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Characterization of 2 MeV, 4 MeV, 6 MeV and 18 MeV Buildup Caps for Use With a 0.6 Cubic Centimeter Thimble Ionization Chamber

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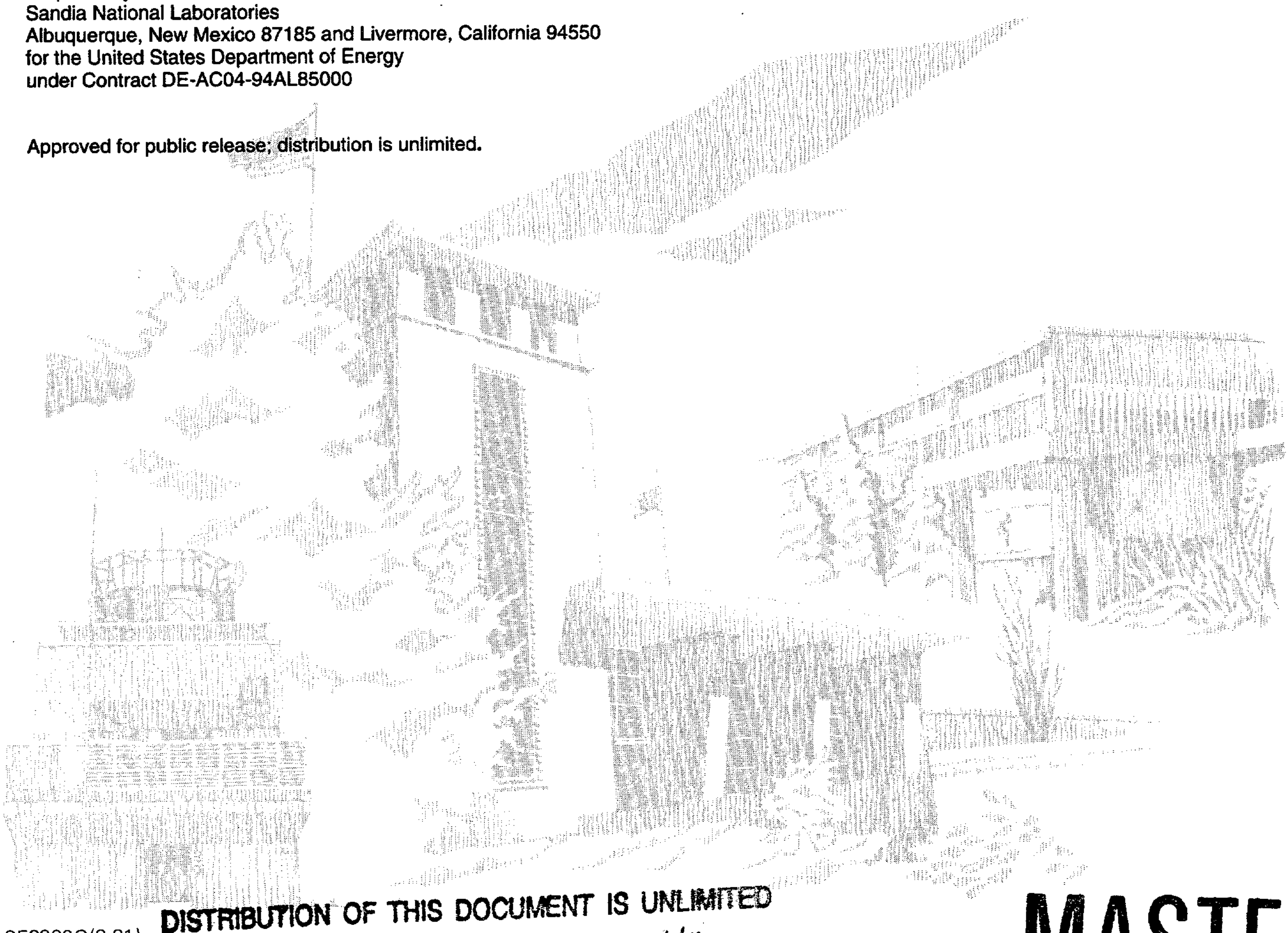

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CHARACTERIZATION OF 2 MEV, 4 MEV, 6 MEV AND 18 MEV BUILDUP CAPS FOR USE WITH A 0.6 CUBIC CENTIMETER THIMBLE IONIZATION CHAMBER

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Abstract

The purpose of this research is to characterize existing 2 MeV, 4 MeV and 6 MeV buildup caps, and to determine if a buildup cap can be made for the 0.6 cm^3 thimble ionization chamber that will accurately measure exposures in a high-energy photon radiation field.

Two different radiation transport codes were used to computationally characterize existing 2 MeV, 4 MeV, and 6 MeV buildup caps for a 0.6 cm^3 active volume thimble ionization chamber: **ITS**, The Integrated TIGER Series of Coupled Electron-Photon Monte Carlo Transport Codes; and **CEPXS/ONEDANT**, A One-Dimensional Coupled Electron-Photon Discrete Ordinates Code Package. These codes were also used to determine the design characteristics of a buildup cap for use in the 18 MeV photon beam produced by the 14 TW pulsed power HERMES-III electron accelerator.

The maximum range of the secondary electron, the depth at which maximum dose occurs, and the point where dose and collision kerma are equal have been determined to establish the validity of electronic equilibrium. The ionization chamber with the appropriate buildup cap was then subjected to a 4 MeV and a 6 MeV bremmstrahlung radiation spectrum to determine the detector response.

The radiation transport code analysis has predicted that the buildup caps are accurate for a bremmstrahlung spectrum, but not for monoenergetic photon beams. For the 4 MeV and 6 MeV buildup caps, electronic equilibrium is established when a typical spectrum from a medical linear accelerator is used as the source term in the radiation transport code analysis.

The RADCAL 1515 radiation monitor and an XRADIN 0.6 cm^3 thimble ionization chamber were used in the verification of the response of the 4 MeV and the 6 MeV buildup caps. An in-air exposure to calibrated 4 MeV and 6 MeV x-ray beam spectrums with appropriate buildup caps was performed. Analysis using an adaptation of the N_{gas} method resulted in dose variations of less than one percent and two percent, respectively, for the caps.

The results of the 4 MeV and 6 MeV analysis were used as a guide to determine the characteristics of a buildup cap for an 18 MeV photon spectrum. These characteristics were used as inputs for the transport codes and a design for an 18 MeV buildup cap is proposed.

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Chapter 1

Introduction

1.1 Purpose

Thimble ionization chambers are used for high-energy dosimetry. Typically, these chambers are used to evaluate the beam calibration for medical therapy accelerators. Phantoms to simulate the human body are used to determine the absorbed dose, in Grays, at a certain depth in tissue. The absorbed dose is determined by applying correction factors to readings from an electrometer. For medical applications, this method has been well developed and the correction factors are widely known. However, there are accelerator facilities, which are not involved in medical therapy, where a direct reading exposure value, in Roentgens, would prove beneficial. Cember [1] states that it is "impossible to build an instrument that meets the criteria for measuring the roentgen" at energies above 3 MeV. Since there is a need to make direct exposure readings in Roentgens for high-energy accelerator facilities, this research has set out to study this possibility.

Much research has been done to determine the characteristics of thimble ionization chambers and their Co-60 calibration buildup caps. However, evaluations of 4 MeV and 6 MeV buildup caps were not found in the literature. Also, there was nothing found in the literature describing applications of buildup caps for in-air measurements at energies higher than the Co-60 calibration energy.

The purpose of this research is to characterize existing 2 MeV, 4 MeV and 6 MeV buildup caps, and to determine if a buildup cap can be made for the 0.6 cm^3 thimble ionization chamber that will accurately measure exposures in a high-energy photon radiation field.

1.2 Thimble Ionization Chambers and Bragg-Gray Theory

The most common forms of the thimble ionization chambers are the spherical and cylindrical shapes with active volumes of 0.1 to 3 cm^3 [2]. A thimble ionization chamber, Figures 1.1 and 1.2, is a type of cavity ionization chamber that the Bragg-Gray Cavity theory addresses.

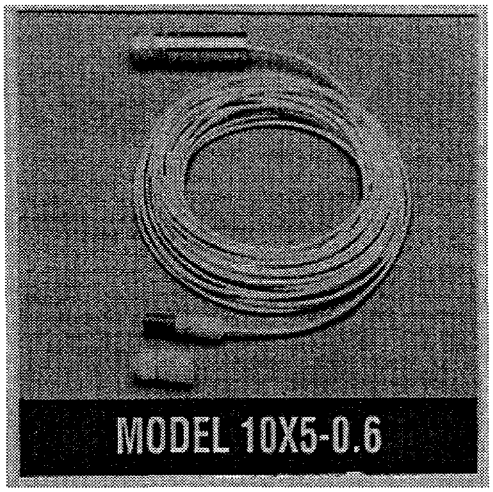

Figure 1.1: Thimble ionization chamber with 12 meter cable.

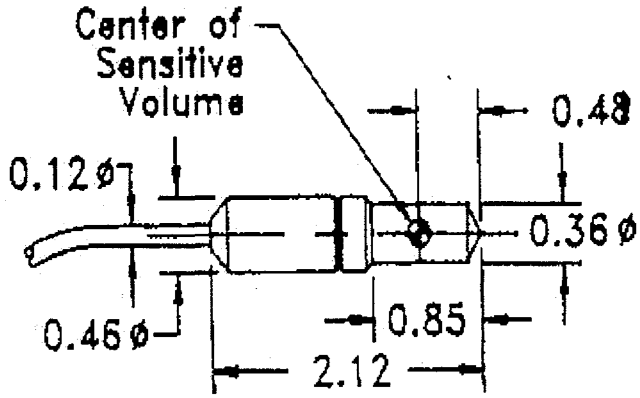

Figure 1.2: Details of a 0.6 cm^3 thimble ionization chamber.

Such thimble ionization chambers contain a cavity filled with a gas and are surrounded by a material that is usually equivalent to air or tissue in its radiation transport properties.

The absorbed dose can be determined in any material by applying the Bragg-Gray theory to measurements made by a cavity ionization chamber with walls constructed from the material of interest. When the wall material is air equivalent, the dose to the wall will be directly related to the exposure in air at that location.

The Bragg-Gray theory addresses the problem of relating the absorbed dose in a thimble ionization chamber inserted into a medium to that of the medium itself. In principal, the Bragg-Gray theory says that there is a relationship between the ionizations produced in a gas-filled cavity and the absorbed dose in a solid medium surrounding the cavity. A thimble ionization chamber, by definition, will satisfy the Bragg-Gray condition that the size of the gas-filled cavity be small enough that the angular and velocity distributions of the primary electrons remain unchanged. However, the other condition, which pertains to the thickness of the ionization chamber wall, is not necessarily a defining characteristic of a thimble ionization chamber. The walls must be the proper thickness for the energy of the radiation being measured. A wall that is too thin results in an insufficient number of photons interacting to produce primary electrons. If the wall is too thick, the incident photons will be absorbed, resulting in an attenuated primary electron flux. The proper thickness will ensure that all of the electrons entering the gas-filled cavity are from the wall material and that no significant attenuation of the beam occurs. This implies that there is an optimum wall thickness depending on the incident photon energy. Therefore, a cavity ionization chamber is designed with a certain wall thickness for a finite photon energy range. To go beyond this energy range one must utilize additional ionization chambers or provide a mechanism that extends the thickness of the ionization chamber walls; this can be accomplished through the use of buildup caps.

1.3 Buildup Caps for Thimble Ionization Chambers

The buildup cap construction is simple; a material with the desired properties is securely attached over the ionization chamber to minimize the air gaps. An example of this can be seen in Figure 1.3. Buildup caps may be constructed of many differing materials depending on the intended use (Figure 1.4). The more common materials are air equivalent plastics (C552, delrin, polystyrene) and tissue equivalent plastics (A-150, Lucite, Plexiglas, and Perspex). There are also buildup caps made of nylon, graphite, aluminum, and other similar metals. Because of the conditions set forth in the Bragg-Gray relationship, it is best to create a buildup cap from the same material as the ionization chamber walls.

For photon energies ranging from about 200 KeV to 2 MeV, a well designed air equivalent thimble ionization chamber with matching buildup cap material will exhibit a response that is relatively energy independent [3]. For this range of energies in air, the Compton effect predominates, and the detector is said to exhibit a flat response (Figure 1.5).

As the material departs from air equivalence, the response of the ionization chamber

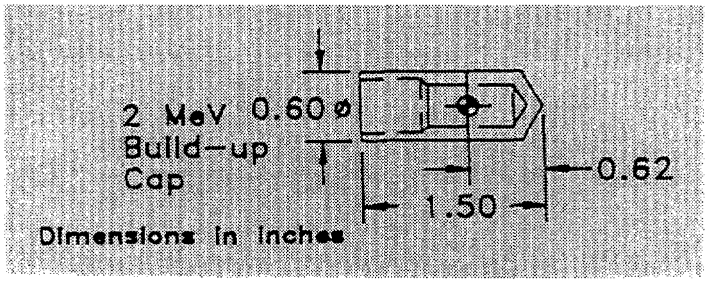

Figure 1.3: Details of buildup cap placed over a thimble ionization chamber.

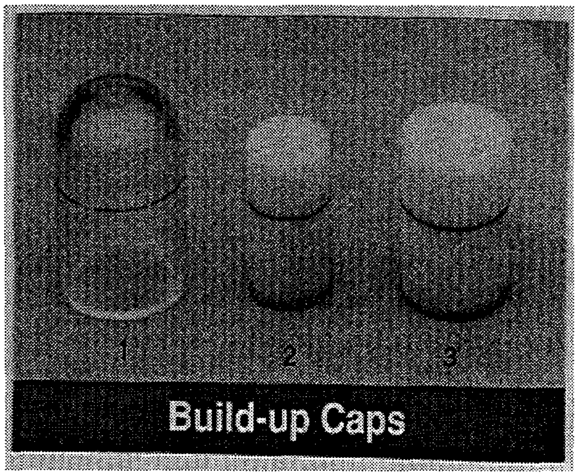

Figure 1.4: (1) Acrylic cap for a 6.0 cm^3 ionization chamber for Co-60 and Cs-137 calibrations, (2 & 3) Delrin caps for 4 MeV and 6 MeV energies for a 0.6 cm^3 thimble ionization chamber.

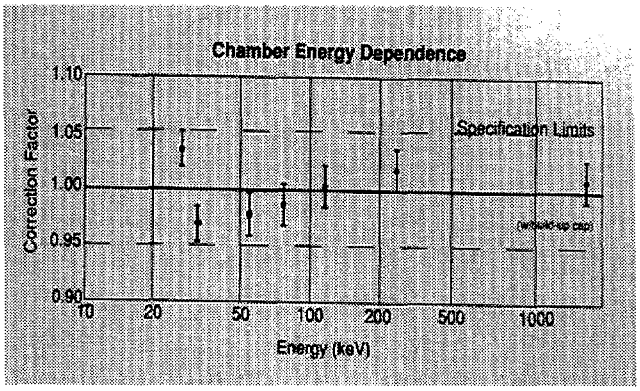

Figure 1.5: Flat response of a 0.6 cm^3 thimble ionization chamber with Co-60 calibration buildup cap.

becomes increasingly energy dependent. For the purpose of exposure determination over a wide range of energies, it is best to use a material that has radiation transport properties similar to that of air. Air equivalent materials have attenuation and stopping power properties that approximate those for air at any given photon/electron energy. To accomplish this, the effective atomic number of the material should be very close to that of air.

1.4 Computer Codes Used for Radiation Transport Analysis

Radiation transport analysis involves following the migration of particles through matter. Interactions within the matter have an influence on the energy and direction of the particle. There are basically two theories used to analyze this migration through matter: diffusion theory and transport theory. Diffusion theory, based on the diffusion equation, is widely accepted and is considered the most useful approximation for performing neutronic analyses. However, diffusion theory is poorly suited for particle migration that is highly forward peaked with interactions that are weakly scattered and highly absorbing [4].

Transport theory, while much more computationally intensive, is better suited than the diffusion theory for an analysis where a neutral particle may be completely absorbed or where very few scattering interactions may occur. There exists two dominant techniques for solving the transport equation of transport theory: Monte Carlo and deterministic.

Monte Carlo techniques are used in computer simulations of the migration of particles in matter. The simulations can produce detailed information of how ionizing radiation is transported through matter. As radiation migrates through matter, there is a probability that a charged particle, photon, or neutron will interact with atoms and nuclei of the material it is traversing. These interactions may result in the particle being scattered or absorbed, thus depositing energy into the material and producing secondary particles within the medium. It is not possible to predict the exact path the particle will take; however, it is possible to predict the distribution of paths and distances for a large number of particles [5]. Nature apparently "rolls the dice" in some way to choose how far and in what direction a given particle will travel. A random number generated by a computer simulates the Monte Carlo technique of rolling the dice. This random number is used to pick the individual flight distances for each particle simulated. By repeating this technique, a large number of particles are simulated, resulting in an observed distribution that is a statistically accurate representation of a photon field fluence through a medium. This distribution is then used to estimate the dose in the medium.

In contrast to the "roll of the dice" method in Monte Carlo techniques, deterministic transport computer codes calculate a numerical solution using a discretized linear Boltzmann transport equation and associated boundary conditions. In this form, the Boltzmann equation and appropriate boundary conditions result in a unique solution consisting of a complete deterministic distribution of particles for the problem as modeled throughout the space, energy, direction-of-motion, and time (if applicable) in the material [4]. This information is then used to estimate the dose and kerma for the material of interest.

It should be mentioned that there are errors, either statistical or methodological associated with each method described above. In stochastic transport or Monte Carlo techniques, errors arise due to statistical estimates of the dose during the transport simulation. As the number of estimates approch infinity, the overall errors in the calculation approach zero, and the estimate of the dose converges to the exact value. Since the number of histories can never be infinity, there is always an error associated with a Monte Carlo calculation. However, since the overall domain of the calculation can be resolved exactly, there are no errors due to approximations in either the boundary conditions or source representation. This is in direct contrast to discrete ordinates methods which are derived by approximating both the domain and the source term, over which the Boltzmann equation is satistified. In this method, there are no statistical errors but there are those arising from the description of the approximate domain and approximate source definition.

Chapter 2

Theory

2.1 Introduction

The basis for any research in radiation physics is the interaction of radiation with matter. In this section, the photon interactions at both low and high energies are of interest. Of particular interest is how these interactions affect the production of electrons and the characteristics of these electrons in a material of interest.

Bragg-Gray Cavity theory and the Spencer-Attix Formulation of the Bragg-Gray Cavity theory will be reviewed in this chapter. Conditions required by cavity theory for the design of a thimble ionization chamber and the application of the Spencer-Attix Formulation, which accounts for the low energy electron contributions in high energy photon measurements, are examined. Additionally, how these theories and formulations are applied to in-beam measurements of high energy bremsstrahlung fields using buildup caps are explained. Finally, the extrapolation of an in-beam dose measurement in a full phantom to a dose to a mini-phantom or buildup cap and, ultimately, to an in-air exposure measurement will be conducted. The extrapolation is permitted because of the cavity-gas calibration factor, N_{gas}, which is fully developed at the end of this chapter.

There are two items that must be addressed to build a foundation for the extrapolation of the in-beam dose measurement theories to an in-air exposure measurement. One is the concept of Charged Particle Equilibrium (CPE), and the other is Transient Charged Particle Equilibrium (TCPE). A knowledge of these concepts will be helpful in understanding the thickness requirement in the design of the walls of an ionization chamber and buildup caps, and in understanding the characterizations performed on the 2 MeV, 4 MeV, 6 MeV, and proposed 18 MeV buildup caps.

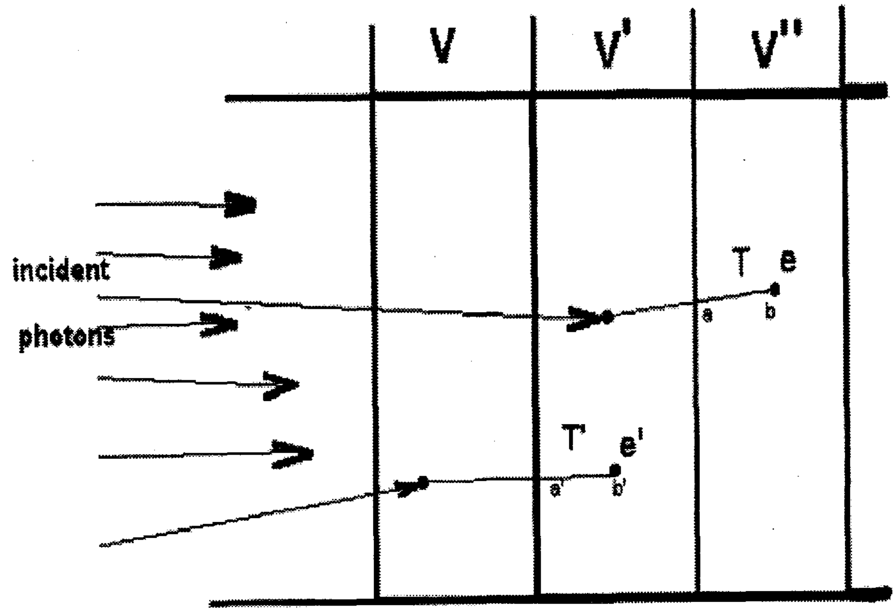

Figure 2.1: A two dimensional representation of electronic equilibrium. Kinetic energy, T', along $a'b'$ is equal to kinetic energy, T, along ab. Path length $a'b'$ is equal to path length ab.

2.2 Charged Particle Equilibrium

The state of charged particle equilibrium means that in any volume element, the charges entering and/or leaving that volume element will be exactly balanced [3]. To achieve this balanced state, several conditions must be met: the first is that the atomic composition of the material must be homogeneous, this implies that each volume element shall have a similar Z-value, stopping power, attenuation and absorption characteristics [6]; second, that the density of the medium must be homogeneous; third, that there exists a uniform field of indirectly ionizing radiation, this implies that the incident photons will not be appreciably attenuated as they pass through the medium; and fourth, that no inhomogeneous electric or magnetic fields are present [6].

Statistically, over a small volume of homogeneous medium in a continuous uniform field of photons, the compensation that occurs when electronic equilibrium is established will be exact. Figure 2.1 shows this compensation in a two dimensional representation.

In Figure 2.1, the incident photon field may be plane-wave or isotropic and monoenergetic or spectral in nature. The incident photon field produces a migrating electron in the volume element V. The electron, e', possesses kinetic energy, T', as it travels into volume element V', where it remains. The path traveled in V' is $a'b'$. The electron deposits an amount of energy equal to the kinetic energy, T', that it had when it entered volume element V'. In the *nonstochastic limit*, a photon will strike an electron within the volume element V', and transfer a sufficient amount of kinetic energy to electron e, such that it will carry an amount of energy equal to T out of V' and into the adjacent volume element V''. As the amount of energy removed from one volume element by an electron is replaced by an identical amount of energy from another electron, then charged particle equilibrium is said to exist if on the average kinetic energy T' is equal to kinetic energy T.

The existence of equilibrium conditions will be determined for the ionization chamber with the 2 MeV calibration buildup cap, the 4 MeV buildup cap, and the 6 MeV buildup cap. Once equilibrium conditions are validated, additional analyses will be performed to fully characterize the 4 MeV and 6 MeV buildup caps. Finally, a thickness sufficiently thick to provide equilibrium conditions will be determined for the proposed 18 MeV buildup cap.

2.3 Transient Charge Particle Equilibrium

Transient charged particle equilibrium is a condition that occurs in materials when exposed to high energy photon fields. The high energy photons incident upon a material will interact and produce secondary particles in the form of free electrons able to migrate through the material. The penetrating power of these secondary electrons increases more rapidly than the penetrating power of the incident high energy photon as the energy is increased [2]. Applying this to the design of an 18 MeV buildup cap means that as the energy of the photons increases so must the thickness of the buildup cap increase to achieve equilibrium conditions. However, a thicker buildup cap will create a situation whereby the proportion of incident photons attenuated at a certain depth in the material will be greater than the proportion of electrons able to penetrate to that depth in the material. Relating this back to Figure 2.1 and charged particle equilibrium, there will be more electrons migrating into volume elements beyond, V″, from all of the volume elements up stream, than will be created in, V″, and leave. In other words, more electrons are created in the volume elements near the surface and they penetrate further into the material, while the photons are attenuated before they reach the deeper volume elements, thus not creating as many electrons. Therefore, the attenuation of the incident beam and the greater range of the secondary electrons will cause CPE to fail.

Exposure measurements of x-rays and gamma rays depend on the existence of CPE. The failure of CPE at high energies, usually above 3 MeV, is the reason that exposure measurements are not considered practical for photon energies above 3 MeV. However, if there existed another known relationship between the dose in air and kerma in air, then exposures for high energy photon fields could be measured. The known relationship is TCPE and is based on subdividing kerma into its collisional and radiative parts [7].

There is great difficulty in measuring kerma for high energy photons. Attix [7] has shown that by dividing kerma into its collisional part and its radiative part, according to the fate of the kinetic energy transferred to the secondary electrons, that air collision kerma in free space can be determined for energies higher than the accepted a-few-MeV limitation. Air collision kerma can then be related to the exposure for a monoenergetic field by:

$$X = \psi \left(\frac{\mu_{en}}{\rho}\right)_{E,air} \left(\frac{e}{W}\right)_{air} = (K_c)_{air} \left(\frac{e}{W}\right)_{air} = \frac{(K_c)_{air}}{33.97} \tag{2.1}$$

and for a photon spectrum by:

$$X = \int_{E=0}^{E_{max}} \left(\frac{\mu_{en}}{\rho}\right)_{E,air} \left(\frac{e}{W}\right)_{air} \psi'(E)\,dE \tag{2.2}$$

where, ψ is the monoenergetic photon fluence in J/m^2, ψ' is in J/m^2-keV for the spectrum, $(\mu_{en}/\rho)_{E,air}$ is the mass energy-absorption coefficient for air at energy E in m^2/kg, K_c is the collisional part of kerma in J/kg, $(e/W)_{air}$ is the reciprocal of the mean energy expended in a gas per ion pair formed and is equal to 1/33.97 C/J, for air X is the exposure in C/kg, and the integral is evaluated with dE in keV. Conversion from the exposure in C/kg to the Roentgen (R) is as follows:

$$X(R) = 3876.0\,X\left(\frac{C}{kg}\right) \tag{2.3}$$

Attix considered measurements of exposure for high energy photons using an air cavity chamber having air equivalent walls thicker than the maximum range of these high energy secondary electrons. When the wall of the chamber is thicker than the range of the most energetic electron produced by the high energy photon beam, the wall begins to attenuate the incident photon beam and CPE fails. However, if the energy of the incident photon

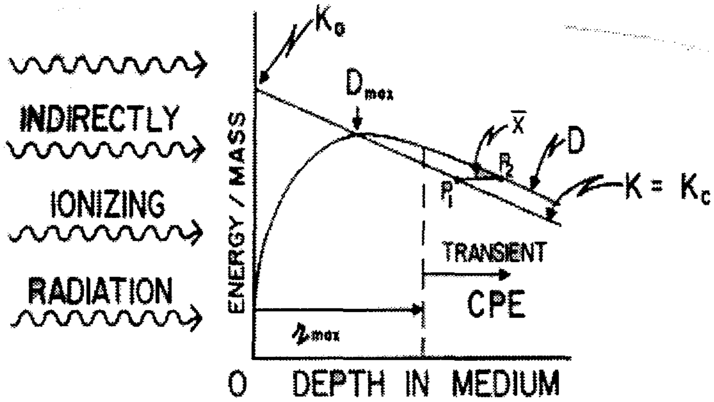

Figure 2.2: TCPE for high energy photons, where radiative losses are assumed to be absent; therefore, kerma equals collision kerma.

beam is sufficiently large and the thickness of the material is not so that it substantially attenuates the photon beam, then a condition of transient charged particle equilibrium (TCPE) may exist. This optimum thickness for TCPE is the basis upon the design for an 18 MeV buildup cap will be proposed.

