+13	0.14173898E+13
1	11	0.21121978E+13	0.21121978E+13
1	12	0.19126101E+13	0.19126101E+13
1	13	0.21815767E+13	0 21815767E+13
1	14	0.19284403E+13	0 19284403E+13
1	15	0.72736172E+12	0.72736172E+12
1	16	0.69584408E+12	0.69584408E+12
1	17	0.48379291E+12	0.48379291E+12
1	18	0.33988467E+12	0.33988467E+12
1	19	0.40712959E+12	0.40712959E+12
1	20	0.32689550E+12	0.32689550E+12
1	21	0.31881085E+12	0.31881085E+12
1	22	0.51860676E+13	0.51847380E+13
1	23	0.95728353E+11	0.95728353E+11
1	24	0.19881393E+13	0 19881393E+13
1	25	0.46339536E+13	0.46339536E+13
1	26	0.65979246E+12	0.65979246E+12
1	27	0.21955192E+13	0 21955192E+13
1	28	0.92654030E+12	0.92654030E+12
1	29	0 12951381E+14	0.12849763E+14
1	30	0.14729550E+13	0.14619167E+13
1	31	0.19372436E+13	0 19259426E+13
1	32	0 19137139E+13	0 19008824E+13
1	33	0.14605006E+13	0.14512141E+13
1	34	0.19243405E+13	0.19127781E+13
1	35	0.35402967E+13	0 35231430E+13
1	36	0 22446337E+13	0 22334370E+13
1	37	0.31510794E+13	0 31343017E+13
1	38	0.63757783E+13	0.63368824E+13
1	39	0.47269465E+13	0 46913600E+13
1	40	0.72398356E+11	0.71881966E+11

detector response values

idp	response value	prev. response

VITA

William Bird was born in Honolulu, Hawaii on September 3, 1976 He attended public schools in Virginia, Kentucky, and Tennessee before enrolling in The University of Tennessee in August of 1994 In May, 1998 he graduated Summa Cum Laude with a Bachelor of Science in Nuclear Engineering

During the course of his undergraduate and graduate work, he has completed several work assignments in the nuclear power industry and in National Labs under the United States Department of Energy As a graduate student, he was the recipient of a Department of Energy Nuclear Engineering/Health Physics Fellowship