TCPE is said to exist at all points within a region where dose (D), is proportional to collision kerma (K_c), with the constant of proportionality being greater than unity [2].

The figures above present the results of a clean (absent of charged particles) broad beam of high energy photons. The beam should be at least twice the diameter of the maximum range of secondary charged particles. For low Z materials (carbon, air, water) the radiative part of kerma (K_r) is small, less than 1 percent [7]. D_{max} occurs at the depth where the rising slope (due to buildup of charged particles) is balanced by the descending slope (due to attenuation of the incident photon field). For pure broad photon beams, D_{max} occurs at the depth where the dose curve crosses the collision kerma curve. The dose curve becomes parallel to the kerma curves at the depth, r_{max}, which is the maximum range of the secondary charged particles that started at the surface of the material. When D and K_c are taken from the same depth, μ' is the slope of the parallel curves, and $\overline{X}$ (Figure 2.2, points $P1$ and $P2$) is the mean distance the secondary charged particles carry their kinetic energy in the direction of the primary rays.

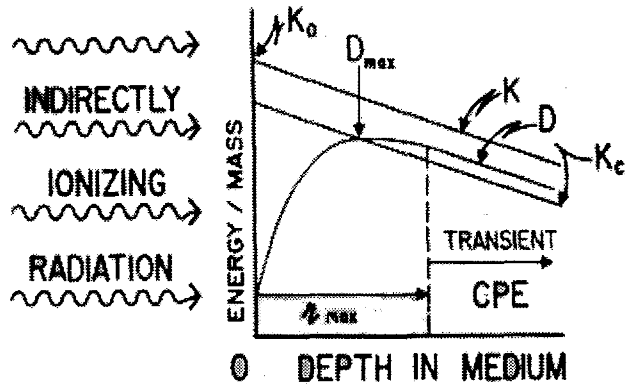

Figure 2.3: TCPE for high energy photons, where radiative losses are significant, kerma equals the sum of the radiative and collisional terms of kerma.

Under conditions where the charged particles remain close to their depth of origin, the dose curve and the collision kerma curve would coincide at all depths and CPE would exist. Therefore, for high energy photon beams incident upon a mass sufficiently large to allow TCPE, the following equation, in principal, can be applied:

$$D \stackrel{TCPE}{=} K_c \left(1 + \mu \overline{X}\right) \tag{2.4}$$

In the above equation, D and K must be at the same depth where TCPE exists, μ' is the slope, which is common to D, K, and K_c, and $\overline{X}$ is the mean path length of the electrons in the direction of the primary rays. When radiative losses are significant, kerma $= K_c \left(\mu_{tr}/\mu_{en}\right)$ with the resulting photons escaping.

For the case where the radiative part of kerma is significant, Figure 2.3, D and K_c maintain the same relationship. However, K_o is no longer equal to K_c, but rather it is the sum of the collisional and radiative parts of kerma. The radiative losses amount to $K_r = \left(\mu_{tr} - \mu_{en}\right)/\mu_{tr} K$. The radiative loss photons are assumed to escape. However, the primary interactions between high energy photons and air equivalent materials are Compton interactions. Therefore, radiative losses for the material used in the evaluation of an 18 MeV buildup cap are essentially nonexistent. With high energy photons, Equation 2.4 illustrates that D and K_c, in principal, are proportional and therefore can be evaluated where TCPE conditions exist.

2.4 Bragg-Gray Cavity Theory

To obtain meaningful measurements of a photon field with an ionization chamber, the Bragg-Gray cavity theory must be satisfied. The Bragg-Gray relationship states that the ionization produced in a small gas-filled cavity in a homogenous medium by a uniform field of ionizing radiation is proportional to the absorbed dose in that medium. Bragg-Gray theory has two central conditions that must be met. One of the conditions is that the thickness of the gas layer, or cavity, be small so that its presence does not perturb the charged-particle field nor create secondary electrons in the gas from incident photon interactions [2]. Additionally, any charged particle entering the cavity must not stop, or be absorbed, in the cavity gas. The second condition is that the charge being collected in the cavity must be due to electrons that originate in the wall material surrounding the cavity [2]. The ionization chamber must satisfy both the Bragg-Gray conditions and the conditions for charged particle equilibrium over the energies of the exposure. For high energy photon fields, the conditions for transient charged particle equilibrium must be satisfied.

The absorbed dose from a fluence, Φ, of identical charged particles with kinetic energy, T, and passing through the interface between two media, g and w, is as follows:

$$D_g = \Phi \left(\frac{dT}{\rho dx}\right)_{c,g} \tag{2.5}$$

$$D_w = \Phi \left(\frac{dT}{\rho dx}\right)_{c,w} \tag{2.6}$$

where the mass collision stopping powers of the two materials are $(dT/\rho dx)_{c,g}$ and $(dT/\rho dx)_{c,w}$. If the fluence is continuous across the interface, then the ratio of the absorbed doses is as follows:

$$\frac{D_w}{D_g} = \frac{\left(\frac{dT}{\rho dx}\right)_{c,w}}{\left(\frac{dT}{\rho dx}\right)_{c,g}} \tag{2.7}$$

The above equation holds true for the case where the layer, g, is thin and an additional layer, w, is added to the opposite side of the g layer. The g layer must be of a thickness that satisfies the first Bragg-Gray condition – that the size of the cavity must be small so as not to perturb the equilibrium spectrum of charged particles. The condition is dependent upon the scattering properties of both materials g and w. The properties of the materials must be similar; the mean path length, in g/cm^2, of the particles traversing layer g is identical to the value if g were replaced by a layer of w equal in g/cm^2 or, in other words, the same mass thickness. It is implied that back scattering at the different material interfaces is similar.

When layer g is a gas and in that gas a charge is produced by the radiation, a relationship between dose and charge can be written

$$D_g = \frac{Q}{M}\left(\frac{W}{e}\right)_g \tag{2.8}$$

where the dose is in Grays, the charge, Q, is in Coulombs, m is the mass of gas in kg, and W/e is the energy needed to produce an ion pair in the gas expressed in J/C. Substituting the above relationship into Equation 2.8 results in the Bragg-Gray relationship below

$$D_w = \frac{Q}{M}\left(\frac{W}{e}\right)_g \frac{\left(\frac{dT}{\rho dx}\right)_{c,w}}{\left(\frac{dT}{\rho dx}\right)_{c,g}} \tag{2.9}$$

It is common practice to use the symbol ${}_m\overline{S}_g^w$ to represent the ratio of the mean unrestricted collision mass stopping powers that yields the following equation.

$$D_w = \frac{Q}{M}\left(\frac{W}{e}\right)_g {}_m\overline{S}_g^w \tag{2.10}$$

Equation 2.10, relates the cavity ionizations, or charge produced in the gas, to the absorbed dose in layer w. When layers w and g are replaced by a small probe such as a thimble ionization chamber and the charge produced in the gas cavity is collected by a dosimeter, then the absorbed dose in the cavity can be related to the absorbed dose in the wall of the ionization chamber. In turn the dose to the walls can then be related to the dose in a material of interest when the probe is placed into the material.

Bragg-Gray theory, in itself, does not require CPE or a homogeneous field of radiation [2]. However, it does require that the charged particle fluence be the same in both the cavity and the wall where the dose is to be determined. Even though the Bragg-Gray relationship does not require CPE conditions, the measurement of exposure does.

An ionization chamber, which meets the conditions for a Bragg-Gray cavity, can be placed in the location of CPE in a material of interest. It can be assumed that the cavity will not perturb the equilibrium spectrum of charged particles at that point. The ionization chamber approximates a cavity so Equation 2.10 applies. Thus the charge collected by the dosimeter can be related to the dose delivered to the material of interest at the location of the ionization chamber.

The Bragg-Gray theory and charged particle equilibrium are the foundation for which the analysis of the thimble ionization chamber with 2 MeV calibration buildup cap is possible. By applying the Spencer-Attix formulation to the Bragg-Gray theory, the 4 MeV and 6 MeV buildup caps can be accurately characterized. Transient charged particle equilibrium, as defined by Attix [7], allows for the possibility of developing a buildup cap for high energy dose measurements. And as will be evident later, when all of these are combined with additional protocols, in-air exposure measurements of high energy photon beams may be possible.

2.5 Ionization Chambers and Thimble Ionization Chamber Design

Ionization chambers come in a variety of shapes and sizes and are attached to electronics that create signals based on the ion pairs formed in the gas cavity. All of the charges of one sign are collected through the application of an electric field. When the electric field is applied, the positive and negative charges represented by the ions and electrons, will drift in the direction of the collecting electrodes, creating an electric current. Under steady-state irradiating conditions, a constant rate of ion pairs will form in a given volume of gas. In the case of a small test volume of gas, the ion pair formation rate will be exactly balanced by the rate at which ion pairs are lost through collection, assuming that recombination is negligible and all the charges are efficiently collected. The steady-state current produced is an accurate measure of the rate at which ion pairs are formed within the volume. The basic purpose of an ionization chamber is to measure this ionization current.

The basic element of an ionization chamber is a volume of gas with an externally applied electric field. Free-air ionization chambers are widely used for accurate exposure measurements for gamma-ray energies below 100 keV. At energies above 100 keV, the larger range of the secondary electrons creates some difficulties. To prevent ionization loss from these highly energetic secondary electrons reaching the electrodes, the dimensions of the chamber must become impracticably large. Therefore, gamma-ray exposure measurements at higher energies are conventionally carried out in cavity chambers where a small volume of gas is surrounded by a solid material. Air is the most common fill gas and is required in those chambers designed for measuring x- or gamma-rays [1]. The fill gas pressure is usually at 1 atm, although many ionization chambers are open and corrections for temperature and pressure are necessary to determine the mass of the gas (M), as used in Equation 2.8.

Geometries for ionization chambers vary and are usually chosen to suit the application. The most important geometrical consideration is that the electric field throughout the active volume be maintained high enough to provide high ion collection efficiency. Spherical and cylindrical geometries are common. The outer shell, or wall of the cylinder, is operated at ground potential and a central conduction rod carries the applied voltage. The wall must be made of a conducting material or have a conductive coating, such as graphite, to distribute the charge uniformly around the cylinder. The thickness of the wall must be thicker than the range of the most energetic secondary electrons. Thicker, however, does not allow one to construct a chamber by simply using an enormous amount of wall material. If the wall is too thick, it will significantly attenuate the incident radiation. If it is too thin, very few interactions will occur in the wall, thus not producing a sufficient number of ionizations. There is an optimal thickness, although manufacturers use a "rule of thumb" where by they make the wall approximately twice as thick as the maximum range of the secondary electrons. The optimal thickness is called the equilibrium wall thickness and is just equal to the range of the most energetic secondary electrons produced in the wall material. At such a thickness, electronic equilibrium is established [1].

As with geometry, the choice of materials depends upon the purpose or intended use of the ionization chamber. The intensity and type of radiation along with its rate of change in space and time are factors that influence both the materials used and the geometry. Additionally, whether the ionization chamber is to be used to measure exposure or absorbed dose, impacts the decision regarding materials to be used in the construction of the ionization chamber. In general terms it can be said that these conditions impose an upper limit on the chamber dimension, and particularly on the dimensions of the gas cavity, but do not, in practice, impose a lower limit [8]. The lower limits are a result of the limitations in mechanical design and the need to obtain an adequate ionization current. The Bragg-Gray theory does not dictate chamber geometry, and the choice of material is primarily a function of the quantity to be measured. If exposure, in Roentgens, is to be measured, the chamber must be made from air-equivalent materials. If the absorbed dose in a particular material is to be measured, then both wall and gas should be matched to this material.

Since the chamber wall not only acts as a source of secondary electrons, but absorbs and scatters the primary radiation, it is undesirable to make it any thicker than necessary. In 1937, L.H. Gray made some interesting observations regarding the production of secondary electrons. Gray discovered that one-half of the total ionizations produced by gamma rays from radium in a small graphite chamber are due to electrons originating within 0.2 mm of the surface of the cavity. He also noticed that the fastest secondary electrons generated had a range of 6 mm, and that only about 10 percent of the total ionizations are due to electrons coming from a depth greater than 0.7 mm citegr:lhim. This suggests that it may not always be essential to make the wall thickness equal to the maximum range of the secondary electron.

However, when the walls are neither thick nor thin with respect to the range of the secondary electrons, an unfortunate situation arises. The energy deposited in the cavity will be due to either a mixture of charged particles originating throughout the material , or a supply of secondary charged particles inadequate for equilibrium [2]. Measurements made of photon radiation with an ionization chamber that has not been properly designed with respect to the thickness of the walls to account for the energy of the incident particles, will be very difficult to interpret. The measurements will not represent the charged nor the uncharged particle field at the undisturbed point of measurement, resulting in inaccurate readings from the detector.

An ionization chamber, while accurate over a large range of energies, cannot be accurate at all energies. A thimble ionization chamber with a calibration buildup cap calibrated at Co-60 energies, will exhibit a flat response over an energy range of tens of KeV to about 2 MeV [9]. If the energy of the incident photon field is increased beyond 2 MeV, the thickness of wall material must be increased. To ensure CPE at high photon energies, a buildup cap of a similar material could be added; however, this is rarely done. The typical use for a thimble ionization chamber is to place it in a tissue equivalent phantom for the purpose of calibrating a therapy beam. If the tissue equivalent phantom were to be changed to an air equivalent phantom and the ionization chamber with phantom was to be placed far from any source of scatter, then an in-air exposure measurement might be possible.

Now suppose that a small part of the phantom is removed and replaced with air. By applying cavity theory, the absorbed dose can be calculated at that point. According to Bragg-Gray theory, there should be no change in the electron fluence coming from the wall; TCPE is maintained. Therefore, the dose at that point will be proportional to the ratio of the collision mass stopping powers of the gas to the wall material. Since only a small volume of material was removed and replaced with air, there will be secondary electrons with ranges greater than the small cavity. In this case, the electrons do not loose all of their energy while crossing the cavity producing ionizations in the gas. The energy retained by the secondary electrons does not produce a dose in the gas, thus some energy is not accounted for in the dose calculation. Compensation for this small loss can be accomplished by applying the Spencer-Attix formulation of the Bragg-Gray relationship.

The Spencer-Attix formulation divides the electrons into two groups. The energy of an electron that can just cross the gas cavity is designated as the cutoff energy. Secondary electrons with energy less than the cutoff value are considered to deposit all of their energy at the point where they were produced. The secondary electrons that have energies above the cutoff are included in the electron spectrum until their energy has dropped below the cutoff. Therefore, the mean unrestricted collision mass stopping power, ${}_m\overline{S}_g^w$, of the Bragg-Gray theory, is replaced by the mean restricted collision mass stopping power, $\left(\overline{L}/\rho\right)_g^w$, of the Spencer-Attix formulation.

Now that the Spencer-Attix formulation has been applied to the Bragg-Gray relationship for an ionization chamber satisfying both the Bragg-Gray conditions and those for TCPE, it is possible to evaluate the ionization chamber in terms of the absorbed dose in the cavity gas. This is especially useful since a calibration factor such as this would be applicable to all low linear energy transfer (LET) radiations where W/e is constant. A protocol for this was developed in 1983 by the American Association of Physicists in Medicine for radiotherapy applications [10]. The protocol defines a quantity called the cavity-gas calibration factor, N_{gas}, for use in calibrating high energy photon beams.

2.6 The Cavity-Gas Calibration Factor, N_{gas}

The average absorbed dose in an ionization chamber's sensitive volume can be related to the dose in another medium that replaces the ionization chamber (that is, if the ionization chamber is at the same location as the medium of interest, and Bragg-Gray cavity theory conditions are met).

The process to relate the dose to the gas in the chamber to that of another medium involves determining the dose to the gas in the cavity first and then transferring this dose to the medium of interest. To accurately accomplish this task, the volume of gas in the ionization chamber must be known to a very small uncertainty; much smaller than the uncertainties in the dose measurement. Since the volume of gas in the chamber is difficult to determine in many instances, a protocol for the determination of the parameter, N_{gas}, has been developed. N_{gas} will be used later in this work to compare the exposure calibration factor reported by Radcal, the secondary calibration laboratory that calibrated the thimble ionization chamber with 2 MeV buildup cap, to the calibrated therapy beam of the medical accelerator. The N_{gas} protocol is based on the work by the Radiation Therapy Committee, Task Group 21, American Association of Physicists in Medicine [10].

N_{gas} is unique for each ionization chamber and does not depend on the composition of the dosimetry phantom. It applies to all ionizing radiation for which (W/e) for air is 33.7 J/C, and can be obtained for any photon beam for which an exposure calibration factor exists. In 1983, 33.7 J/C was the best estimate for the energy required to produce one ion pair in dry air. A value of 33.97 J/C is commonly accepted today [2]. However, all of the variables and parameters in the N_{gas} protocol are based on the previous value, therefore, 33.7 J/C will be used in the determination of the cavity-gas calibration factor.

Exposure, under electronic equilibrium conditions, is related to the dose in-air, which in turn can be related to the dose to the wall of an air equivalent ionization chamber. The dose to the wall is related to the dose to the gas in the cavity of an ionization chamber that meets all of the conditions of Bragg-Gray theory. Exposure can be calculated from the following:

$$X = \frac{1}{k} J_{gas} \left(\frac{\overline{L}}{\rho}\right)_{gas}^{wall} \left(\frac{\overline{\mu}_{en}}{\rho}\right)_{wall}^{air} \frac{1}{\beta_{wall}} \prod_i K_i \tag{2.11}$$

where, X is the exposure in Roentgen, k is the charge produced in-air per unit mass per unit exposure and is equal to ($2.58x10^{-4}$ C kg-1 R-1), wall refers to the ionization chamber wall and buildup cap, J_{gas} is the charge per unit mass of the gas in the chamber in (C/kg), $\left(\overline{L}/\rho\right)^{wall}_{gas}$ is the ratio of the mean restricted collision mass stopping power of the wall material to that of the gas in the cavity for secondary electrons released by Co-60 gamma rays, $(\overline{\mu}_{en}/\rho)^{air}_{wall}$ is the ratio of the mean mass energy-absorption coefficient for air to that of the wall for Co-60 gamma rays, β_{wall} is the quotient of absorbed dose by the collision fraction of kerma in the chamber wall and is equal to 1.005, and $\prod_i K_i$ is a product of factors that account for humidity, ionization recombination losses, stem scatter, correction to zero wall thickness, and other small corrections.

The National Institute for Standards and Testing (NIST), or an approved secondary laboratory, provides calibration factors to users. This is accomplished by comparing the exposure at the center of a graphite chamber under a known exposure rate to the exposure results of the user's chamber under identical conditions. The Co-60 exposure calibration factor N_x, is given by:

$$N_x = \frac{X}{M} \tag{2.12}$$

where, X, is the known NIST exposure rate and, M, is the electrometer reading for the dosimeter. M, is given in Coulombs or scale division at standard temperature and pressure, and is uncorrected for ionization recombination.

For x-rays in the range from 2 to 50 MeV, the dose to the gas in the cavity is given by:

$$D_{gas} = J_{gas}\left(\frac{W}{e}\right) \tag{2.13}$$

where, D_{gas}, is the dose to the cavity gas in Gy, and W/e for room air is 33.7 J/C. The response of the detector is directly related to J_{gas}, when it is corrected for ionization recombination by a correction factor A_{ion}. Also, the quotient of D_{gas} by the detector reading M is a constant and depends on the dimensions and the composition of the ionization chamber. Therefore, by substitution N_{gas} becomes:

$$N_{gas} = \frac{D_{gas}A_{ion}}{M} \tag{2.14}$$

where, N_{gas}, is the dose to the cavity gas in Gy/C or Gy/scale division, and A_{ion} is the ion collection efficiency at the time of calibration.

For the case where the wall of the ionization chamber and the buildup cap are made of the same material, the cavity-gas calibration factor, upon combining Equations 2.11-2.14, becomes:

$$N_{gas} = N_x \frac{K\left(\frac{W}{e}\right) A_{ion} A_{wall} \beta_{wall}}{\left(\frac{\bar{L}}{\rho}\right)_{gas}^{wall} \left(\frac{\bar{\mu}_{en}}{\rho}\right)_{wall}^{air}} \tag{2.15}$$

where, A_{wall}, is a factor that corrects for attenuation and scatter in the wall and buildup cap. When the chamber wall and buildup cap are made of different materials, the value of N_{gas} is calculated by:

$$N_{gas} = N_x \frac{K\left(\frac{W}{e}\right) A_{ion} A_{wall} \beta_{wall}}{\alpha \left(\frac{\bar{L}}{\rho}\right)_{gas}^{wall} \left(\frac{\bar{\mu}_{en}}{\rho}\right)_{wall}^{air} + (1-\alpha) \left(\frac{\bar{L}}{\rho}\right)_{gas}^{cap} \left(\frac{\bar{\mu}_{en}}{\rho}\right)_{cap}^{air}} \tag{2.16}$$

The value of α is the fraction of ionizations due to electrons from the chamber wall, and $(1-\alpha)$ is the fraction of ionizations due to electrons from the buildup cap. The value of N_{gas} should be recalculated any time there is a change in the Co-60 exposure calibration factor N_x. AAPM Protocol-21 provides additional details about the cavity-gas calibration factor [10].

2.7 Dose to a Mini-Phantom

The dose to a mini-phantom, D_m, is the dose at the center of a hypothetical mass of medium sufficiently large to provide charged particle equilibrium. Holt et al. explains that the dose to a full phantom may be determined from in-air measurements at the same point in space but without the medium present, by substituting the full phantom for a mini-phantom [11]. A buildup cap that is sufficiently thick to provide charged particle equilibrium can be considered a mini-phantom. This concept will be developed in this section and later shown to be an accurate substitution.

The dose to a full phantom has been extensively evaluated by [2,10,12], and follows the theories developed by Bragg-Gray and Spencer-Attix. When applying the Spencer-Attix formulation of the Bragg-Gray theory to the concepts presented by Holt et al., the dose to a mini-phantom can be expressed in its general form:

$$\frac{D_{mini}}{D_{air}} = \left(\frac{\bar{L}}{\rho}\right)_{air}^{mini} \tag{2.17}$$

which is similar to Equation 2.12. In Equation 2.17, $\left(\overline{L}/\rho\right)_{air}^{mini}$ is the ratio of the mean restricted collision mass stopping power averaged over the electron slowing-down spectrum in the mini-phantom material compared to air. It should be noted that all electron generation, both primary and secondary electrons, are averaged over the entire slowing down spectrum in the Spencer-Attix formulation for the determination of the restricted collision mass stopping powers in Equation 2.17.

The dose to the air at the point of measurement is equal to the exposure reading from an electrometer, M, multiplied by the cavity-gas calibration factor, N_{gas}. Rewriting Equation 2.17 results in the following:

$$D_{mini} = MN_{gas}\left(\frac{\overline{L}}{\rho}\right)_{air}^{mini} \quad (2.18)$$

Even though the finite size of the cavity can be taken into account by applying the Spencer-Attix formulation, minor perturbations of the electron and photon fluences occur; therefore, correction factors must be applied. The result is a general relationship between the dose to the gas in the chamber and the dose to the mini-phantom that replaces the chamber when it is removed. The equation below for the dose to a mini-phantom is similar to that developed in the American Association of Physicists in Medicine (AAPM) Protocol 21 [10], for the dose to a medium. The dose to a mini-phantom is determined as follows:

$$D_{mini} = MN_{gas}\left(\frac{\overline{L}}{\rho}\right)_{air}^{mini} P_{ion}P_{repl}P_{wall} \quad (2.19)$$

where, M, is the exposure reading in C or scale division, $\left(\overline{L}/\rho\right)_{air}^{mini}$ is the ratio of the mean restricted collision mass stopping power for the mini-phantom material to the air in the cavity, P_{ion} is the ion-recombination correction factor and corrects for ionization recombination losses that occur at the time the user's radiation therapy beam is calibrated, and P_{wall} is unity when the mini-phantom and the ionization chamber walls are both air equivalent. The correction factor, P_{repl}, depends upon the type and energy of the radiation, the radius of the air cavity in the cylindrical ionization chamber, and the gradient of the depth-dose curve at the point at which the measurement is taken. However, if the measurements are made at the point where maximum dose occurs in the material, d_{max}, gradient corrections are not required. Values for P_{repl} can be obtained from Figure 5 of the AAPM Protocol

21 [10].

In conclusion, the Bragg-Gray theory coupled with the Spencer-Attix formulation, along with the development of the cavity-gas calibration factor, permits the direct dose relationship between the dose to the gas in an ionization chamber when measured using a full phantom to the dose to the gas in an ionization chamber when the full phantom is replaced by a mini-phantom. The mini-phantom thickness must be sufficiently large to allow transient charged particle equilibrium conditions to be met. An analysis of the dose to a mini-phantom and the existence of equilibrium conditions will be evaluated later using radiation transport computer code simulations and in-beam measurements.

Chapter 3

Previous Work

3.1 Introduction

A review of the literature resulted in only one report where the material delrin was used. Several articles were found to support the use of computer modeling of ionization chambers, calibration buildup caps, full phantom dose estimates, and therapy beam spectral information. Many investigators also suggested that there was sufficient foundation for extrapolating their findings to energies above 25 MV and possibly to 45 MV. However, there was no mention of any type of buildup cap other than the 2 MeV Co-60 calibration buildup cap. Additionally, there was no mention of in-air measurements of photon fields using thimble ionization chambers with any buildup cap other than the 2 MeV calibration buildup cap.

Throughout the remainder of this document, the terms "MeV," and "MV" will be used extensively. Whenever the term MV appears, it should be assumed that it refers to the potential voltage of a linear accelerator. The term MeV refers to a monoenergetic radiation source. All of the buildup caps are designated in terms of MeV.

3.2 Application of Thimble Ionization Chambers for High-energy X-ray Beam Measurements

Green and Massey [13] investigated a method for the measurement of absorbed dose for x-rays generated at voltages greater than 8 MV. Their investigation initiated and lead to the acceptance that properly constructed thimble ionization chambers calibrated at 2 MeV can be used for photon radiation in the high-energy range. However, for a range of radiation qualities in the absence of full spectral information, it is necessary to estimate the mean secondary electron energy for each quality. The National Bureau of Standards Handbook 78 [14] suggested that an x-ray beam would have a mean photon energy of 40-45 percent of the peak energy. This mean photon energy was used to estimate the mean secondary electron energy and finally to determine stopping power values.

At the higher energies they found that the secondary electrons that produced ion pairs in the gas, originated in the material surrounding the wall of the chamber (tissue equivalent phantom); only a small fraction of the ionizations results from interactions between the radiation and the material of the chamber wall and the central electrode. Additionally, they inferred that because of the increase in the mean range of the secondary electrons this fraction decreases with an increase in photon energy. Therefore, they suggest that it is reasonable to extrapolate these experimental findings to energies higher than 20 MV. This work, by Green and Massey, applied directly to thimble ionization chambers surrounded by a water phantom. They did not look into buildup caps nor did they use a mini-phantom.

Jayaraman et al. [15], reviewed the AAPM protocol for high-energy dosimetry. Their evaluation was that the protocol was too complicated and required too many physical variables that were difficult to obtain for some chambers. The authors proposed that the protocol could be used to redesign thimble ionization chambers used in therapy beam calibrations. The purpose of the redesign was to reduce the number of physical constants required by the protocol.

Their ideal design would be to have the product of $P_{wall} \cdot P_{repl}$ equal to 1 over an energy range from Co-60 gamma rays to 45-MV x-rays. P_{wall} and P_{repel} have the same definition as stated in Chapter 2. In their review of readily available ionization chambers, they found that the 0.6 cm^3 collecting volume chambers provided the necessary sensitivity but had wall thicknesses ranging from 0.05 to 0.5 g/cm^2. Next they evaluated wall materials. The optimum materials were Bakalite and acrylic. Materials such as C552, an air equivalent plastic, nylon, and graphite did not provide the necessary values for P_{wall} and P_{repl}.

In the design of the buildup cap for the Co-60 calibration, they determined that using a cap with identical properties as the wall material would reduce the number of physical variables. From this they determined that, by proper design, an ionization chamber would agree with that from the AAPM Protocol 21 theoretical equation within 0.7 percent for photon energies from Co-60 to 45 MV.

3.3 Materials Used in the Construction of Ionization Chamber Walls and Buildup Caps

Lempert et al. [16], describe the methods employed to measure the fraction of ionization due to electrons arising in the chamber wall for photon beams in the range of Co-60 to 25 MV. They used a Farmer-type 0.6 cm^3 graphite-walled ionization chamber with graphite caps for Co-60 energies. Additional caps made of polymethylmethacrylate (PMMA) were used to extend the energy range of the ionization chamber. They noted that a major complication with the experiment was the high-energy secondary electrons that originated in the accelerator head and the air path leading to the detector. These secondary electrons will contaminate the x-ray beam unless the proper thickness of wall or buildup material surrounds the chamber.

Their experimental work concluded that the fraction of ionizations due to electrons arising in the chamber wall depends mainly on the wall thickness, when expressed in g/cm^2, and is independent of atomic number for materials whose mean atomic numbers are in the range of 6 (graphite) to 7.2 (water). Lempert et al. also used Monte Carlo codes to simulate the irradiation conditions. They found that the response of chambers having walls and buildup caps of carbon, polystyrene, PMMA, muscle, and water varied by no more than ± 1.5 percent.

The purpose of their experiments was to obtain data required for high-energy x-ray dosimetry where the composition of the chamber wall is different from the dosimetry phantom. Using the relationship proposed by Almond and Svensson [17], the dose to the medium or the dosimetry phantom, which is normally water, can be calculated. Further calculations demonstrated that for dosimetry of x-ray beams from 2 MV to 25 MV, that the ionizations due to the electrons produced in the chamber wall is minimal compared to the phantom material.

Kutcher et al. [12], investigated the difference in ionization chamber response between using and not using the Co-60 buildup caps when performing in water dose measurements. Depending on the energy of the incident photon beam, electrons that ionize the air in the cavity will be generated in different regions of the phantom, buildup cap, and ionization chamber wall material. At Co-60 energies, for a chamber with a Co-60 equilibrium cap, a large fraction of the electrons will arise from the inner wall. At higher energies, more and eventually all of the electrons will be generated in the cap. At still higher energies, most electrons must arise from the water surrounding the chamber. The conclusions were that the tissue equivalent caps are water equivalent for photons at the Co-60 and 4 MV energies. At higher energies, measurements made with the addition of the buildup cap can differ by 1.5 percent from measurements made without the buildup cap. It was recommended that when measuring photon doses in water, the most water-equivalent system be used. Therefore, it is logical to assume that for in-air measurements, like those proposed later in this work, the most air-equivalent system should be used.

3.4 Radiation Transport Code Applications in Photon Dosimetry

Nath and Schulz [18], used Monte Carlo photon-electron coupled codes to calculate the response and wall correction factors for various ionization chambers in a Co-60 gamma-ray field. An evaluation of the chamber wall material and its thickness, the central electrode material and its dimensions, and the shape and size of the sensitive volume was performed. Their calculations indicated that the correction factors for the wall and the detector's response were sensitive to the shape and volume of the ionization chamber. Additionally, it was shown that these correction factors were relatively independent of the choice of material for the chamber wall and electrode. However, independence only applies when the materials were compared on the basis of their electron density.

Cylindrical chambers exhibit a dependency on both the radius and length of the sensitive volume. When the radius increases above 0.5 cm, the contribution from the end caps begins to increases rapidly and the contribution from the sides decreases. The wall correction factor for a graphite Farmer-type chamber was unaffected by the choice of materials. A 0.6 cm^3 cylindrical chamber was simulated using the Monte Carlo method. The simulation resulted in a wall correction factor of 0.990 $\pm$0.004. Their simulated values were in good agreement with experimental values from the National Bureau of Standards and the Bureau International des Poids et Measures.

Rocha et al. [19], investigated the effects of buildup cap materials on the response of an ionization chamber. The ionization chamber wall and buildup caps were made from delrin.

Their investigation was to determine if the calibration factors reported by the Secondary Standard Dosimetry Laboratories are accurate when an ionization chamber is equipped with a buildup cap for calibration using Co-60. The calibration factor provided by the calibration laboratories is an air kerma or exposure calibration factor and is given the symbol N_x.

Attenuation and scattering effects for Co-60 gamma rays in the wall of the ionization chamber and the buildup cap, as well as their non-air-equivalence, were studied using cylindrical ionization chambers. The chamber walls were constructed from delrin. Caps of delrin, graphite, PMMA, C552, A-150 and aluminum were analyzed. Comparisons between the theoretical values and the experimental results for the attenuation and scattering correction factor, A_{wall}, and their air equivalence were in good agreement for each material. The theoretical values were obtained from the AAPM [10], the International Atomic Energy Agency [20], and the Sociedad Espanola de Fisica Medica [21] protocols. Delrin, graphite and C552 all proved to be essentially air equivalent.

The EGS4 Monte Carlo code was used to calculate the ionization chamber response and wall attenuation in a broad divergent Co-60 beam. The results for the five materials investigated showed that the mean experimental value of A_{wall} was 0.9894 $\pm$0.0004 for the low-density materials. This is within 0.02 percent of the published theoretical values regardless of the material used for the buildup cap.

3.5 Considerations for Ionization Chamber Positioning for In-beam Measurements

Mohan et al. [22] used the **EGS3** Monte Carlo code to compute the photon spectra for different medical linear accelerators. Their investigation revealed that the mean photon energy was lower than the generally accepted value of one-third the maximum energy. They verified the spectra with measured data. Evaluations of both a Clinac-4 (4 MV) and a Clinac-6 (6 MV) linear accelerator, manufactured by Varian Corporation, were performed.

The physical parameters for their computer analysis and verification measurements were for a 100 cm source-to-surface distance and a 10x10 cm field. For both accelerators, the calculated versus measured doses were in excellent agreement. The mean energy for the 4 MV and the 6 MV spectra within 2 cm from the central axis were 1.51 $\pm$0.06 MV and

1.92 $\pm$0.02 MV respectively.

Mohan et al. [22] have demonstrated that the Monte Carlo simulation is accurate for determining the energy spectra and angular distributions of photon beams produced by linear accelerators. Additionally, they confirmed that the spectrum in the central part of the beam is harder than at points away from the center, and that up to 5 percent additional error could be introduced in the peripheral region due to the softness of the beam; thus defining the central axis as the optimal position for in-beam exposure measurements.

Brownridge et al. [23], also performed experiments to determine the energy distribution in the spectrum from a clinical linear accelerator. Using a Ge(Li) detector, they determined the photon spectrum from a LINAC capable of producing 10 MeV photons. They also found that the peak in the photon spectrum occurred at a lower energy, below 4 MV, than the generally accepted one-third the maximum energy of 15 MV for this particular LINAC.

3.6 Summary of Previous Work

From the previous work it is evident that computer simulations are an effective and accurate tool for evaluating the validity of the many correction factors used in the determination of the absorbed dose in a material from an ionization chamber measurement [17–19]. Additionally, the fact that the ionizations in the gas cavity were due to electrons produced in the phantom material, there is support for the possibility that an air equivalent mini-phantom could be used for in-air measurements of high-energy photon beams [12, 16]. Investigators have also shown that Monte Carlo techniques can be used to analyze the energy and angular distribution of the bremsstrahlung spectra from linear accelerators [22, 23].

Therefore, it is proposed that if a chamber can be designed for dose measurements in water phantoms for therapy beams with energies ranging from a few MV up to 45 MV [13, 15], then a buildup cap can be designed for an existing thimble ionization chamber to be used in high-energy photon beam measurements.

Chapter 4

Computer Analysis Using Radiation Transport Codes

4.1 Introduction

Two different computer codes have been used in this analysis. **ITS**: The Integrated TIGER Series of Coupled Electron-Photon Monte Carlo Transport Codes, and **CEPXS/ONEDANT**: A One-Dimensional Coupled Electron-Photon Discrete Ordinates Code Package. Both codes were used to obtain detailed information regarding the transport of radiation through matter.

ITS is a Monte Carlo code package useful in predicting the response of radiation measurement systems by solving coupled electron/photon radiation transport problems [24]. **ITS** is capable of modelling one, two or three dimensional geometries with transport solutions over the range from 1.0 GeV to 1.0 KeV.

ONEDANT is a one-dimensional diffusion accelerated neutral particle transport code that solves the one-dimensional multigroup Boltzmann transport equation [25]. The code is capable of handling plane, cylindrical and spherical geometries in one dimension for regular and adjoint problems, permitting anisotropic scattering and anisotropic inhomogeneous sources, and allowing for differing boundary flux conditions. The discrete-ordinates approximation is used for treating the angular variation of the particle distribution, and the diamond-difference scheme is used for discretization of the spatial variable and the stopping power term.

4.2 Geometry Considerations

The initial step was to characterize the ionization chamber with its calibration buildup cap. There was a question as to how to accurately represent the geometry of the cylindrical ionization chamber and 2 MeV delrin buildup cap. A three dimensional representation, although an exact replica of the system, proved to be difficult because of the conical shape of the end of the ionization chamber. Therefore a one dimensional analysis was investigated.

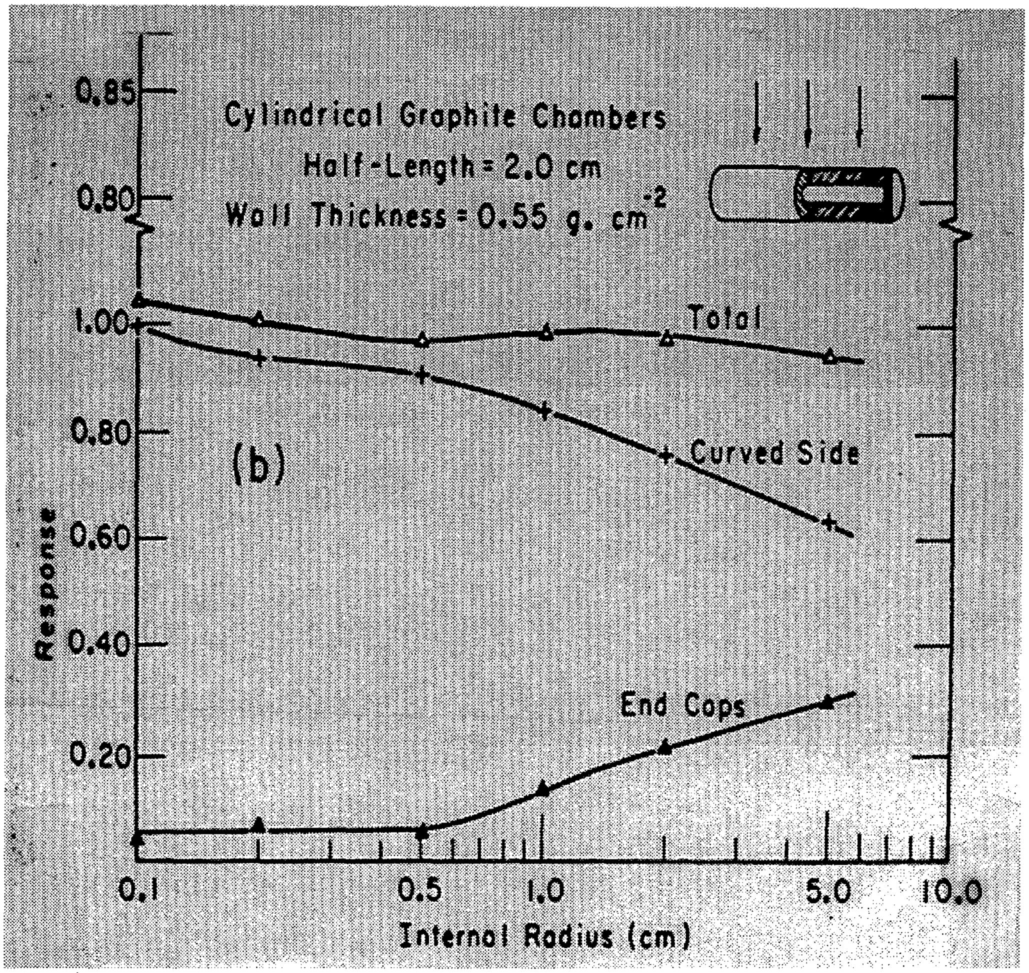

Figure 4.1: Relative response of dose to air per unit collision kerma in-air for cylindrical ionization chambers as a function of radius.

Nath and Schulz [18], in their evaluation of wall correction factors, determined the effects of geometry on the dose profiles. Figure 4.1, shows the response of the detector with respect to the internal radius of the ionization chamber [18]. The chamber presented in the graph is a graphite chamber with a length of 2.0 cm. Their work showed that for ionization chambers with less than a 0.5 cm radius, the contribution from the end caps is very small. The ionization chamber used to evaluate the 4 MeV and 6 MeV buildup caps has a radius 0.295 cm and a length of 2.85 cm. Therefore, a one dimensional representation is valid.

The University of New Mexico's VAX Station 6000-320, was used to perform the **ITS** Monte Carlo analysis on the buildup caps and ionization chamber. An input file was created for the ionization chamber and buildup cap based on the materials and dimensions supplied

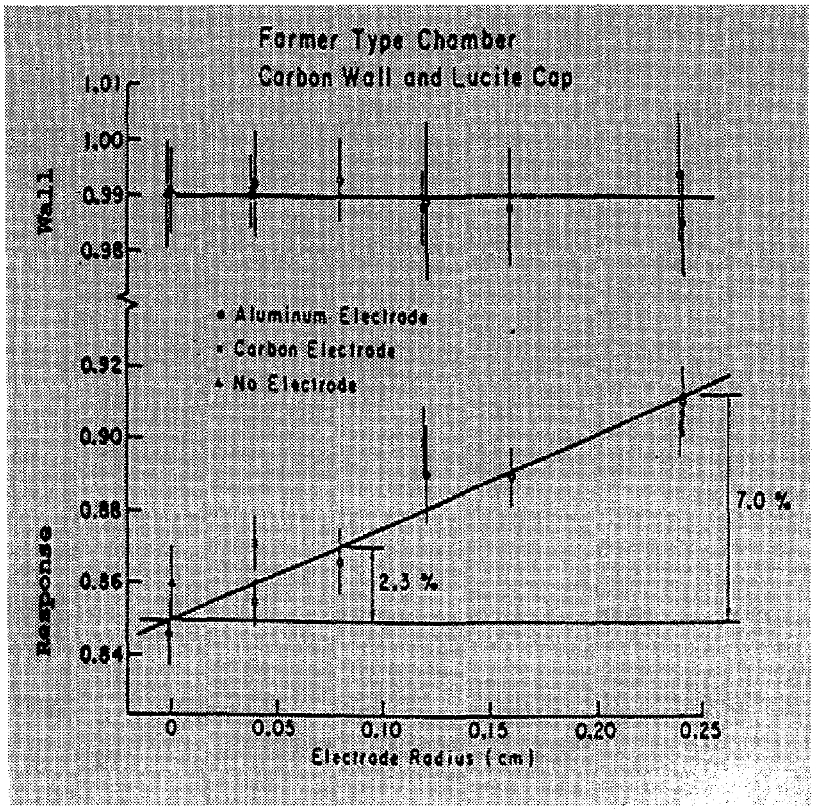

Figure 4.2: Effects of the electrode on ionization chamber response and correction factors as a function of the radius of the central electrode.

by the ionization chamber manufacturer. **ITS** files were set up with the photons incident upon the delrin buildup cap. A vacuum was assumed to be on the outside and each material was assumed to be an infinite plane. The central electrode was not modeled.

The response of the ion chamber and the effects on the correction factor, A_{wall}, as a function of increasing central electrode size can be seen in Figure 4.2 [18]. A 1 mm radius electrode may increase the response of a thimble ionization chamber by as much as 2.3 percent. The radius of the central electrode of the 0.6 cm^3 ionization chamber used in this work is 0.635 mm. It is expected to increase the response by less than one percent, with the correction factor for the ionization chamber wall increasing by less than one tenth of one percent. Therefore, the effects of the small carbon electrode will not impact the results of the computer modeling, so the electrode was not represented as a material in the input file. To comprehensively represent the ionization chamber, a mirror image of the incident photon side materials was used to complete the path the photons and electrons would travel.

The central cavity is filled with dry air and considered to be at standard temperature and pressure.

4.3 Radiation Transport Codes; ITS versus CEPXS/ONEDANT

ITS Monte Carlo simulations starting with ten thousand histories and ten batches were initially attempted. The histories were increased to one-hundred thousand and finally to one million with considerable increase in computational labor, in hopes of achieving convergence. However, because of the thinness of the material, and it being air equivalent, there were very low numbers of photon/electron interactions so convergence was not achieved within the available resources. Additionally, **ITS** is only capable of giving the dose profile. For this work, the kerma profile is very important for determining the achievement of charged particle equilibrium. As a result of the extensive computing time requirements, convergence problems, and the inability to provide a kerma profile, **ITS** was considered inadequate. Therefore, another method that could analyze both kerma and dose, converge much faster, and provide good accuracy was needed. To this end, a deterministic code was used.

Benefits of the **CEPXS/ONEDANT** code over the **ITS** code are that it satisfies all of the above requirements. Additionally, **CEPXS/ONEDANT** uses Biggs and Lighthill [26, 27], the same data bases **ITS** uses in generating the cross section data. Therefore, the **CEPXS/ONEDANT** computer code is used in the analysis of the ionization chamber with the 2 MeV calibration buildup cap, in the characterization of the existing 4 MeV and 6 MeV buildup caps, and in the determination of the characteristics of the 18 MeV buildup cap.

4.4 Thimble Ionization Chamber With 2 MeV Calibration Buildup Cap

Radcal Corporation's Model 10X5-0.6 ionization chamber was used in this work. It has a 0.6 cm^3 active volume within its basically cylindrical shape. Such small cylindrical chambers are usually referred to as thimble ionization chambers. The ionization chamber was designed for high dose rates ranging from 10 mR/min to 54 kR/min depending on the associated electronics, and an integrated exposure capability of 0.2 mR to 420 kR. Energy dependence is rated at $\pm$ 5 percent, from 40 keV to 1.33 MeV with the buildup cap in place. The calibration accuracy is ± 3 percent for Co-60 photon energies.

Figure 4.3, shows a cutaway representation of the ionization chamber with the 2 MeV buildup cap. The cap and the outer wall of the ionization chamber are constructed out of Polyoxymethyline CH_2O. The trade name for this material is delrin and is manufactured by DuPont. Delrin has a density of 1.417 g/cm^3 [28]. The inner wall of the chamber is constructed out of Polyvinildene Fluoride CH_2CF_2. Polyvinildine Fluoride is generally referred to as C552 and is manufactured by Radix Corporation. The density of C552 is 1.76 g/cm^3 [29].

There is a mixture of alcohol and graphite that is applied to the outside of the inner wall of the ionization chamber. The coating is a graphite alcohol suspension and forms a very thin sheath of which the thickness is not specified by Radcal, but was approximated through measurements and comparisons of the engineering drawings supplied by Radcal. A Material Safety Data Sheet provided by the Acheson Colloids Company [30] reveals that the suspension consists of Isopropanol 66 weight percent, Graphite 15 weight percent, n-Butyl Alcohol, Hexylene Glycol, and Propylene Glycol Methyl Ether all consisting of 5 weight percent each. This mixture can be considered to approximate C552 or Polyvinildene Fluoride in its radiation transport properties [31].

The graphite coating on the outside surface of the C552 is there because the C552 is not always blended well enough to avoid localized non-conducting spots in the chamber wall. If these spots were to be left non-conducting, charge would collect at these points during an exposure and slowly bleed off at the end of an exposure. This slow bleed off may look like electrical leakage in the exposure mode or a low level exposure rate in the rate mode [32].

For the analysis of the buildup cap and the ionization chamber, a monoenergetic 1.253 MeV incident photon beam was used. This energy is an approximation of the average energy expected from a Co-60 calibration source. Figure 4.4 contains the input file for the **CEPXS/ONEDANT** code. The materials are layered such that the delrin buildup cap and the delrin outer wall are assigned as material one. Material two is the graphite coating, and material three is the C552 inner wall. The air cavity is material four. As seen in Figure 4.4, the material layers are duplicated again for completeness. Appendix A contains the remaining input and output data files for the 2 MeV, 4 MeV, and 6 MeV buildup caps.

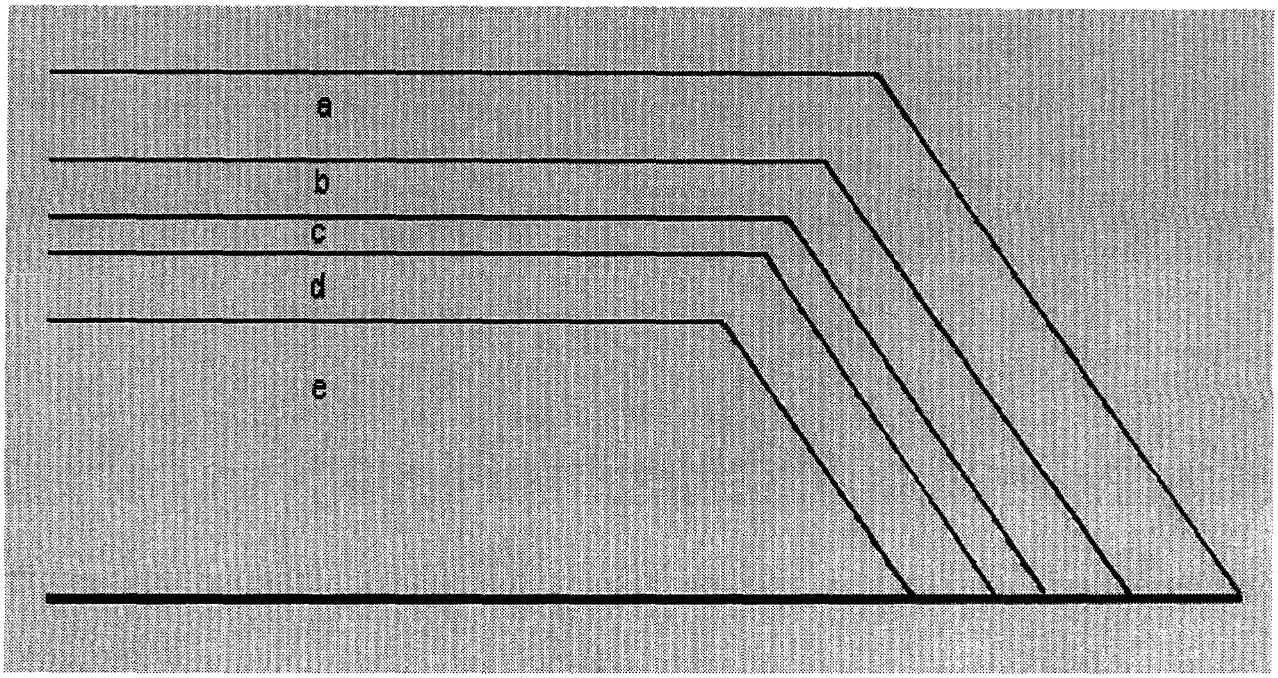

Figure 4.3: Simulated cutaway view of the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap. Dimension for the layers are in cm. delrin buildup cap, $a = 0.28956$, delrin outer wall, $b = 0.08126$, graphite coating, $c = 0.03050$, C552 inner wall $d = 0.05080$, and the air in the cavity, $e = 0.29464$.

Figure 4.5, is an example labeled to indicate the different materials of the buildup cap and thimble ionization chamber with the material interface thicknesses noted along the x-axis. Note the appearance of the discontinuity at the delrin/graphite interface, and the less noticeable discontinuity at the interface between the graphite coating and the C552 inner wall material. These discontinuities reflect the differences in the materials. This diagram will be useful when viewing the graphs of the **ONEDANT** output data.

An energy deposition profile for the monoenergetic plane-wave source is represented in Figure 4.6. For charged particle equilibrium to exist, certain conditions must be met. The range of the maximum secondary electron can not exceed the thickness of the wall and buildup cap material. Another, is that the point where the maximum dose occurs, must reside within the thickness of the buildup cap and wall material. Finally, there must be a point somewhere within the thickness of the buildup cap and wall material, where dose is equal to kerma.

The maximum range of a secondary electron from the 1.253 MeV photon source is approximately 0.41 cm. The thickness of the buildup cap, graphite layer and the C552

```
TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 2.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* C552.
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 4.0
DIRECTION
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE
```

Figure 4.4: Input file for the 1.253 MeV monoenergetic plane-wave photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

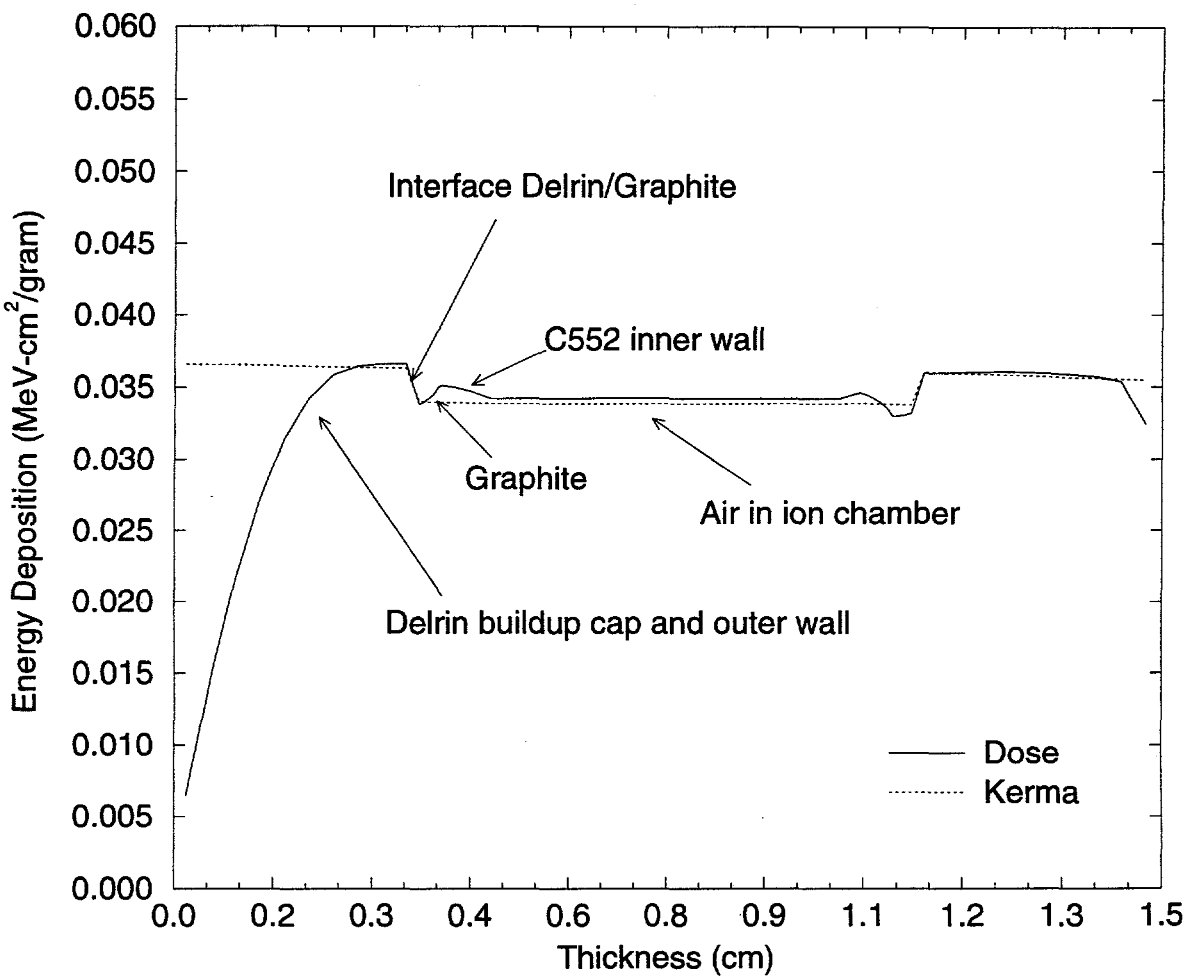

Figure 4.5: Graphical representation with materials and boundry layers shown for a plane-wave 1.253 monoenergetic photon source incident upon the material layers of the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

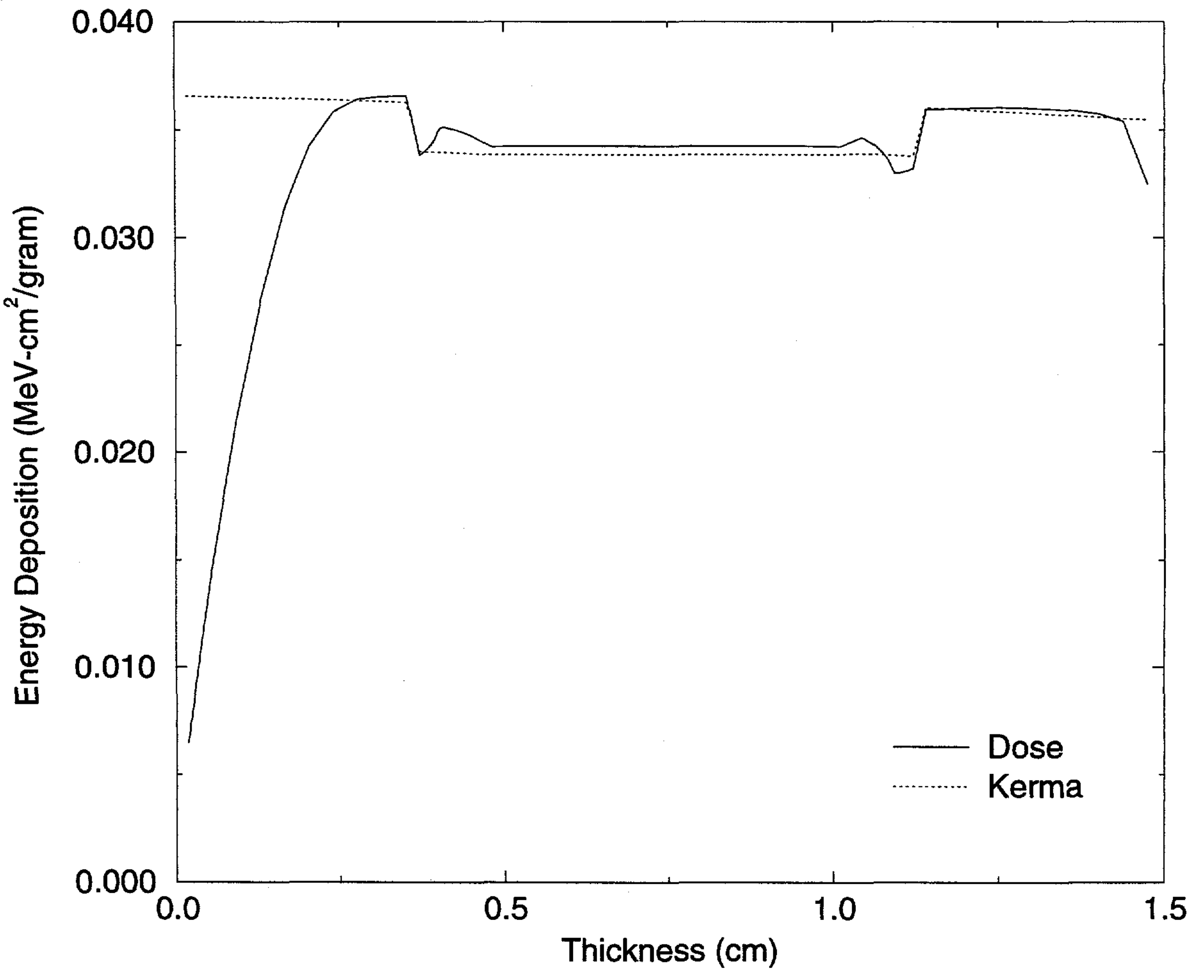

Figure 4.6: Energy deposition profile for a 1.253 MeV monoenergetic plane-wave source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

inner wall is approximately 0.45 cm. Therefore, the range of the most energetic secondary electron is within the thickness of the ionization chamber wall and buildup cap. Range data for electrons with energies up to 18 MeV can be found in Appendix B of this report. Maximum dose deposition is within the C552 inner wall material.

In the graph in Figure 4.6, it can be seen that the dose is equal to kerma at approximately 0.28 cm into the buildup cap material. This is also verified in the output data in Appendix A. The energy deposition is normalized per incident photon. The flat portion in Figure 4.6, is the air in the chamber. The analysis suggests that the dose is somewhat higher than kerma in the cavity gas. This difference may be due to the forward flow of electrons resulting from the plane-wave photon source. To evaluate this more closely, the plane-wave was replaced with an isotropic incident photon source. The results are shown in Figure 4.7.

The isotropic source is a better representation of the Co-60 calibration source. While the dose and kerma for the isotropic source are both higher by almost a factor of two, the thickness at which they are equal is less and the maximum dose occurs at the point where dose equals kerma. The maximum range of the most energetic secondary electron remains the same for both the plane-wave and isotropic sources. A plane-wave source effectively bombards the material with a forward flow of electrons and simulates a transient charged particle equilibrium condition. For a more detailed description of TCPE, refer to Chapter 2 Figure 2.2 and the discussion in that section. Note that in Figure 4.6, the dose rises above kerma and parallels kerma, except where anomalies arise as a result of material interface effects. In contrast to the plane-wave source, the isotropic source exhibits conditions similar to charged particle equilibrium. Since there is no generalized forward flow of secondary electrons, there will not be a simulation of transient conditions; dose does not exceed and parallel kerma the way it did for the plane-wave source. It is again noted that kerma and dose are not exactly equal at the center of the gas filled cavity. This is believed to be a result of the computer model used and should, for all practical purposes, be considered equal.

The buildup cap used in this analysis is advertised as a 2 MeV buildup cap. Comparisons of the results of the plane-wave source with the isotropic source suggest that the buildup cap was constructed with the intent to be used in an isotropic field for calibration. The

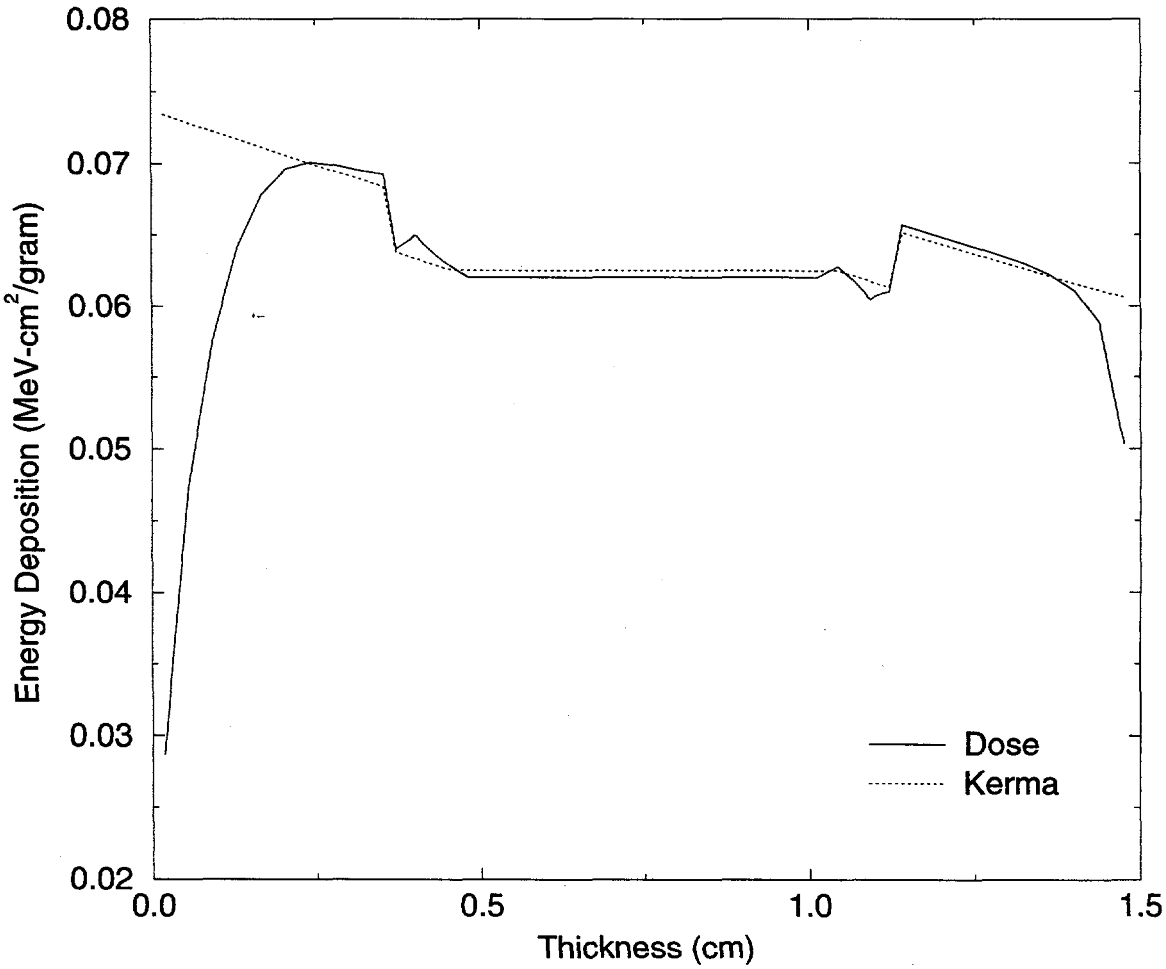

Figure 4.7: Energy deposition profile for a 1.253 MeV monoenergetic isotropic photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

conditions for charged particle equilibrium, maximum range of the secondary electrons, and the depth at which maximum dose occurs have been verified for the ionization chamber with the calibration buildup cap. Computer simulations of the radiation transport under the conditions of calibration, which uses an isotropic source, and with a 2 MeV monoenergetic plane-wave source were evaluated. Results of both are presented in Figures 4.8 and 4.9.

A 2 MeV monoenergetic photon has an average range in the materials used for the ionization chamber wall and buildup cap of approximately 7.2 cm. This is greater than the 4.5 cm thickness of the ionization chamber and buildup cap. Thus, there is no opportunity to achieve charged particle equilibrium (Figure 4.10). This suggest that the cap and ionization chamber combination could not be used for a 2 MeV monoenergetic photon source. Perhaps the buildup cap was advertised as a 2 MeV buildup cap with the intent that it would be used to measure the dose from a bremsstrahlung spectrum with a maximum photon energy of 2 MeV.

The mean photon energy of a bremsstrahlung spectrum from a medical accelerator, according to the spectral information provided by Mohan et al. [22], suggests that an x-ray beam will have a mean photon energy of 40-45 percent of the peak energy. Therefore, for a 2 MeV spectrum the mean photon energy would be approximately 1.1 MeV. Since the thimble ionization chamber was designed primarily for beam calibrations of clinical medical accelerators, it is evident that the 2 MeV buildup cap should perform appropriately if used in a photon spectrum.

Computational analysis of a 1.253 monoenergetic isotropic photon source incident upon the ionization chamber without the calibration buildup cap, suggest that the wall of the ionization chamber alone does not provide adequate thickness to achieve charged particle equilibrium (see Figure 4.10). The Certificate of Conformance, in Appendix E, also contains information regarding the calibration factors for a Cs-137 calibration source. Even though the gammas from a Cs-137 calibration source are about half the energy of the Co-60 calibration source, charged particle equilibrium can not be achieved without the 2 MeV buildup cap. The range of the secondary electrons at Cs-137 energies is 0.19 cm, larger than the 0.163 cm of wall material. The preceding is mentioned only to point out that one must be sure of the calibration photon energies, and whether or not the buildup cap is used

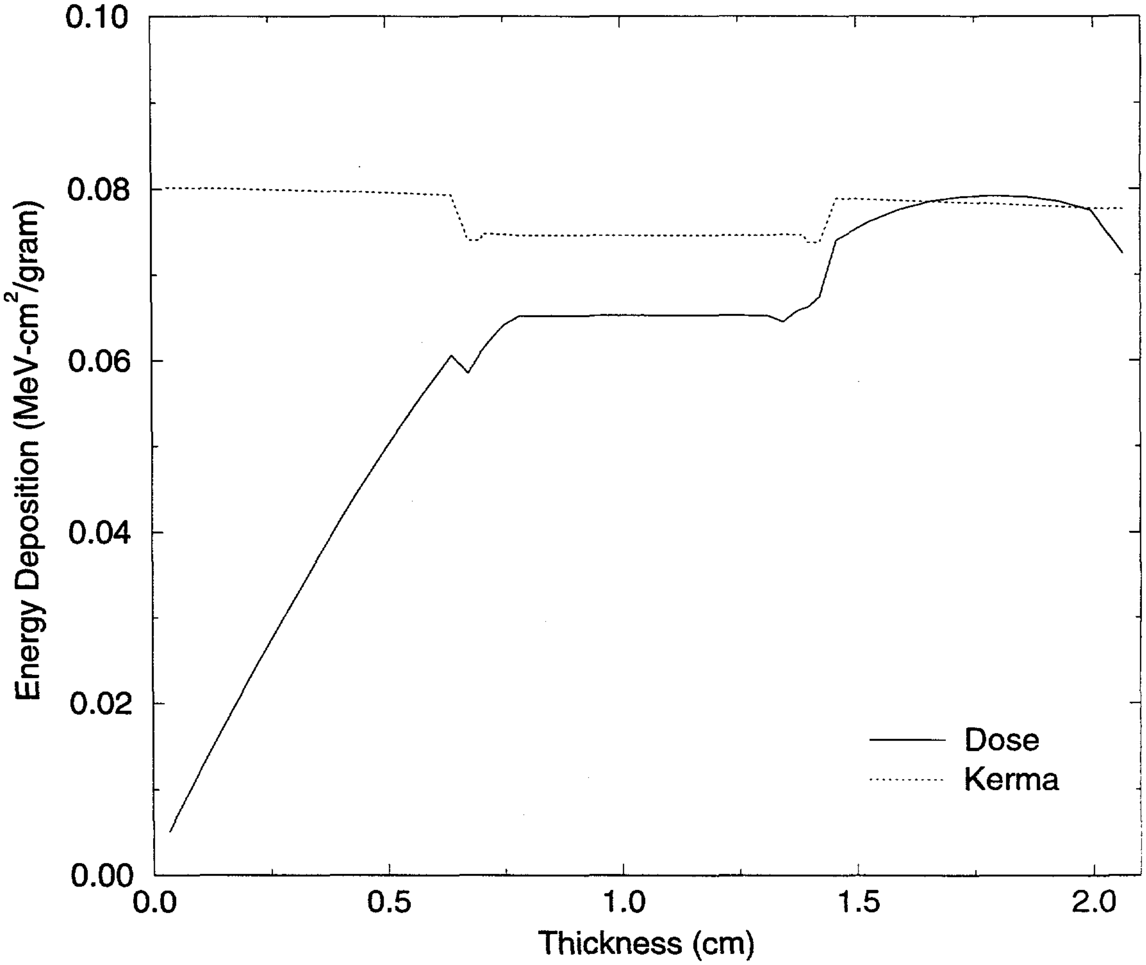

Figure 4.8: Energy deposition profile for a 2.0 MeV monoenergetic plane-wave photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

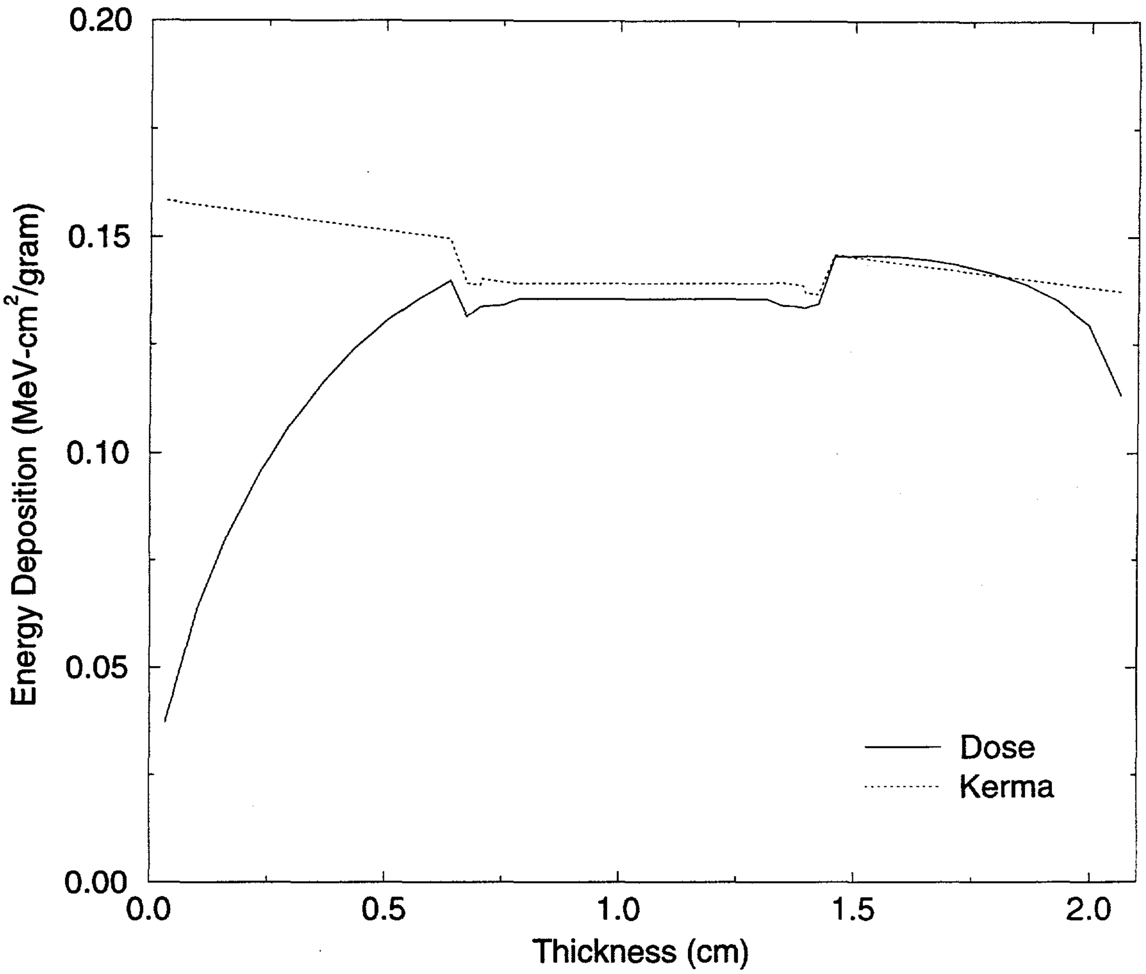

Figure 4.9: Energy deposition profile for a 2.0 MeV monoenergetic isotropic photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 2 MeV calibration buildup cap.

during the calibration.

4.5 Characterization of Existing 4 MeV and 6 MeV Buildup Caps

The 4 MeV and 6 MeV caps utilized in this evaluation were different colors. The 4 MeV cap had a yellowish color while the 6 MeV cap was white. In a personal letter from David Landsverk, Production Manager for Radcal Corporation [32], he explained that the difference in the appearance between these two caps is that delrin yellows with exposure to radiation. It is apparent that the 4 MeV cap had been exposed to radiation. However, yellowing of the 4 MeV buildup cap does not affect the response of the ionization chamber.

When measurements are made in high-energy photon fields, the 2 MeV buildup cap is removed, and the higher energy buildup caps are placed directly over the ionization chamber. Therefore, in the computational analysis of both the 4 MeV and 6 MeV buildup caps, only the thickness of material one was adjusted to reflect the size of the different buildup caps. Similar computational analyses to those for the 2 MeV buildup cap were performed for both the 4 MeV and the 6 MeV buildup caps. Input and output data files for the monoenergetic plane-wave and isotropic photon sources can be found in Appendix A. Figures 4.11, and 4.12, show the results of the 4 MeV monoenergetic plane-wave and isotropic sources respectively. Analysis of the 4 MeV monoenergetic plane-wave data suggest that the maximum dose is not achieved until a thickness greater than the thickness of the buildup cap, ionization chamber wall and air cavity is penetrated. The range of the most energetic secondary electron is estimated to be 1.5 cm, which is much greater than the thickness of the buildup cap and wall of the ionization chamber (0.71 cm). Evaluation of the 4 MeV isotropic photon source data suggest that a similar disparity between dose and kerma occurs This data suggest that the 4 MeV buildup cap will not be accurate if used in a 4 MeV monoenergetic photon field. Therefore a spectrum source was evaluated.

Both 4 MeV and 6 MeV bremsstrahlung spectra from Varian Corporation's Clinac-4 and Clinac-6 medical linear accelerators were obtained from Mohan et al. [23]. A 4 MV spectrum was used to provide information regarding the radiation transport of a plane-wave and isotropic spectral sources; the results of which can be found in Figures 4.13 and 4.14 respectively. Data from the plane-wave spectral source analysis suggests that this

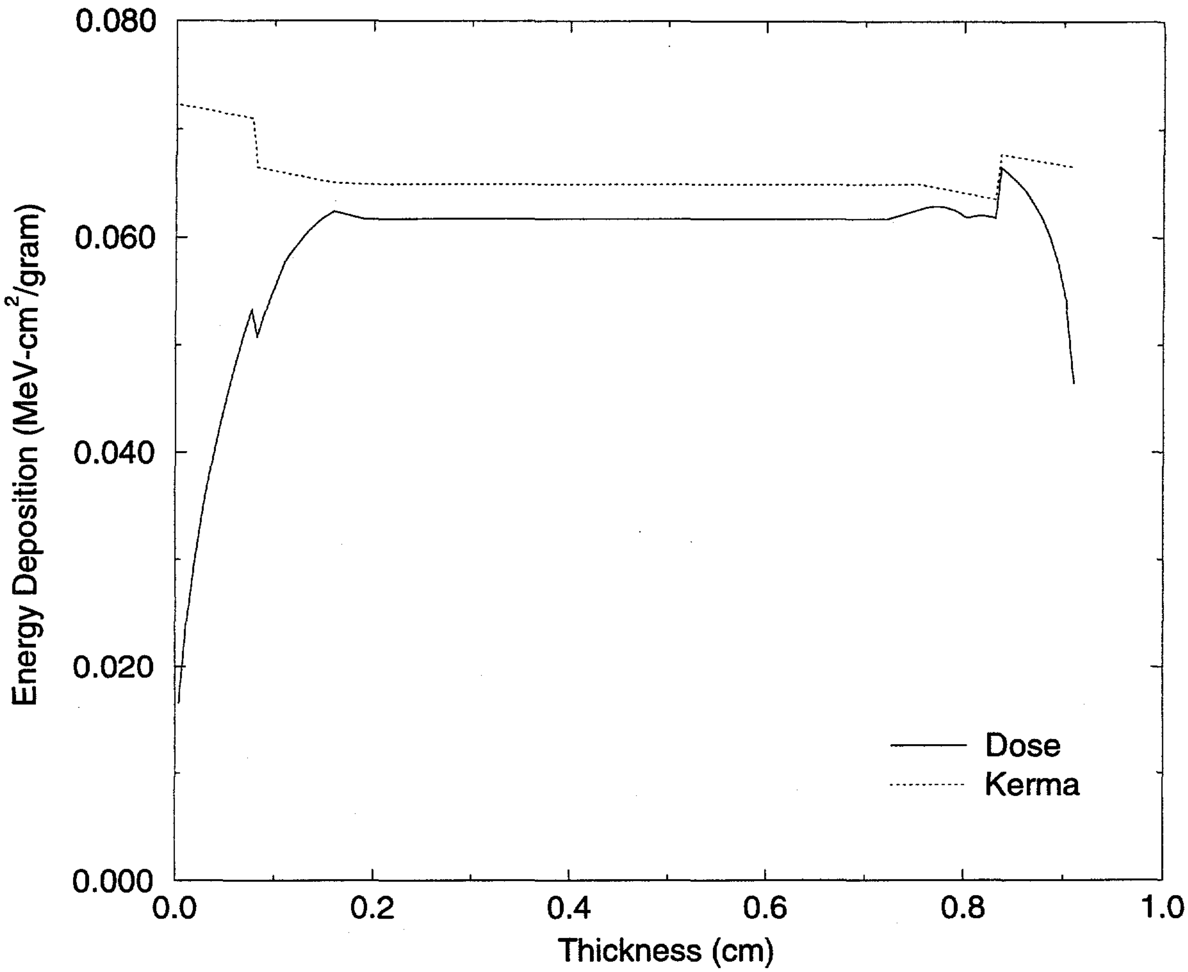

Figure 4.10: Energy deposition profile for a 1.253 monoenergetic isotropic photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber without the Co-60 calibration buildup cap.

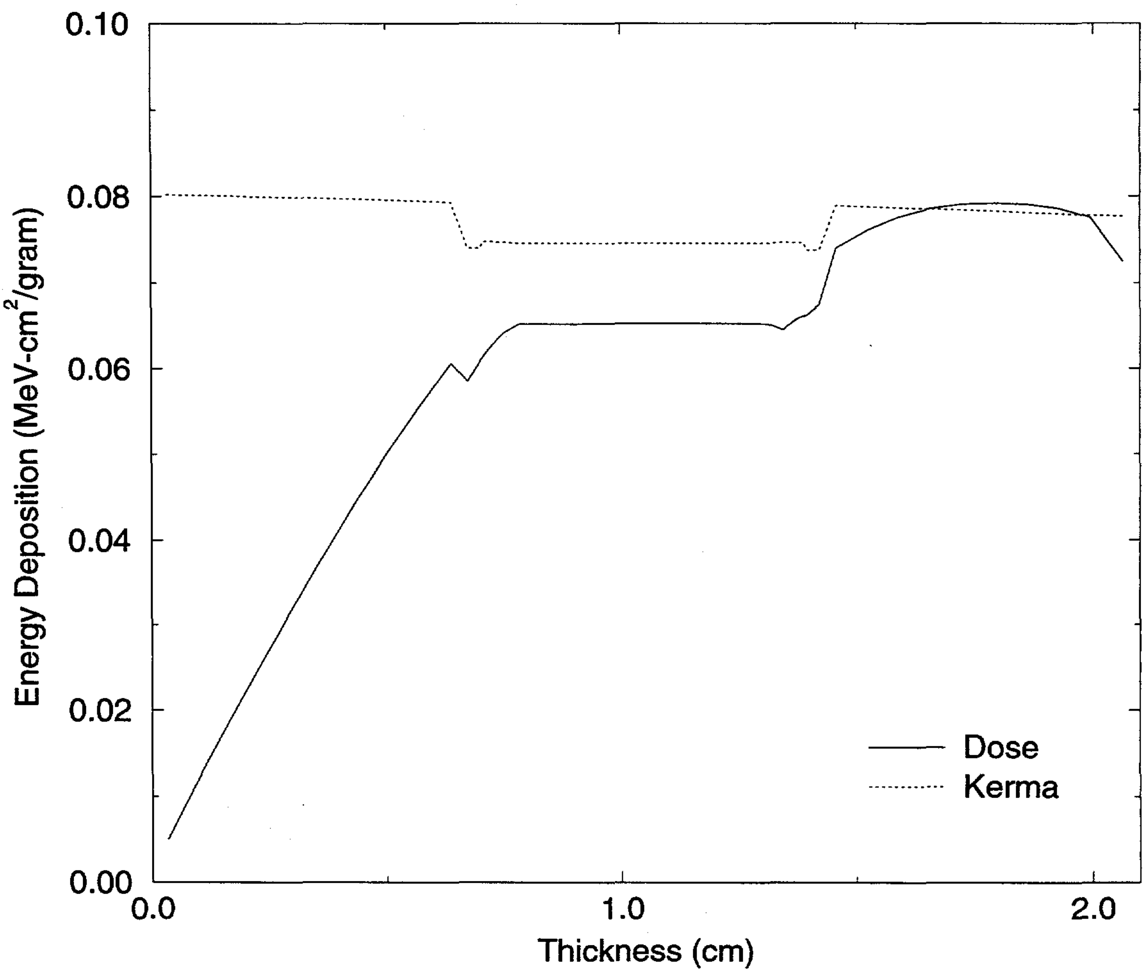

Figure 4.11: Energy deposition profile for a 4.0 MeV monoenergetic plane-wave photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 4 MeV buildup cap.

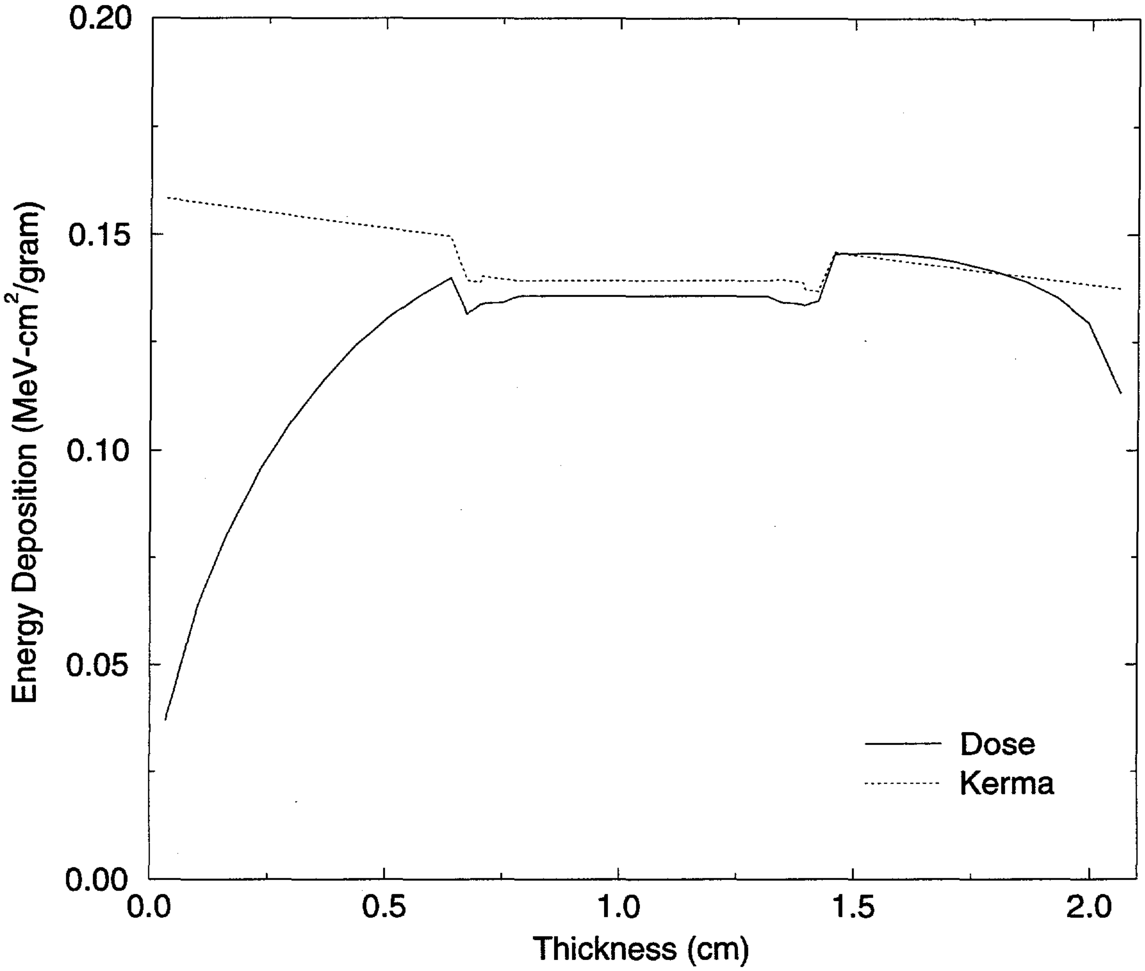

Figure 4.12: Energy deposition profile for a 4.0 MeV monoenergetic isotropic photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 4 MeV buildup cap.

source does not achieve charged particle equilibrium even though the range of the maximum secondary electron is less than the thickness of the 4 MeV buildup cap. The reason is that the forward peaked bremsstrahlung spectrum causes the maximum dose and the point where dose is equal to kerma to occur at a greater depth in the material than the isotropic source. The data suggest that the isotropic spectral source achieved charged particle equilibrium. The data indicates that there is a point in the wall material where dose and kerma are equal, and that the maximum dose occurs within the material surrounding the gas cavity. The energy of the maximum secondary electrons is approximately 1.51 MeV resulting in a range of nearly 0.55 cm. This is within the thickness of the 4 MeV delrin buildup cap. Therefore, the 4 MeV buildup cap appears to be well suited for measurements of a 4 MV isotropic bremsstrahlung spectrum.

Computational analyses similar to those for the 4 MeV buildup cap were performed for the 6 MeV buildup cap. The monoenergetic plane-wave and isotropic sources both failed to provide charged particle equilibrium (Figures 4.15, and 4.16). Evaluation of the data for the 6 MV plane-wave spectral source predicts strong forward currents of photons resulting in a deeper dose profile. The maximum dose does not occur until a thickness greater than the buildup cap, wall and gas cavity has been penetrated. This is evident in Figure 4.16, were the maximum dose and the point where dose is equal to kerma occurs on the exiting side of the ionization chamber. The range of the most energetic secondary electron is greater than the thickness of the 6 MeV buildup cap and ionization chamber wall. Therefore, charged particle equilibrium is never achieved, and the charge collected in the gas cavity will not be representative of the dose to the medium surrounding the gas cavity.

The isotropic 6 MV spectral source achieved equilibrium conditions. However, one interesting observation is that unlike the 4 MV spectral source, the maximum energy of the secondary electrons has exceeded the conditions in the material where charged particle equilibrium would be obtained and has resulted in transient charged particle equilibrium (Figure 4.17). Note that for the isotropic spectral source, Figure 4.18, the dose rises above kerma and remains above kerma, neglecting interface effects, by a constant amount over the region of equilibrium. Refer to Chapter 2, Figures 2.2 and 2.3 for further explanation of this transient phenomenon. Again, as with the 4 MeV buildup cap, the 6 MeV buildup

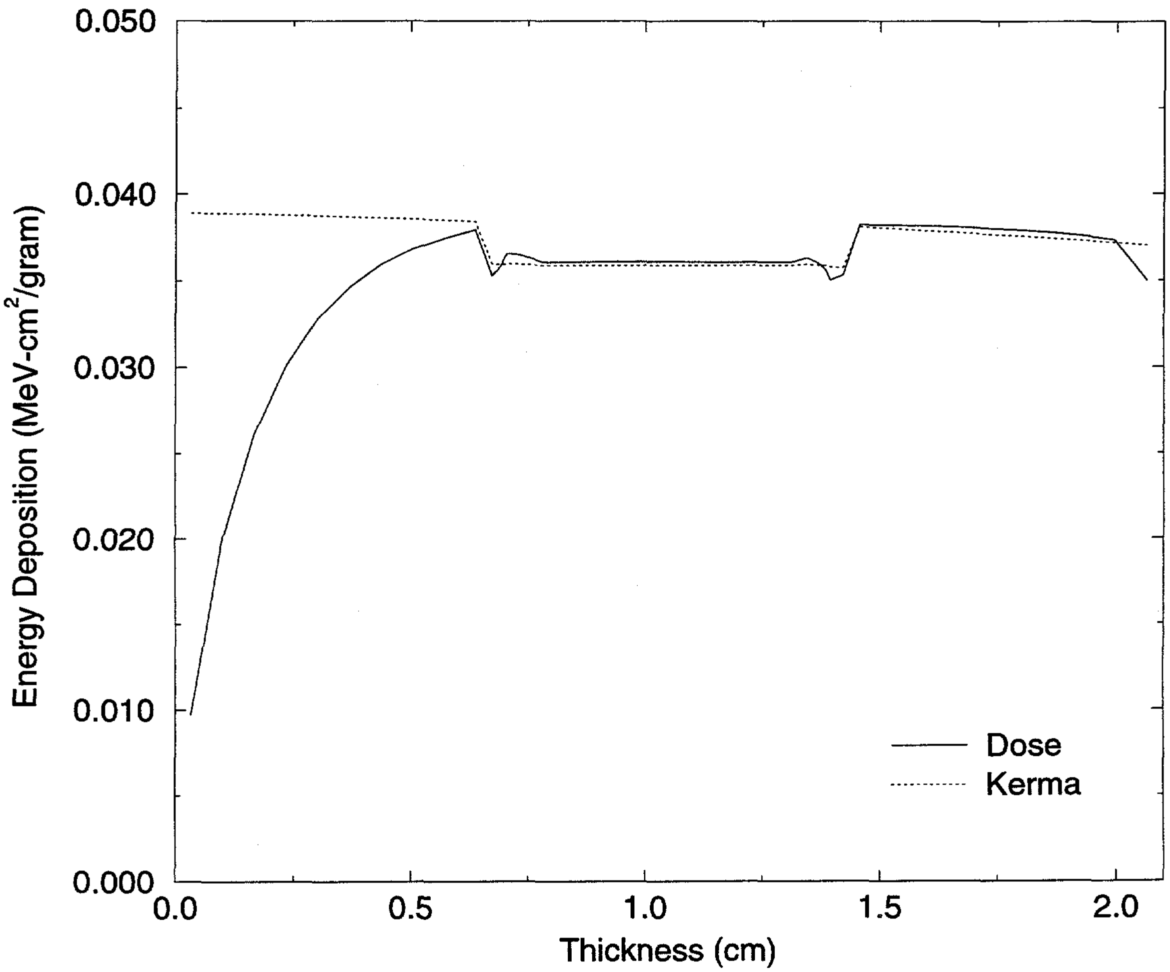

Figure 4.13: Energy deposition profile for a 4.0 MV plane-wave spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 4 MeV buildup cap.

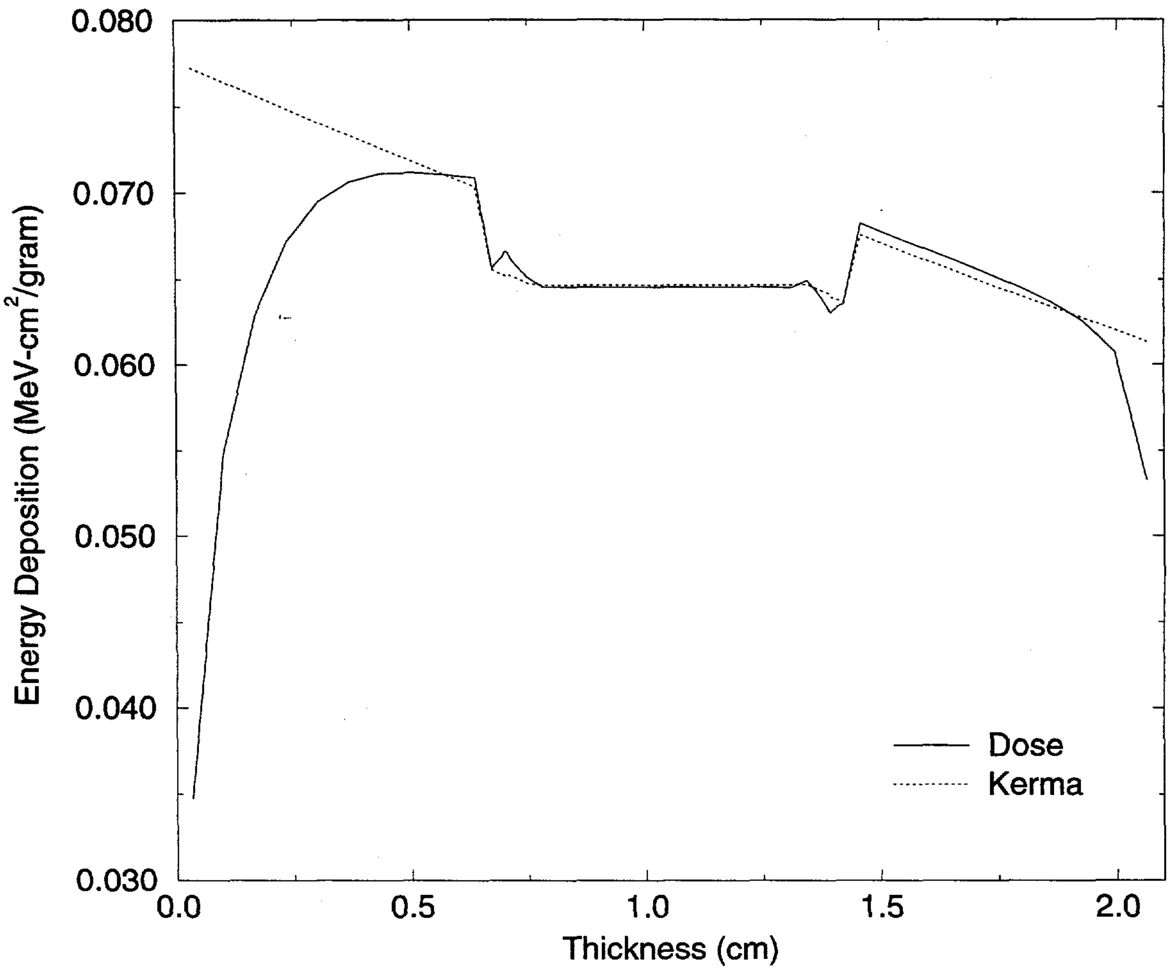

Figure 4.14: Energy deposition profile for a 4.0 MV isotropic spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 4 MeV buildup cap.

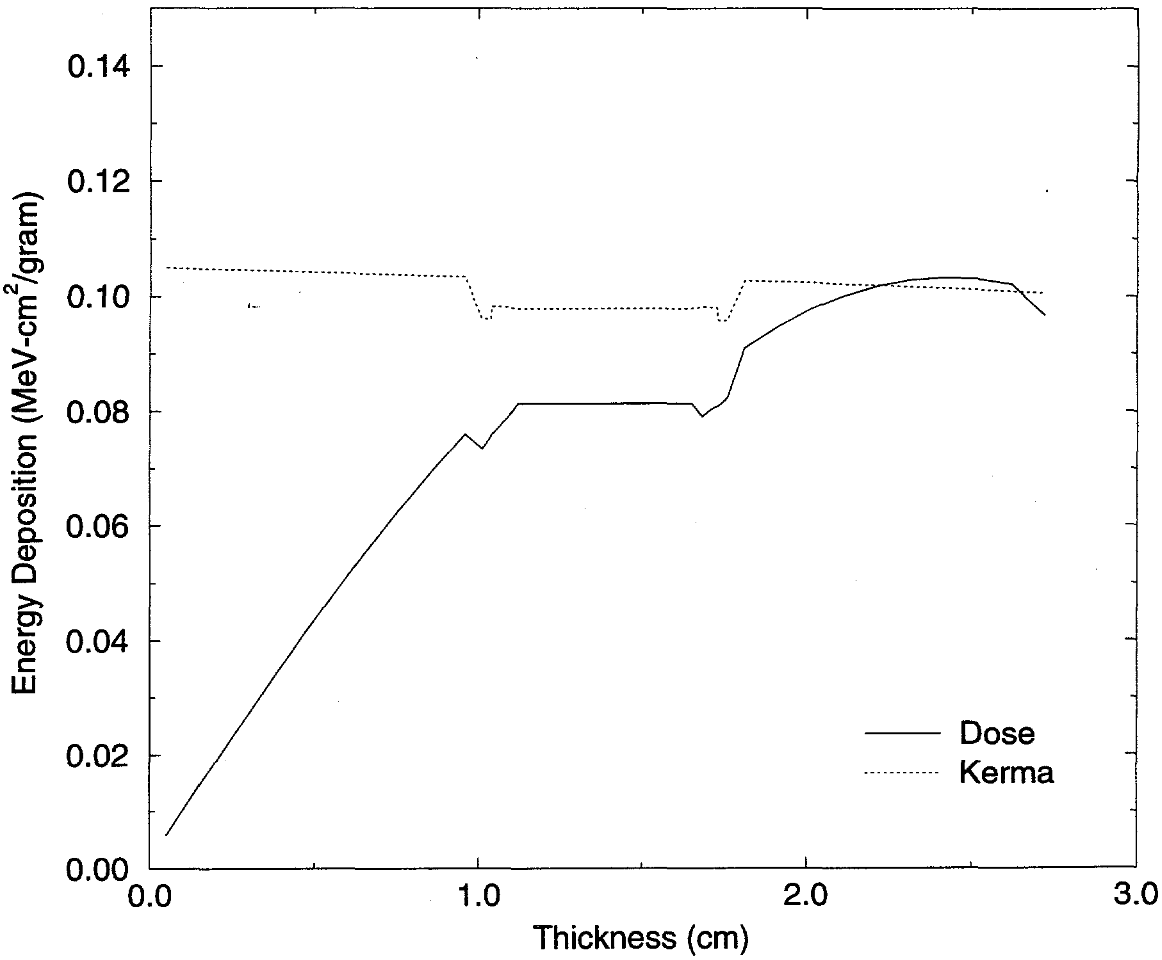

Figure 4.15: Energy deposition profile for a 6.0 MeV monoenergetic plane-wave photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 4 MeV buildup cap.

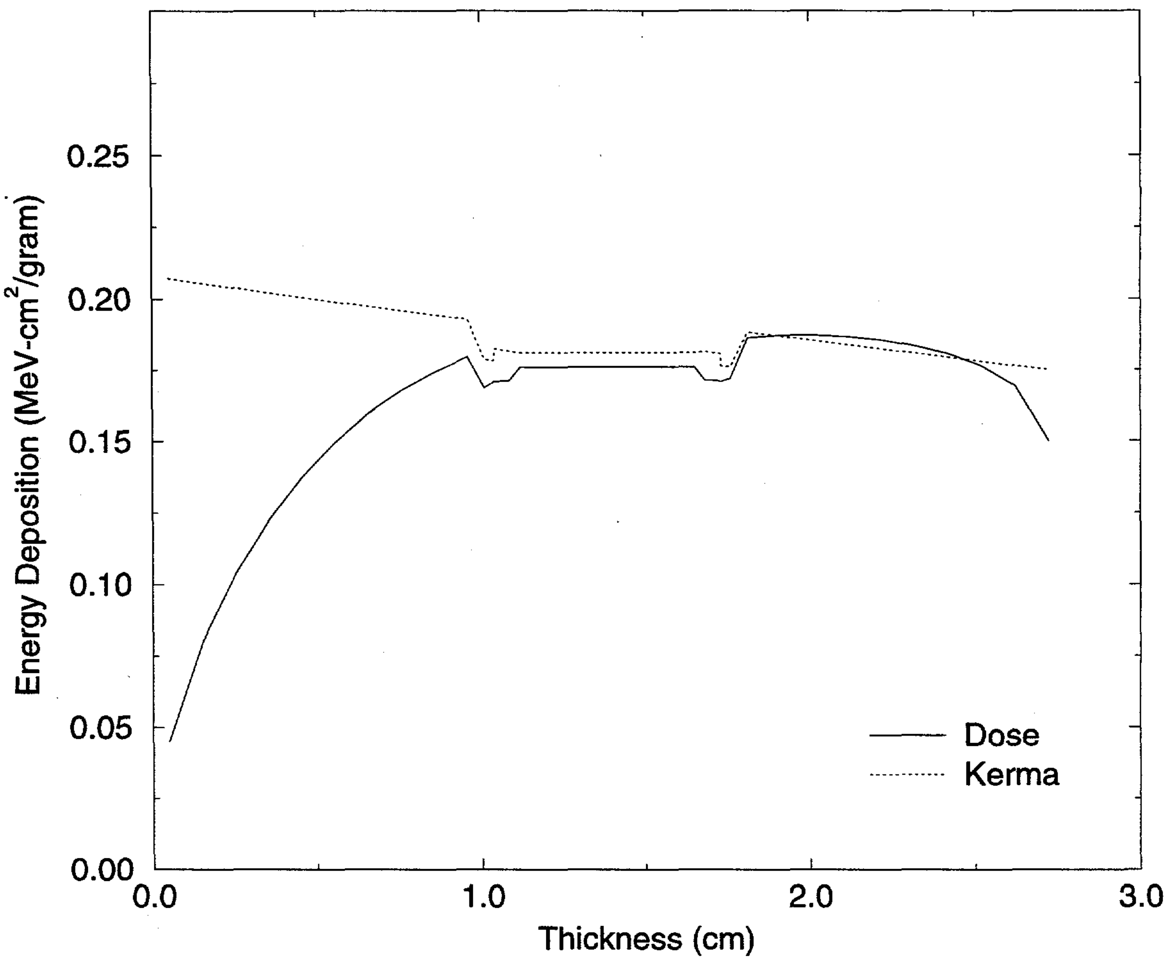

Figure 4.16: Energy deposition profile for a 6.0 MeV monoenergetic isotropic photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 6 MeV buildup cap.

cap is well suited for measurements of a 6 MV bremsstrahlung spectrum.

4.6 Characterization of a Proposed 18 MeV Buildup Cap

To characterize an 18 MeV buildup cap, both monoenergetic and spectral sources in plane-wave and isotropic geometries, were simulated to evaluate the required thickness of delrin needed to achieve transient charged particle equilibrium. The effects of 18 MeV monoenergetic plane-wave and isotropic photon sources incident upon an infinite slab of delrin were first evaluated. Figures 4.19 and 4.20, suggest that a thickness of over 6 cm of delrin is needed to achieve transient charged particle equilibrium. It is believed that an appropriate thickness and proper correction factors could be determined for 18 MeV monoenergetic photon sources. However, since the buildup cap is to be used on an ionization chamber measuring spectral sources instead of monoenergetic sources, it was decided to base the thickness of delrin and any correction factors on the information obtained from a known 18 MeV spectrum.

The spectral source used came from the 14 TW Pulsed Power HERMES-III Electron Accelerator at Sandia National Laboratory in Albuquerque, New Mexico. The spectrum was generated from the work by Sanford et al. [33], and an unpublished work by Jason VanDenburg [34]. The generated spectrum can be found in Appendix C. Figure 4.21 shows the data from the 18 MV plane-wave spectrum photon source incident upon a semi-infinite slab of delrin. At a thickness of 3.6 cm, the kerma and dose profiles are equal. However. this thickness is not adequate to establish transient charged particle equilibrium. This occurs at the point where the dose and kerma curves become parallel. At approximately 5.4 cm of delrin, transient charged particle equilibrium is established for an 18 MV plane-wave spectral source. An isotropic spectral source was also investigated and the results are shown in Figure 4.22. The dose profile is markedly different from the plane-wave spectrum. Maximum dose occurs at a shallower depth in the material, kerma and dose are equal at the point of maximum dose, and the graph has an exponential shape. It is believed that the plane-wave source forces the particles deeper into the material. The result is less photon attenuation causing a more linear reduction in kerma; thus any electrons created by the interaction of the photons will follow a similar shape. The isotropic source does not force the

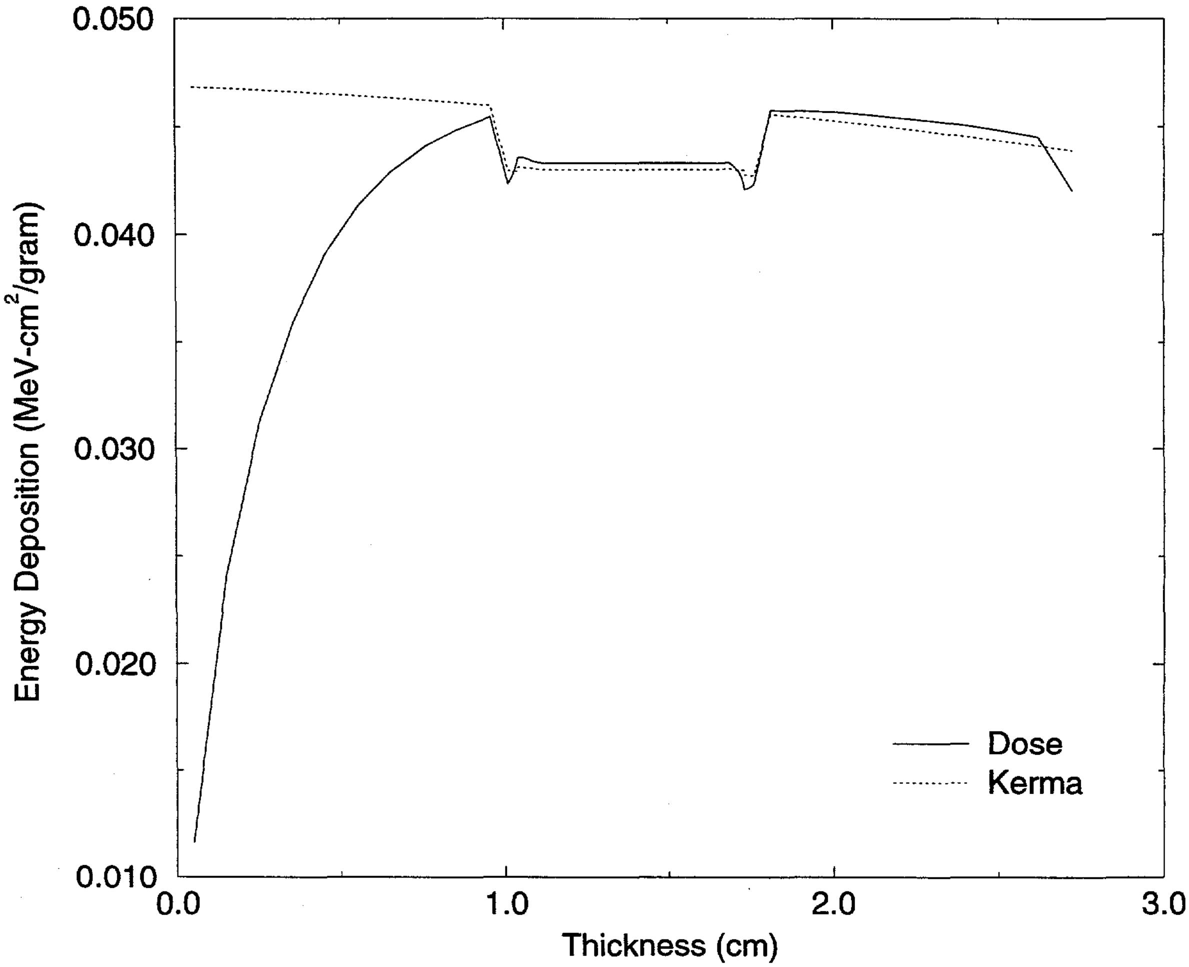

Figure 4.17: Energy deposition profile for a 6.0 MV plane-wave spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 6 MeV buildup cap.

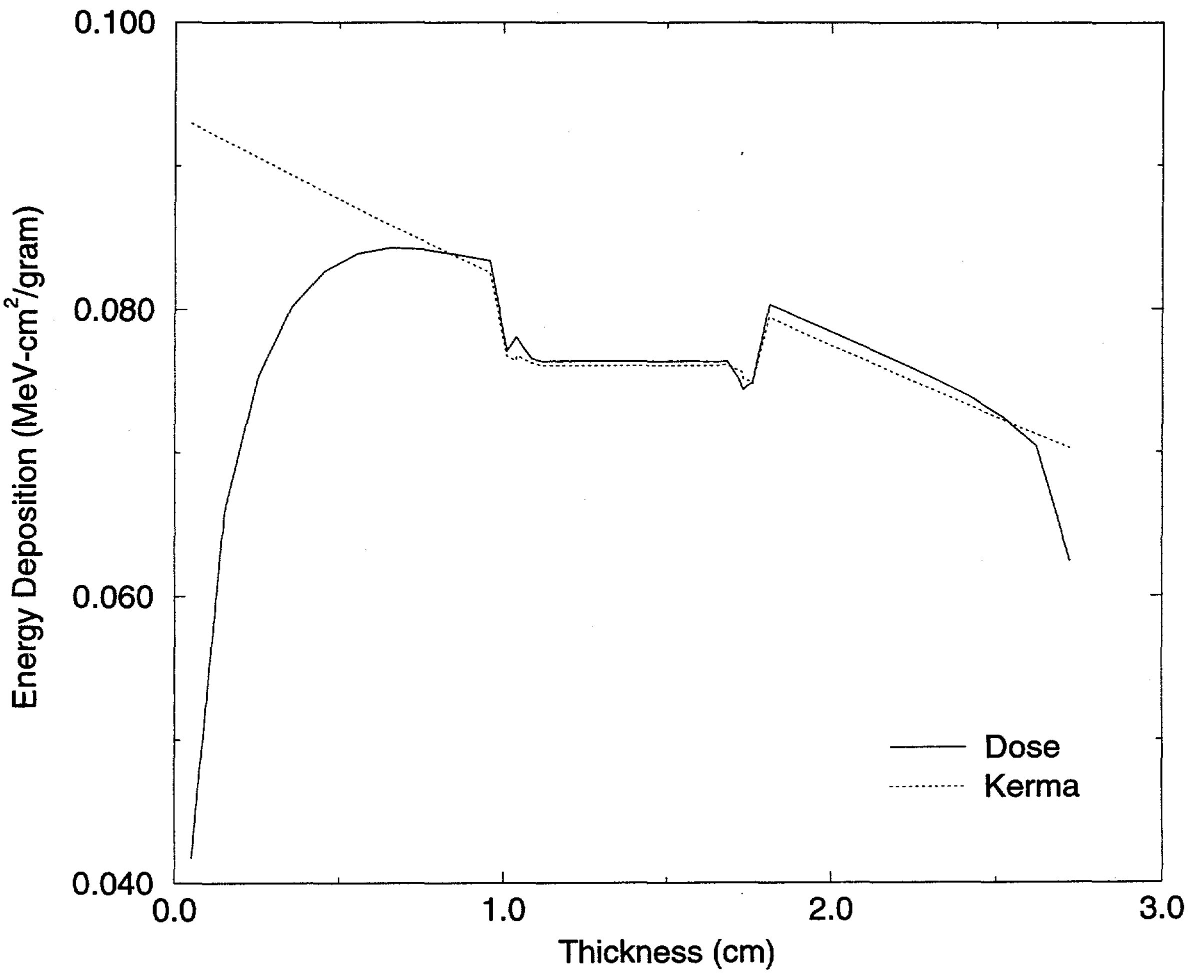

Figure 4.18: Energy deposition profile for a 6.0 MV isotropic spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 6 MeV buildup cap.

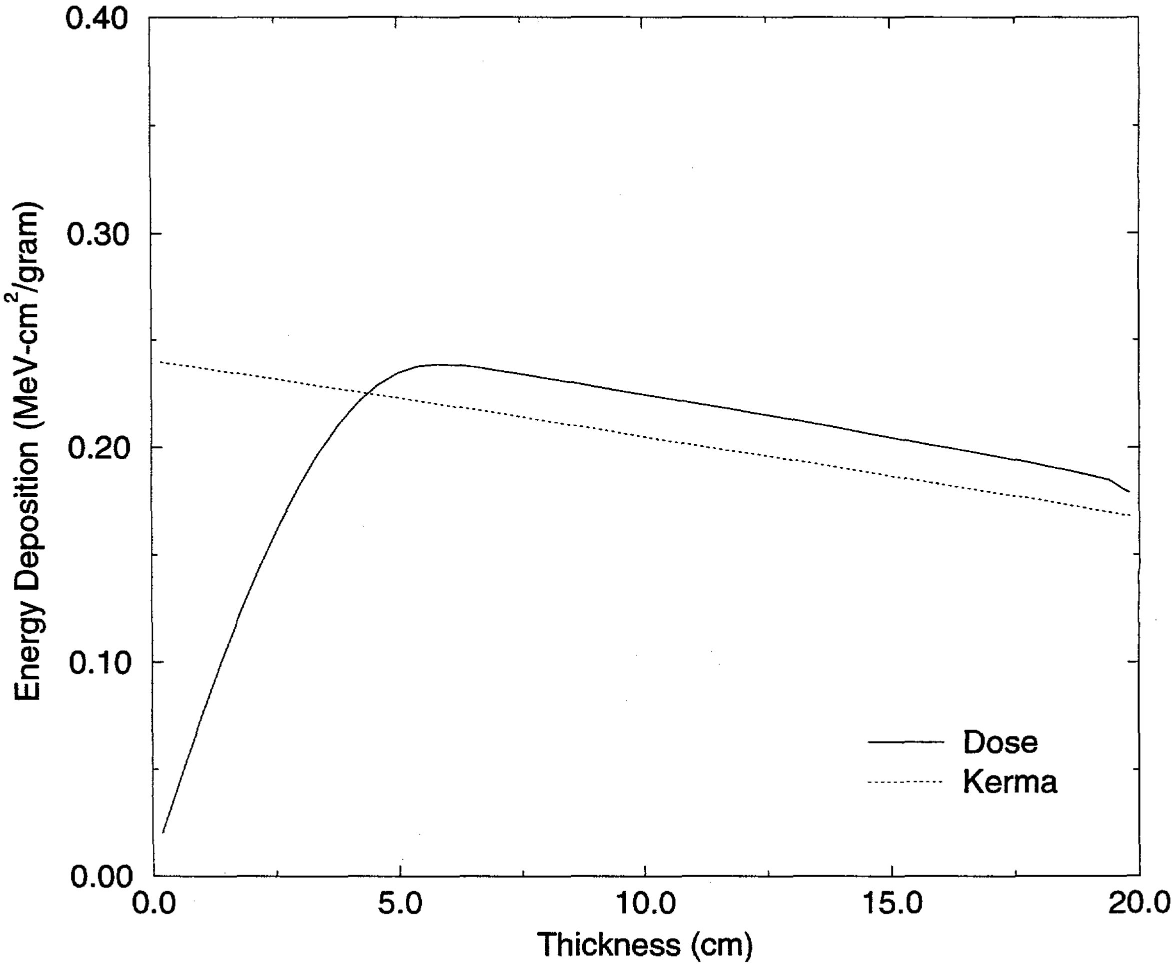

Figure 4.19: Energy deposition profile for an 18.0 MeV monoenergetic plane-wave photon source incident upon an infinite slab of delrin.

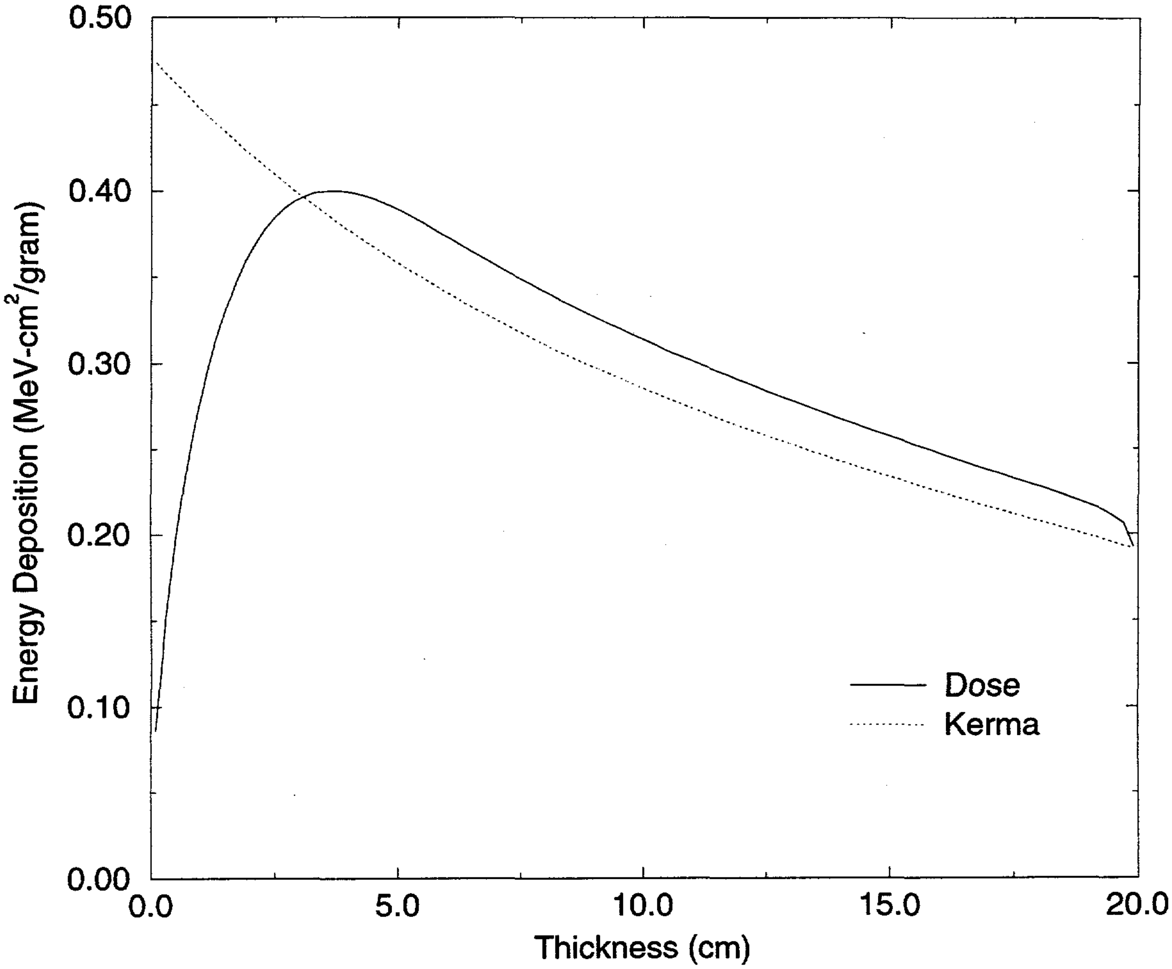

Figure 4.20: Energy deposition profile for an 18.0 MeV monoenergetic isotropic photon source incident upon an infinite slab of delrin.

incident photons as deeply into the material. As a result, there are fewer photons available for interactions as the thickness of material increases; thus resulting in the characteristic exponential shape.

A thickness of 5.4 cm to ensure transient charged particle equilibrium for an 18 MV plane-wave spectral source was assigned to material one. The thickness of the outer wall of the ionization chamber is 0.08126 cm. Therefore, a buildup cap of approximately 5.32 cm is proposed. Figure 4.23, shows the energy deposition profile for the proposed buildup cap and the thimble ionization chamber in an 18 MV plane-wave spectral beam of photons. Dose and kerma begin to parallel each other in the outer wall of the ionization chamber, and remain parallel throughout the gas cavity. An isotropic spectral source was also used to evaluate the proposed buildup cap. Figure 4.24, shows that dose and kerma are parallel at about 4 cm of delrin and remain parallel throughout the gas cavity as well. This indicates that a buildup cap of at least 5.32 cm will provide adequate buildup for either a plane-wave or isotropic spectral source.

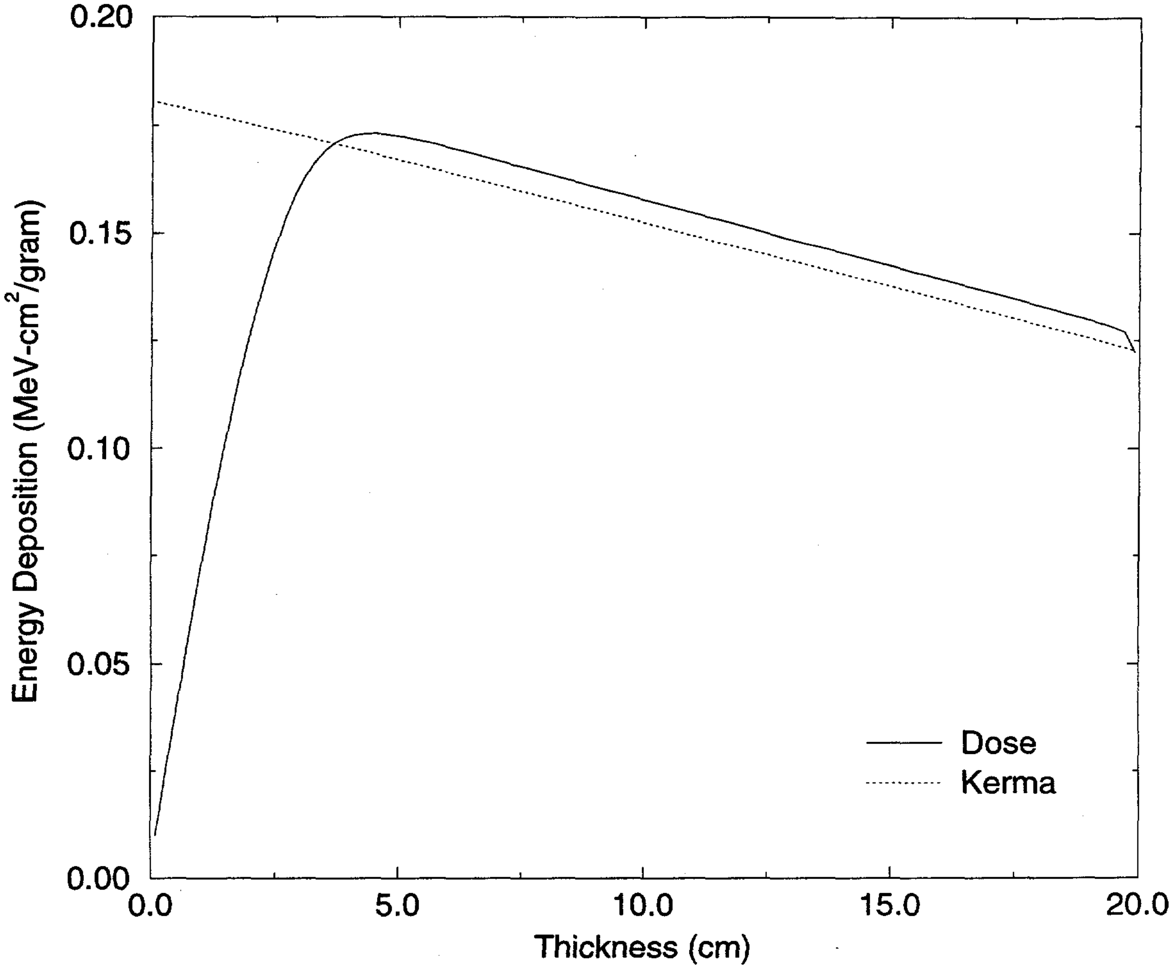

Figure 4.21: Energy deposition profile for an 18.0 MV plane-wave spectral photon source incident upon an infinite slab of delrin.

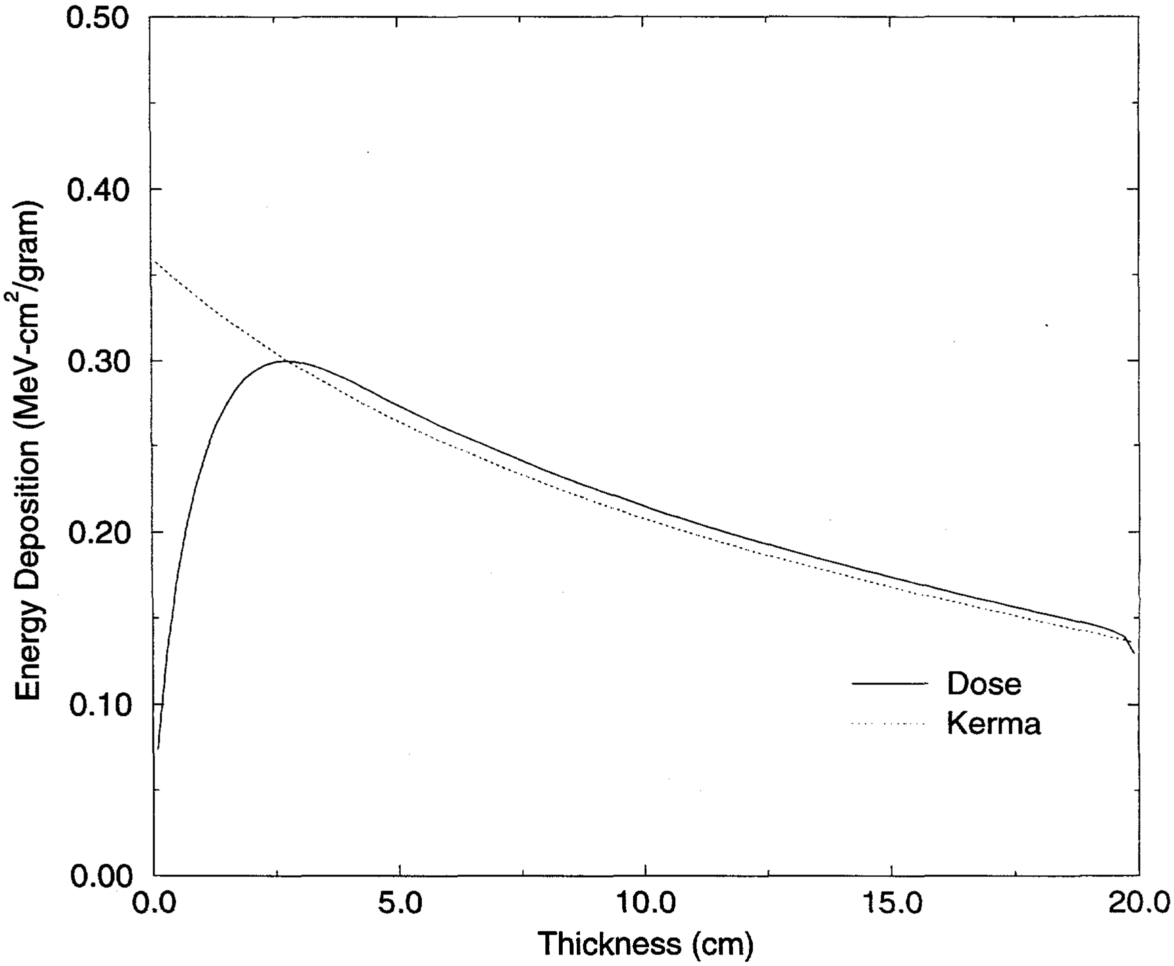

Figure 4.22: Energy deposition profile for an 18.0 MV isotropic spectral photon source incident upon an infinite slab of delrin.

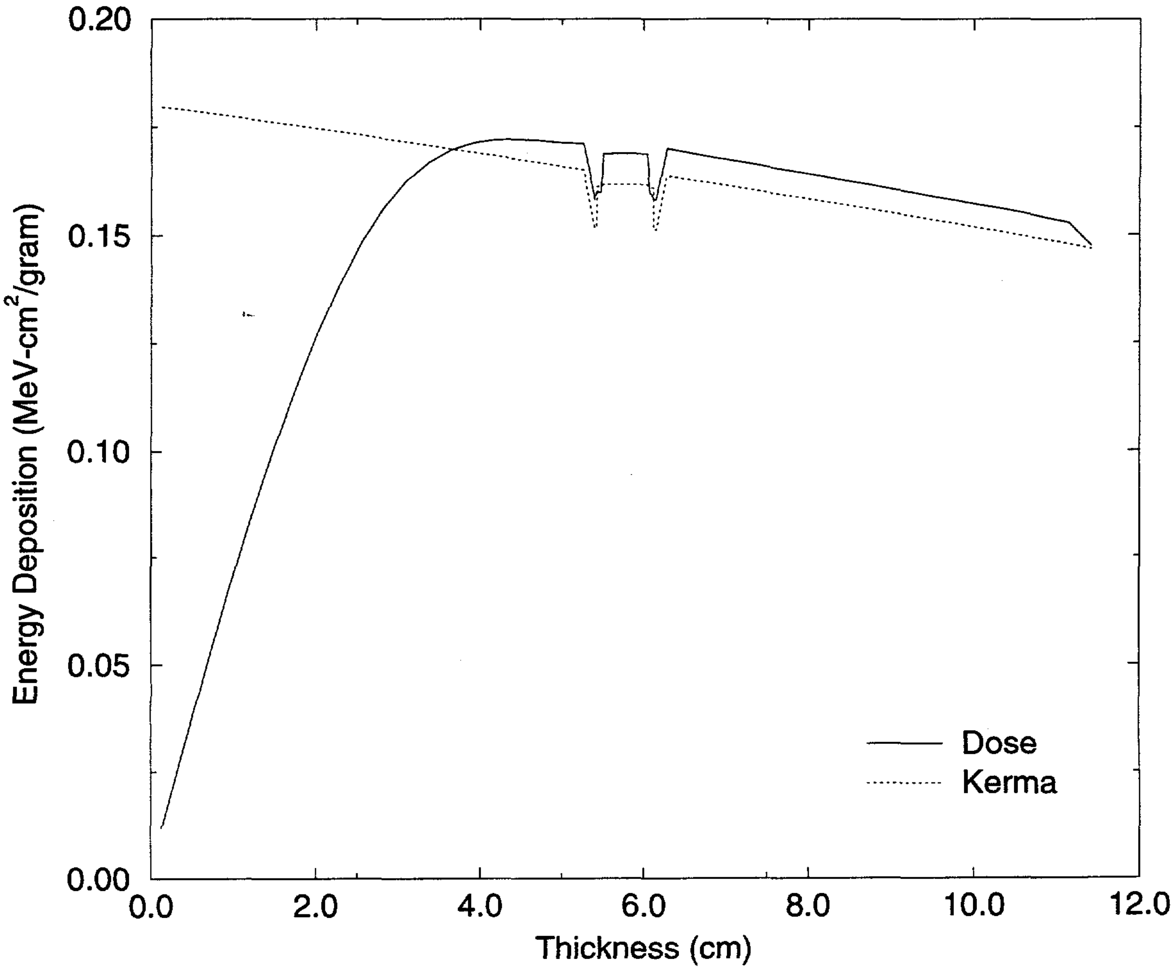

Figure 4.23: Energy deposition profile for an 18.0 MV plane-wave spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 5.4 cm of delrin.

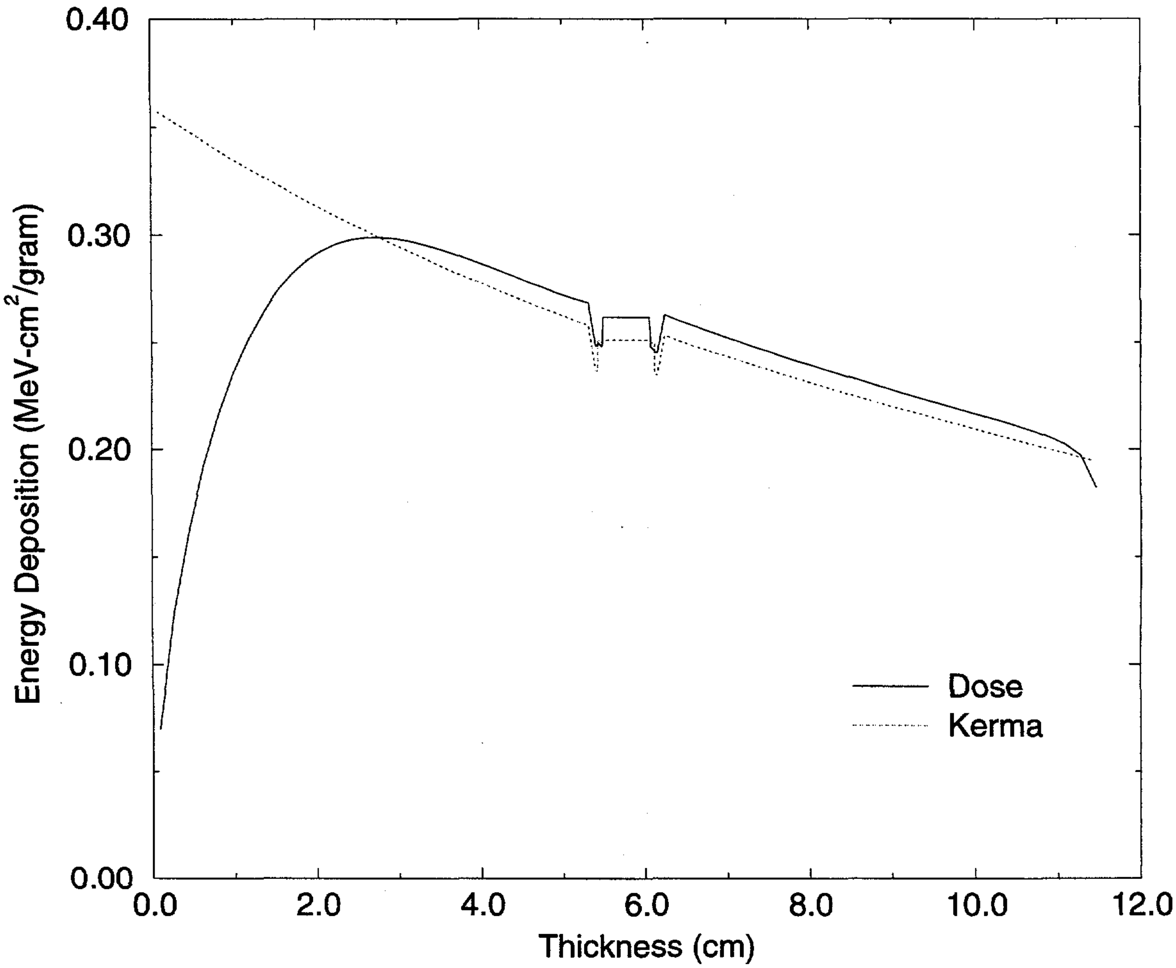

Figure 4.24: Energy deposition profile for an 18.0 MV isotropic spectral photon source incident upon the 0.6 cm^3 active volume thimble ionization chamber with 5.4 cm of delrin.

Chapter 5

Experimental Measurements and Analysis

5.1 Introduction

In-beam measurements were performed to validate the results obtained from the computational characterization of the 4 MeV and 6 MeV buildup caps. The 0.6 cm^3 active volume thimble ionization chamber was attached to a Radcal 1515 Radiation Monitor for exposure measurements. This combination of equipment was calibrated on December 22, 1993 by Radcal Corporation. The calibration testing procedure employed National Institute for Standards and Testing traceable techniques. An exposure correction factor (N_x) of 0.98 Roentgens-per-scale-division was assigned to this dosimetry system by Radcal, an NIST approved secondary laboratory calibration facility. The complete calibration record is contained in Appendix E.

5.2 In-beam Measurement Methods

Two separate linear accelerator facilities were used to perform the measurements contained in this work. The 4 MeV buildup cap measurements were conducted at the St. Joseph Healthcare's Radiation Oncology facility, Albuquerque, New Mexico. Measurements for the 6 MeV buildup cap were conducted at the University of New Mexico's Cancer Research and Treatment Center also in Albuquerque, New Mexico.

Measurements performed for both the 4 MeV and the 6 MeV buildup caps were made along the central axis. At both facilities similar setups were used. The ionization chamber was placed at a distance of 100 cm from the bremsstrahlung production target in a *10x10* cm field for measurements made of the Clinac 6/100 medical accelerator. An 80 cm distance was used for the measurements made of the Clinac 4/80 medical accelerator. The chamber was attached to a stable stand approximately 40 cm from the surface of the therapy bed as shown in Figure 5.1. In an effort to minimize the effects of beam output variations, a weekly calibration check was performed immediately preceding the in-beam measurements made

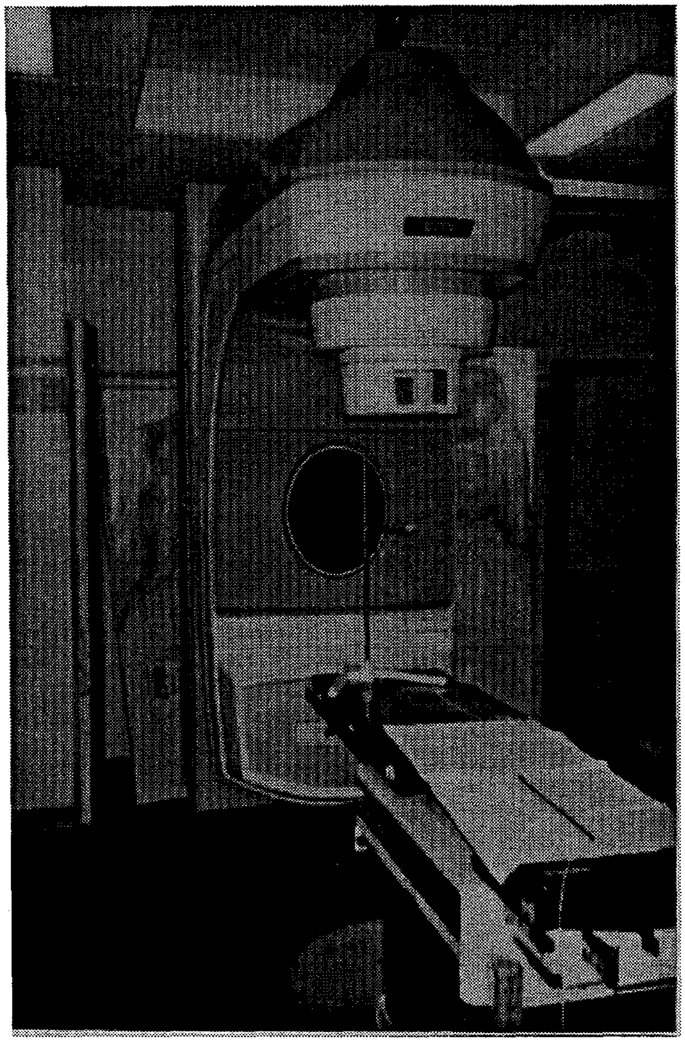

Figure 5.1: In-beam measurement setup for the 6 MV accelerator. An identical setup was used in the measurements conducted on the 4 MV accelerator.

with the 4 MeV and 6 MeV buildup caps. Exposure measurements were then carried out following the procedures set forth by each facility's Chief Clinical Physicist for the weekly calibration checks. The results of the in-beam measurements were compared to these weekly calibration checks.

5.3 Results of In-beam Measurements

The 6 MeV buildup cap was evaluated using the bremsstrahlung spectrum from a Varian Associates Clinac 6/100 clinical medical accelerator. Exposures were set for a 100 monitoring unit set, rated at 250 monitoring units per minute. Additional information regarding the gantry and collimator setup of the Varian Associates Clinac 6/100 can be found in

Appendix D.

Before measurements were performed, the chamber stability was checked. The ionization chamber was placed in the beam and exposed several times. This allowed the ionization chamber and the electrical lead to stabilize with respect to any static charge built up in the system. Random current leakage measurements were taken and found to average less than 0.2 R/100 mu.

Three measurements were taken with the ionization chamber and 6 MeV buildup cap combination. The average value of the leakage was subtracted and an average of the three measurements was determined. The result was an average exposure reading of 104.4 Roentgens. Additional measurements using the ionization chamber with no buildup cap, with the 2 MeV buildup cap, and with the 4 MeV buildup cap were conducted. In each case three measurements were taken; the average leakage was subtracted, and an average exposure value determined. The results of these measurements will be discussed in Section 5.6.

The exposure measurements for the 4 MeV buildup cap were conducted in a similar manner. A Varian Associates Clinac 4/80 was used. Additional information regarding the Clinac 4/80 is contained in Appendix D. Each exposure was set for 200 monitoring units rated at 200 monitoring units per minute. Random leakage measurements resulted in an average leakage value of 0.1 R/200 mu. Subtracting this value from each of the three measurements and averaging the exposure readings resulted in an exposure reading of 199.7 Roentgens for the 4 MeV buildup cap. Additional measurements in the beam were taken with the ionization chamber alone, and with the 2 MeV and 6 MeV buildup caps in place. These results will also be addressed in Section 5.6. Before the exposure measurements can be used to compare with the measurements obtained in the weekly calibration checks, the value of N_{gas} must be calculated. AAPM Protocol 21 was followed in determining the value of N_{gas} for the 0.6 cm^3 thimble ionization chamber.

5.4 Calculation of the Cavity-gas Calibration Factor, N_{gas}

Figure 5.2 shows the worksheet provided by the AAPM Protocol 21. The equation listed on the work sheet is identical to Equation 2.18 in Chapter 2. The values in sections one through three of the work sheet have all been reported earlier in this work with the exception of the

Worksheet (1) for calculating the cavity-gas calibration factor N_{gas}

Name: Randell L. Salyer Date: 10/20/94

The cavity gas calibration factor is obtained from Eq. (6):

$$N_{gas} = N_X \frac{k(W/e)A_{ion}\,A_{wall}\,\beta_{wall}}{\alpha(\bar{L}/\rho)^{wall}_{air}(\bar{\mu}_{en}/\rho)^{air}_{wall} + (1-\alpha)(\bar{L}/\rho)^{cap}_{air}(\bar{\mu}_{en}/\rho)^{air}_{cap}}\,.$$

When chamber wall and buildup cap are of the same material, $\alpha = 1.00$.
When chamber wall and buildup cap are of different materials, α is obtained from Fig. 1.

1. (a) Chamber model and serial number: 10 X 5 - 0.6
   (b) Cavity inside diameter: 5.893 mm
   (c) Wall material and thickness: C552/ 0.2583 g/cm^2
   (d) Buildup cap material and total wall plus cap thickness: delrin/0.811 g/cm^2
   (e) Polarizing potential: 291 V

2. (a) Calibration laboratory and date: Radcal Corp. 12/21/94
   (b) Cobalt-60 exposure calibration factor at 22 °C and 1 atmosphere:

   N_X = ________ R/C

   or N_X = 0.98 R/scale division

3. (a) Charge per unit mass of air per unit exposure: $k = 2.58 \times 10^{-4}$ C/kg R
   (b) Average energy per unit charge: $W/e = 33.7$ J/C
   (c) Absorbed dose/collision fraction of kerma: $\beta_{wall} = 1.005$

4. (a) Ion-collection efficiency (obtained from NBS or ADCL, Sec. III D): A_{ion} = 1.00
   (b) Wall-correction factor (Tables II or III): A_{wall} = 0.987
   (c) Fraction of ionization due to electrons from chamber wall (Fig. 1): α = 0.975
   (d) Stopping-power ratio, wall/air (Table I): $(\bar{L}/\rho)^{wall}_{air}$ = 1.00
   (e) Energy-absorption coefficient ratio, air/wall (Table I): $(\bar{\mu}_{en}/\rho)^{air}_{wall}$ = 1.00
   (f) Fraction of ionization due to electrons from buildup cap: $(1-\alpha)$ = 0.025
   (g) Stopping-power ratio, cap/air (Table I): $(\bar{L}/\rho)^{cap}_{air}$ = 1.087
   (h) Energy-absorption coefficient ratio, air/cap (Table I): $(\bar{\mu}_{en}/\rho)^{air}_{cap}$ = 0.937

5. Cavity-gas calibration factor at 22 °C and 1 atmosphere:

   N_{gas} = ________ Gy/C

   or N_{gas} = 0.00845 Gy/scale division

Figure 5.2: Worksheet from the AAPM Protocol 21, 1983.

polarizing voltage. This value was obtained from the Certificate of Conformance provided by Radcal Corporation (Appendix E). Section 4 of the worksheet contains many correction factors for which detailed descriptions have been provided in Chapter 2. A brief list is provided here for convenience.

- A_{ion} is the ion-collection efficiency in the user's chamber at the time of Co-60 exposure calibration.
- A_{wall} Corrects for the attenuation and scatter in the wall and buildup cap when exposed to Co-60 gamma rays.
- α is the fraction of ionizations produced in the air cavity due to electrons created in the chamber wall.
- $\left(\overline{L}/\rho\right)_{air}^{wall}$ is the ratio of the mean restricted collision mass stopping powers of the wall material to the air in the cavity.
- $(\overline{\mu}_{en}/\rho)_{wall}^{air}$ is the ratio of the mean mass energy-absorption coefficients of the air in the chamber to the wall material.
- $(1-\alpha)$ is the fraction of ionizations produced in the air cavity due to electrons created in the buildup cap.
- $\left(\overline{L}/\rho\right)_{air}^{cap}$ is the ratio of the mean restricted collision mass stopping powers of the buildup cap material to the air in the cavity.
- $(\overline{\mu}_{en}/\rho)_{cap}^{air}$ is the ratio of the mean mass energy-absorption coefficients of the air in the chamber to the buildup cap material.

The values reported on the work sheet were determined as follows. The ion-collection efficiency A_{ion} is 1.00, for a 0.6 cm^3 thimble ionization chamber [33]. A_{wall} was determined using Table 5.4, which is reproduced from the AAPM Protocol 21 [10]. The tabulated values in Table 5.4, are the percentage of attenuation and scattering per unit wall thickness in g/cm^2. Using interpolation techniques on the values in Table 5.4, an inner axial length

Inner Axial Length (cm)	Inner Diameter (cm)			
	0.4	0.6	0.8	1.0
0.4	1.56	2.10	2.70	3.22
0.6	1.53	2.05	2.60	3.10
0.8	1.51	2.00	2.50	2.96
1.0	1.49	1.95	2.40	2.84
1.5	1.44	1.80	2.15	2.52
2.0	1.42	1.65	1.90	2.22
2.5	1.4	1.52	1.70	1.90

Table 5.1: Attenuation and scattering as a function of the internal dimensions of a cylindrical ionization chamber.

of 2.144 cm, and an inner diameter of 0.5893 cm, a value for gamma was determined. A_{wall} is calculated by:

$$A_{wall} = 1 - \left(\frac{t\gamma}{100}\right) \tag{5.1}$$

where, t, is the thickness of the wall and buildup cap in g/cm^2, and A_{wall} was determined to be 0.987. The value for α was obtained from Figure 1, of Protocol 21, and found to be equal to 0.975. The inner wall material, C552, has a value of 1.00 for both the $\left(\overline{L}/\rho\right)^{wall}_{air}$ and $(\overline{\mu}_{en}/\rho)^{air}_{wall}$. These values were also provided by Protocol 21. The value of $(1-\alpha)$ was calculated to be 0.025. The remaining two correction factors $\left(\overline{L}/\rho\right)^{cap}_{air}$ that was 1.087, and $(\overline{\mu}_{en}/\rho)^{air}_{cap}$ that was 0.937, were provided by Dr. Thomas Kirby of the University of New Mexico's Cancer Research and Treatment Center. The cavity-gas calibration factor was then calculated to be 0.845 cGy/scale division.

5.5 Mini-phantom Dose Calculations

The final procedure is to determine if the dose to the buildup caps, or mini-phantoms, is equal to the dose values delivered by the calibrated beams of the medical accelerators. Clinical medical accelerators are set up to deliver a certain dose based on the number of monitoring units (mu) dispensed. A monitoring unit is a measure of the radiation output of the accelerator that is directly related to the dose delivered at the desired location. One monitoring unit corresponds to the delivery of 1.000 cGy at d_{max} in a full tissue phantom that has a 100 cm source-to-surface distance and a 10x10 cm field. Using the results of the in-beam measurements and the method stated in Section 2.4 of Chapter 2, doses to the 4 MeV and 6 MeV buildup caps were determined and compared to the calibrated beam rating.

Kirby et al. [35], in developing their method for measuring the peak scatter factor (PSF), discuss a procedure whereby a small water phantom is used instead of a full phantom to perform the weekly calibration checks of clinical medical accelerators. Once the peak scatter factor for a specific machine is determined experimentally, the calibration dose delivered by the accelerator can be determined using a mini-phantom of water and Equation 5.2 below.

$$D_{mini} = \frac{D_{full}}{PSF} \frac{\left(\frac{\overline{\mu}_{en}}{\rho}\right)_{water}}{\left(\frac{\overline{\mu}_{en}}{\rho}\right)_{tissue}} \tag{5.2}$$

where, $(\overline{\mu}_{en}/\rho)_{water}$, and $(\overline{\mu}_{en}/\rho)_{tissue}$, are the mean mass energy-absorption coefficients necessary to convert from a water dose to a tissue dose; their values are 0.0180 and 0.0178 respectively. The dose to the water phantom was calculated to be 0.973 cGy/mu.

The transport code characterization of the 6 MeV buildup cap predicted that transient charged particle equilibrium would exist if placed in the beam of the Clinac 6/100 linear accelerator. Therefore, a measurement taken under such conditions should result in a calculated dose to the 6 MeV buildup cap very close to that in the full phantom, or in the case of the weekly calibration check, close to the value obtained using the water phantom.

From Chapter 2, the dose to a mini-phantom is represented by:

$$D_{mini} = M N_{gas} \left(\frac{\overline{L}}{\rho}\right)_{air}^{delrin} P_{repl} P_{wall} P_{ion} \tag{5.3}$$

where, M, is the reading from the Radcal detector in Roentgens per scale division. This reading should be corrected for temperature and pressure. However, the Radcal 1515 detector has barometric pressure and temperature sensors that automatically compensate and correct the readings for temperature and pressure.

The descriptions of M, N_{gas}, $\left(\overline{L}/\rho\right)_{air}^{delrin}$, P_{wall}, and P_{ion} have been presented in previous sections; however, the values are 1.044 R/mu, 0.845 cGy/scale division, 1.087, 1.00, and 1.00, respectively. The value of P_{repl} was obtained from the AAPM Protocol 21 and determined to be 0.992. The result of the calculation of the dose to the delrin mini-phantom from the in-beam exposure measurement was 0.951 cGy/mu. The equivalent mini-phantom dose using the buildup cap measurement would be calculated as follows:

$$D_{mini} = M N_{gas} \left(\frac{\overline{L}}{\rho}\right)_{air}^{delrin} P_{repl} P_{wall} P_{ion} \left(\frac{\overline{\mu}_{en}}{\rho}\right)_{delrin}^{water} \tag{5.4}$$

where the conversion from the delrin buildup cap material to water is accomplished by applying the factor $(\overline{\mu}_{en}/\rho)^{water}_{delrin}$ which equals 1.029. The result is a full phantom equivalent dose to water from the buildup cap measurement of 0.979 cGy/mu. This is within 0.62 percent of the value obtained by the independent measurement performed during the weekly calibration check.

The 4 MeV buildup cap evaluation resulted in a 0.35 percent discrepancy between the dose to the mini-phantom of water and the dose to the buildup cap. All calculations for the 4 MeV buildup cap dose determination can be found in Appendix D.

5.6 Buildup Curves

At the time of making measurements on the 4 MeV and 6 MeV buildup caps, additional measurements were made for the purpose of validating that the thickness of buildup material for max dose also was appropriate for max exposure. Each of the data points on the following buildup curves (Figures 5.3 through 5.5) represent an associated buildup cap: no buildup cap (0.155 g/cm^2), 2 MeV buildup cap (0.204 g/cm^2), 4 MeV bulidup cap (0.389 g/cm^2), 6 MeV bulidup cap (0.627 g/cm^2) and 8 MeV bulidup cap (1.591 g/cm^2).

In Figure 5.3, the maximum exposure occurs when the 4 MeV buildup cap is used in the 4 MV beam. Note that without adequate material thickness for buildup, as with no cap or the 2 MeV cap, there are not sufficient interactions so the detector gives an exposure reading much lower than should be.

With the 4 MeV cap in place, the maximum exposure reading is achieved, kerma is at a maximum, and the results are an accurate exposure measurement. However, when the 6 MeV buildup cap is used, a decrease in the exposure occurs. This lends supporting evidence for the proposition that there is an optimal thickness for buildup caps. If the 6 MeV buildup cap thickness were to be used in a photon beam similar to the 4 MV accelerator beam, the amount of discrepancy in the dose measurement increases by a factor of five.

The 6 MeV buildup cap measurements revealed a very similar situation. Figure 5.4 shows the exposure versus density thickness for the Clinac 6/100. Unfortunately there was not another buildup cap of delrin to use to get the measurement after the max to show the effects of attenuation. However, unpublished data from Dr. Thomas Kirby of

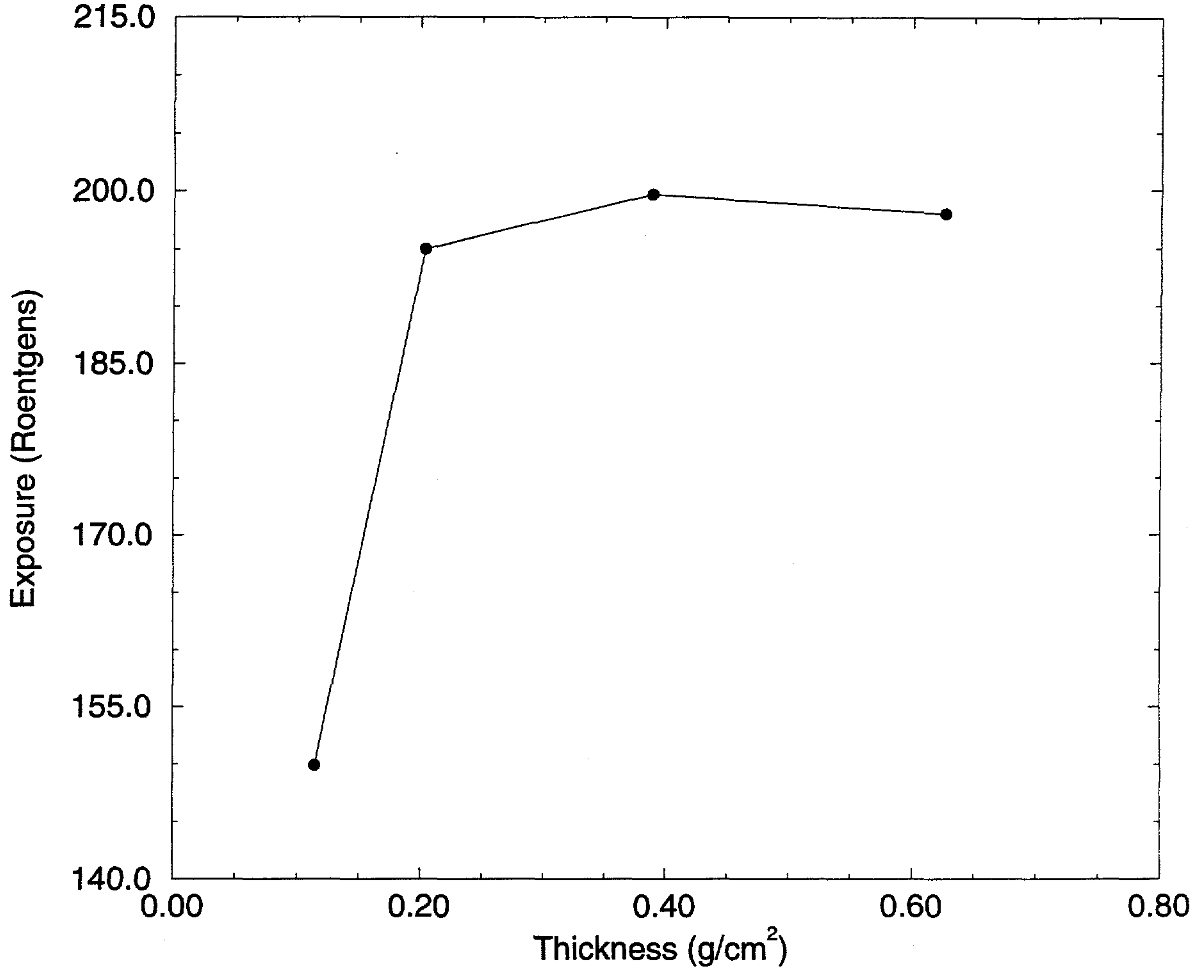

Figure 5.3: Exposure versus density thickness for the 4 MV spectrum from the Clinac 4/80.

the University of New Mexico's Cancer Research and Treatment Center, shows identical relationships between exposure and density thickness for a 6 MV beam incident upon acrylic buildup caps.

In an effort to validate that the relationship between acrylic buildup caps and exposure also holds true for delrin buildup caps, further analysis using transport codes is presented. Since delrin has been shown to be air equivalent, and since exposure is related to dose by:

$$D_{air} \stackrel{CPE}{=} (K_c)_{air} = X \left(\frac{W}{e}\right)_{air} \tag{5.5}$$

dose was substituted for exposure measurements to evaluate the effects of a simulated 8 MeV buildup cap placed in a 6 MV isotropic spectral beam. Figure 5.5, is a plot of dose versus density thickness for a 6 MV spectrum.

To simulate an 8 MeV buildup cap, 1.285 cm of delrin was added to the outer wall thickness of 0.0813 cm for a total thickness of 1.366 cm. A thickness of 1.366 cm was determined by calculating the effective energy for an 8 MV isotropic spectrum. From Mohan et al. [22], the effective energy of an 8 MeV spectrum is approximately 45 percent of the Maximum, or in this case, 3.6 MeV. Appendix B, which contains electron range data, shows an electron range of 1.366 cm in material 1, for a 3.6 MeV electron.

Again, as with the 4 MV beam incident upon the different thicknesses of delrin, the data shows that if an 8 MeV buildup cap were to be used in the 6 MV beam, the buildup would not be appropriate, and an invalid exposure measurement would be made. It should also be noted that if a thickness of twice the range of the secondary electron were to be used, that similar results would have occurred. The range of the maximum secondary electron from a 6 MV spectrum is 0.9989 cm. Twice this amount would be 2.697 cm, which is much greater than the 1.366 cm used to simulate the 8 MeV buildup cap. Therefore, if twice the range of the secondary electrons were to be used to construct a 6 MeV buildup cap, it would result in invalid exposure measurements.

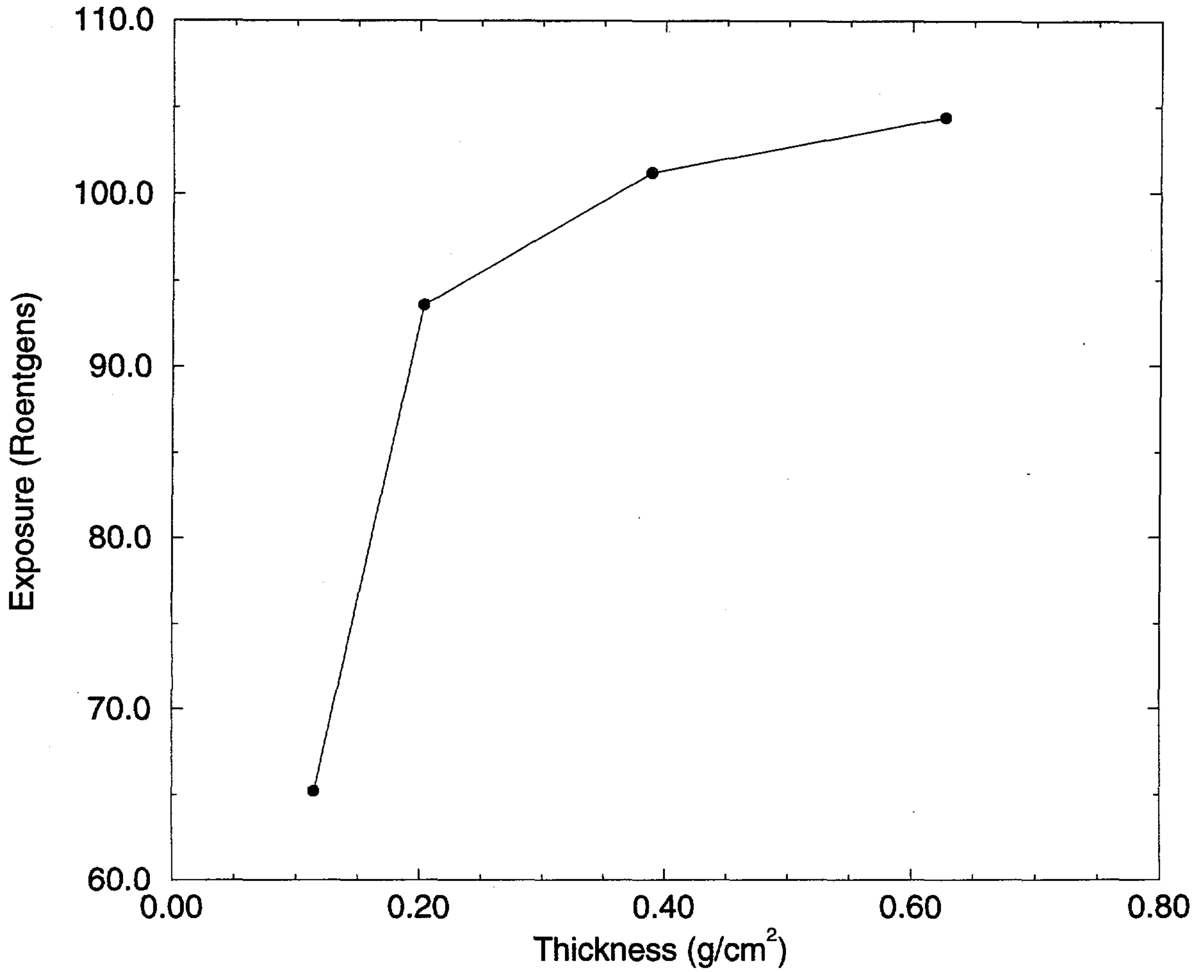

Figure 5.4: Exposure versus density thickness for the 6 MV spectrum from the Clinac 6/100.

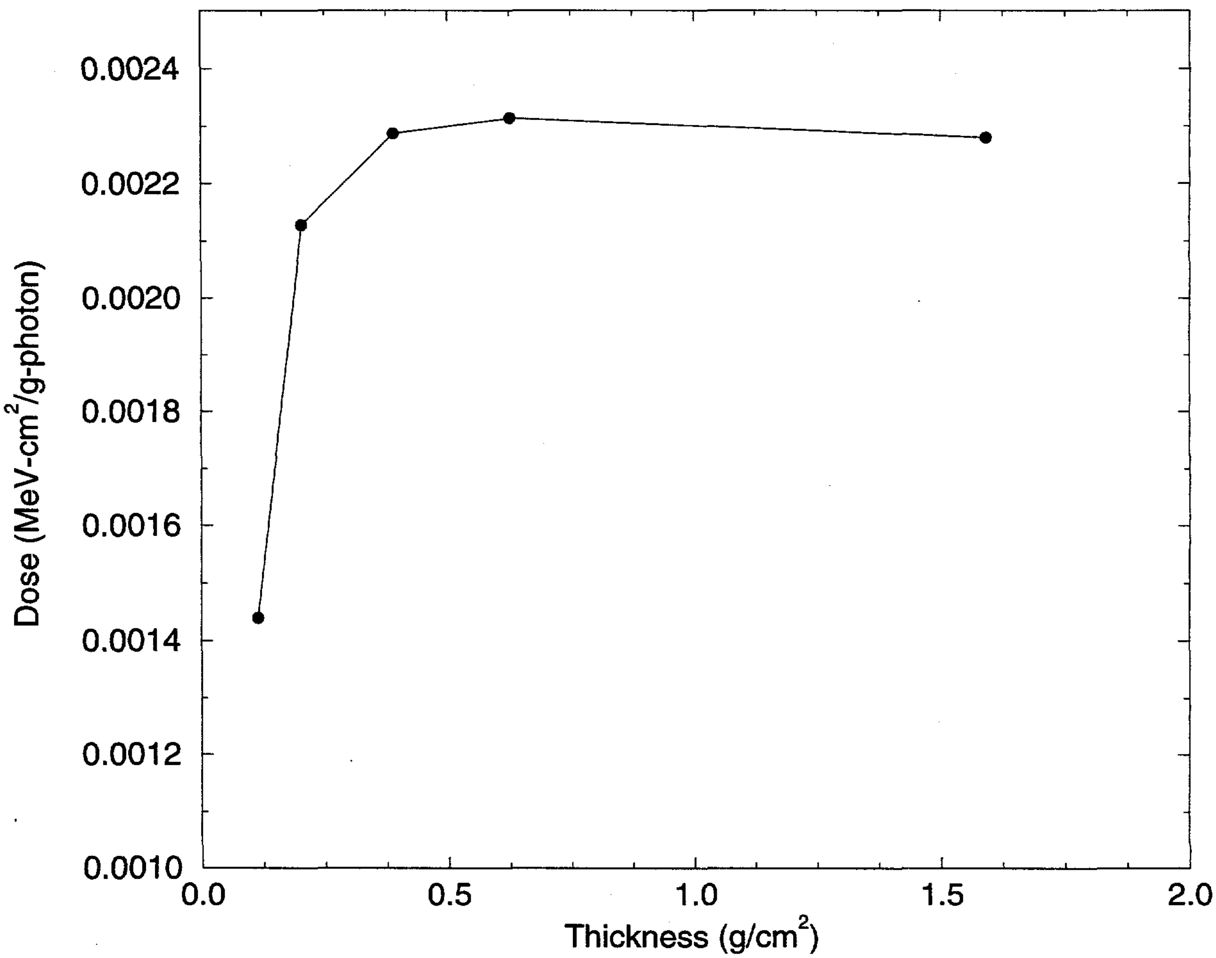

Figure 5.5: Dose versus density thickness for a simulated 6 MeV spectrum.

Chapter 6

Discussion

6.1 Introduction

The aim of the present investigation was to determine if the buildup caps could be used to accurately report the exposure readings from accelerators that produce bremsstrahlung radiation. The intent was to determine correction factors that, when applied to the ionization chamber with either the 4 MeV or the 6 MeV buildup cap, would be accurate in high-energy photon fields. The calibration laboratory, using the NIST protocols, determines the exposure calibration factor for the Co-60 energy. It is generally accepted, that for energies ranging from a few tens of keV, to about 2 MeV, the Co-60 calibration factor should be adequate. The manufacturer's specifications state this; however, neither the literature or the manufacturer mentions exposure correction factors for higher energy radiation fields. Therefore, this research has validated the 2 MeV buildup cap exposure calibration factor, and has determined the exposure correction factors for the 4 MeV and 6 MeV buildup caps.

6.2 The Existing 2 MeV, 4 MeV, and 6 MeV Buildup Caps

A representative model of the 2 MeV calibration buildup cap with incident 1.253 MeV monoenergetic plane-wave and isotropic photon sources, was analyzed using **ONEDANT**; a radiation transport code. The range of the most energetic secondary electron and the points where kerma equals dose and where maximum dose occurs, is within the thickness of the 2 MeV buildup cap and ionization chamber wall material. This suggest that the buildup cap is capable of providing sufficient buildup, at Co-60 photon energies, for charged particle equilibrium to be established. A transport code analysis of the buildup cap performance with the energy increased to 2 MeV and with the same monoenergetic sources, revealed that the 2 MeV buildup cap is not sufficiently thick to provide buildup at an energy of 2 MeV. However, the mean energy of a bremsstrahlung spectrum with a maximum 2 MeV end point energy would be 1.1 MeV. Therefore, the data suggest that the buildup cap, although advertised as a 2 MeV buildup cap, is only suitable for spectral isotropic sources with 2 MeV maximum energies, and for calibration with a Co-60 source.

The 4 MeV and 6 MeV buildup caps were evaluated using 4 MeV and 6 MeV monoenergetic plane-wave and isotropic sources respectively. The data from both the plane-wave and isotropic sources suggest that maximum dose, the point where kerma equals dose, and the range of the most energetic secondary electron would not occur in the buildup cap or the wall material; implying that charged particle equilibrium could not be established for this material at the given energy for either the 4 MeV or the 6 MeV buildup cap.

Spectral information was obtained from a Clinac 4/80 and a Clinac 6/100, and used as the 4 MV and 6 MV photon sources in the computer modeling. Data from the 4 MV plane-wave spectral source suggests that the range of the maximum secondary electron is much greater than the thickness of the wall of the ionization chamber with the 4 MeV buildup cap in place. Similar results were found for the 6 MeV buildup cap at 6 MV energy. Therefore, the maximum dose and the point where kerma equals dose will not occur in the wall of the ionization chamber or in either buildup cap. However, the data from the model of the 4 MeV buildup cap with incident 4 MV isotropic spectral source suggests that the range of the most energetic secondary electron, maximum dose, and the point where kerma equals dose, will occur within the thickness of the ionization chamber wall and buildup cap. The radiation transport code simulation of the 6 MV isotropic spectral source and buildup cap produced similar results to those found for the 4 MV isotropic spectral source and buildup cap. Again, as with the 2 MeV buildup cap, the data suggest that the 4 MeV and 6 MeV buildup caps are appropriate for measuring isotropic spectral sources.

Once Bragg-Gray theory and charged particle equilibrium conditions were predicted by the radiation transport computer codes, in-beam experimental measurements were performed. To minimize the effects of beam output variations, a standard weekly calibration check was preformed by each facility's medical physicist immediately prior to the experimental measurements. A Clinac 4/80 and a Clinac 6/100 was used to produce the photon fields to be measured. The measured value was then used as the exposure term to determine the dose to the mini-phantom (buildup cap). The dose to the mini-phantom (4 MeV buildup cap) adjusted to water equivalence was 0.971 cGy/mu. Comparing this to the value obtained from the weekly beam calibration check, which was 0.974 Gy/mu, resulted in an error of only 0.35 percent. The dose to the mini-phantom (6 MeV buildup cap) adjusted to water equivalence was 0.979 cGy/mu. Comparing this to the value from the weekly beam calibration check of 0.973 cGy/mu, resulted in only a 0.62 percent difference. This data indicates that the buildup cap is a valid representation of a mini-phantom and is accurate in determining the dose to the mini-phantom material. Since the mini-phantom material is air equivalent, then an extrapolation to the dose in air and finally to an exposure in air should be reasonable.

The Certificate of Conformance reports an exposure calibration factor of 0.98 R/scale-division to be used for the Radcal 1515 detector with ionization chamber and buildup cap. This data has shown that the 2 MeV, 4 MeV, and the 6 MeV buildup caps, when used in isotropic spectral photon fields, are sufficiently thick to allow for proper buildup. Additionally, the data suggests that the method developed to determine the dose to a mini-phantom, and the use of the cavity-gas calibration factor method, N_{gas}, are accurate methods and can be extrapolated to the in-air exposure measurements using the 4 MeV and the 6 MeV buildup caps. Therefore, the exposure calibration factor of 0.98 R/scale-division which was assigned to the Radcal 1515 detector with the 0.6 cm^3 active volume *thimble* ionization chamber and 2 MeV calibration buildup cap, will be accurate for exposure measurements made in photon fields as outlined in this work.

6.3 Buildup Curves and Optimum Thickness of the 4 MeV and 6 MeV Buildup Caps

Buildup curves were produced by measurements and supported by transport code simulations. Exposure measurements were taken in the 4 MV beam using the ionization chamber without the 2 MeV buildup cap, with the 2 MeV buildup cap, with the 4 MeV buildup cap, and finally with the 6 MeV buildup cap placed over the ionization chamber. Measurements made in the 4 MV beam with anything other than the 4 MeV buildup cap resulted in measurement readings that were too low. The 2 MeV buildup cap, when placed in the 4 MV beam, did not provide sufficient thickness for proper buildup. The 6 MeV buildup cap attenuated too much of the 4 MV incident photon beam resulting in a lower exposure measurement.

A similar evaluation was performed for the 6 MV photon field. However, the lack of a buildup cap larger than the 6 MeV buildup cap made it necessary to use the transport code to develop a buildup curve for the 6 MV beam and predict the last point. The data suggest that an inadequate exposure reading will result for any buildup cap placed in the 6 MV beam except the 6 MeV buildup cap. Therefore, these buildup curves support the proposition that there is an optimum thickness of material that should be used to construct a buildup cap for high energy photon dosimetry.

6.4 The Proposed 18 MeV Buildup Cap

An 18 MeV buildup cap was computationally characterized with regards to the maximum range of the most energetic secondary electron, the point where dose and kerma are equal, the thickness at which maximum dose occurs, and the existence of transient charged particle equilibrium. Spectral information from the 14 TW Pulsed Power HERMES-III Electron Accelerator at Sandia National Laboratory was used as the photon source in the evaluation of the proposed 18 MeV buildup cap. An infinite slab of delrin was used as the target. Both plane-wave and isotropic sources were evaluated and a thickness of delrin, which may satisfy both types of sources, was proposed.

The characterization of the 18 MeV buildup cap predicts that a cap of delrin, 5.32 cm thick, should provide adequate buildup for the HERMES-III spectrum. However, it should be noted that the calibration factor provided for the Co-60 calibration will not be sufficient. Transient equilibrium conditions has resulted in a much greater discrepancy between kerma and dose at 18 MV than was present at the 6 MV energy. Therefore, adjustments will be needed to correct for transient charged particle equilibrium conditions.

Chapter 7

Future Work

There still remains one major unanswered question. Does the 18 MeV buildup cap work? A 5.32 cm cap, made from delrin, should be machined to fit over the 0.6 cm^3 thimble ionization chamber. This cap should be placed in the HERMES-III spectrum and measurements made. It would be best to use a full phantom and the AAPM Protocol 21, to determine the dose to tissue. Following the steps used in Chapter 5, in-air measurements made with the proposed 18 MeV buildup cap could then be compared to the full phantom dose, and an exposure calibration factor based on the difference could be determined. If the HERMES-III spectrum is not available, there are many medical accelerators that can produce high-energy photon spectra that may be satisfactory for the verification of the 18 MeV buildup cap and an exposure calibration factor.

Radiation transport methods should be applied to the characterization of several buildup caps for use in photon spectrums between 6 and 18 MV. The characterization should be extended to buildup caps for use in photon spectrums up to 45 MV. Also, buildup caps for use in monoenergetic beams should be evaluated.

Finally, it would be interesting to look at the plane-wave and the isotropic spectrums. The electron currents from the radiation transport codes could be used to determine exactly what is happening when transient charged particle equilibrium conditions are, and are not met. This analysis may lead to a means of determining exposure calibration factors based on computer models of transient charged particle equilibrium conditions.

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Appendix A, Input/Output DataFiles for the 2 MeV, 4 MeV, and 6 MeV Buildup Caps.

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 1.253 MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.3708
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.3708
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 1.253
COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


*********************************************************************
*                                                                   *
*                 PROBLEM DEFINITION                                *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	3.7080E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	3.7080E-01	1 UNKNOW	1.4170E+00	10

```
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order = 16
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0001E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	9.9999E-01
2	1.0000E+00
3	9.9984E-01
4	1.0002E+00
5	1.0001E+00
6	9.9971E-01
7	1.0000E+00

```
1*********************************************************************
 *                                                                   *
 *                         OUTPUT (CRAY)                             *
 *                                                                   *
 *             AVERAGE SOURCE ENERGY =  1.2530E+00 MeV               *
 *                                                                   *
 *          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE    *
 *                                                                   *
 *            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A       *
 *            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                *
 *                                                                   *
 *       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
 *       ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
 *                                                                   *
 *       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
 *                FOR NON-CHARGED-PARTICLE OUTPUT                    *
 *                                                                   *
 *********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	5.2542E-01	6.1379E-02
2	C	5.3680E-02	6.4459E-02
3	UNKNOW	8.9408E-02	6.3868E-02
4	UNKNOW	7.6184E-04	6.2056E-02
5	UNKNOW	8.9408E-02	6.1796E-02
6	C	5.3680E-02	6.0791E-02
7	UNKNOW	5.2542E-01	6.1867E-02

TOTAL ENERGY DEPOSITED =   8.2762E-02 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	7.0849E-02
2	C	6.3574E-02
3	UNKNOW	6.2957E-02
4	UNKNOW	6.2487E-02
5	UNKNOW	6.2166E-02
6	C	6.1527E-02
7	UNKNOW	6.2877E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.85400000E-02	2.868555E-02	5.254236E-02	UNKNOW	1
5.56200000E-02	4.739311E-02	5.254236E-02	UNKNOW	1
9.27000000E-02	5.764269E-02	5.254236E-02	UNKNOW	1
1.29780000E-01	6.406078E-02	5.254236E-02	UNKNOW	1
1.66860000E-01	6.778211E-02	5.254236E-02	UNKNOW	1
2.03940000E-01	6.956924E-02	5.254236E-02	UNKNOW	1
2.41020000E-01	7.006630E-02	5.254236E-02	UNKNOW	1
2.78100000E-01	6.988011E-02	5.254236E-02	UNKNOW	1
3.15180000E-01	6.949365E-02	5.254236E-02	UNKNOW	1
3.52260000E-01	6.921574E-02	5.254236E-02	UNKNOW	1
3.72325000E-01	6.398595E-02	5.368000E-03	C	2
3.75375000E-01	6.411753E-02	5.368000E-03	C	2
3.78425000E-01	6.421167E-02	5.368000E-03	C	2
3.81475000E-01	6.430199E-02	5.368000E-03	C	2
3.84525000E-01	6.439287E-02	5.368000E-03	C	2
3.87575000E-01	6.448736E-02	5.368000E-03	C	2
3.90625000E-01	6.458808E-02	5.368000E-03	C	2
3.93675000E-01	6.469823E-02	5.368000E-03	C	2
3.96725000E-01	6.482251E-02	5.368000E-03	C	2
3.99775000E-01	6.497884E-02	5.368000E-03	C	2
4.03840000E-01	6.491189E-02	8.940800E-03	UNKNOW	3
4.08920000E-01	6.461926E-02	8.940800E-03	UNKNOW	3
4.14000000E-01	6.436867E-02	8.940800E-03	UNKNOW	3
4.19080000E-01	6.413966E-02	8.940800E-03	UNKNOW	3
4.24160000E-01	6.392578E-02	8.940800E-03	UNKNOW	3
4.29240000E-01	6.372283E-02	8.940800E-03	UNKNOW	3
4.34320000E-01	6.352784E-02	8.940800E-03	UNKNOW	3
4.39400000E-01	6.333852E-02	8.940800E-03	UNKNOW	3
4.44480000E-01	6.315259E-02	8.940800E-03	UNKNOW	3
4.49560000E-01	6.297528E-02	8.940800E-03	UNKNOW	3
4.81560000E-01	6.204301E-02	7.618356E-05	UNKNOW	4
5.40480000E-01	6.205777E-02	7.618356E-05	UNKNOW	4

5.99400000E-01	6.206427E-02	7.618356E-05	UNKNOW	4
6.58320000E-01	6.206724E-02	7.618356E-05	UNKNOW	4
7.17240000E-01	6.206766E-02	7.618356E-05	UNKNOW	4
7.76160000E-01	6.206590E-02	7.618356E-05	UNKNOW	4
8.35080000E-01	6.206197E-02	7.618356E-05	UNKNOW	4
8.94000000E-01	6.205549E-02	7.618356E-05	UNKNOW	4
9.52920000E-01	6.204550E-02	7.618356E-05	UNKNOW	4
1.01184000E+00	6.202728E-02	7.618356E-05	UNKNOW	4
1.04384000E+00	6.277205E-02	8.940800E-03	UNKNOW	5
1.04892000E+00	6.257609E-02	8.940800E-03	UNKNOW	5
1.05400000E+00	6.238221E-02	8.940800E-03	UNKNOW	5
1.05908000E+00	6.218149E-02	8.940800E-03	UNKNOW	5
1.06416000E+00	6.197156E-02	8.940800E-03	UNKNOW	5
1.06924000E+00	6.174921E-02	8.940800E-03	UNKNOW	5
1.07432000E+00	6.151049E-02	8.940800E-03	UNKNOW	5
1.07940000E+00	6.124967E-02	8.940800E-03	UNKNOW	5
1.08448000E+00	6.095771E-02	8.940800E-03	UNKNOW	5
1.08956000E+00	6.060607E-02	8.940800E-03	UNKNOW	5
1.09362500E+00	6.045893E-02	5.368000E-03	C	6
1.09667500E+00	6.057588E-02	5.368000E-03	C	6
1.09972500E+00	6.066393E-02	5.368000E-03	C	6
1.10277500E+00	6.073795E-02	5.368000E-03	C	6
1.10582500E+00	6.080162E-02	5.368000E-03	C	6
1.10887500E+00	6.085692E-02	5.368000E-03	C	6
1.11192500E+00	6.090493E-02	5.368000E-03	C	6
1.11497500E+00	6.094592E-02	5.368000E-03	C	6
1.11802500E+00	6.097913E-02	5.368000E-03	C	6
1.12107500E+00	6.098205E-02	5.368000E-03	C	6
1.14114000E+00	6.568390E-02	5.254236E-02	UNKNOW	7
1.17822000E+00	6.515848E-02	5.254236E-02	UNKNOW	7
1.21530000E+00	6.463405E-02	5.254236E-02	UNKNOW	7
1.25238000E+00	6.409313E-02	5.254236E-02	UNKNOW	7
1.28946000E+00	6.354573E-02	5.254236E-02	UNKNOW	7
1.32654000E+00	6.296694E-02	5.254236E-02	UNKNOW	7
1.36362000E+00	6.225191E-02	5.254236E-02	UNKNOW	7
1.40070000E+00	6.110015E-02	5.254236E-02	UNKNOW	7
1.43778000E+00	5.888779E-02	5.254236E-02	UNKNOW	7
1.47486000E+00	5.034846E-02	5.254236E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.85400000E-02	7.340862E-02	5.254236E-02	UNKNOW	1
5.56200000E-02	7.282415E-02	5.254236E-02	UNKNOW	1
9.27000000E-02	7.224603E-02	5.254236E-02	UNKNOW	1
1.29780000E-01	7.167392E-02	5.254236E-02	UNKNOW	1
1.66860000E-01	7.110759E-02	5.254236E-02	UNKNOW	1
2.03940000E-01	7.054685E-02	5.254236E-02	UNKNOW	1
2.41020000E-01	6.999150E-02	5.254236E-02	UNKNOW	1
2.78100000E-01	6.944137E-02	5.254236E-02	UNKNOW	1
3.15180000E-01	6.889630E-02	5.254236E-02	UNKNOW	1
3.52260000E-01	6.835608E-02	5.254236E-02	UNKNOW	1
3.72325000E-01	6.378972E-02	5.368000E-03	C	2
3.75375000E-01	6.374168E-02	5.368000E-03	C	2
3.78425000E-01	6.369367E-02	5.368000E-03	C	2
3.81475000E-01	6.364571E-02	5.368000E-03	C	2
3.84525000E-01	6.359778E-02	5.368000E-03	C	2
3.87575000E-01	6.354989E-02	5.368000E-03	C	2
3.90625000E-01	6.350203E-02	5.368000E-03	C	2
3.93675000E-01	6.345422E-02	5.368000E-03	C	2
3.96725000E-01	6.340643E-02	5.368000E-03	C	2
3.99775000E-01	6.335869E-02	5.368000E-03	C	2
4.03840000E-01	6.331342E-02	8.940800E-03	UNKNOW	3
4.08920000E-01	6.323394E-02	8.940800E-03	UNKNOW	3
4.14000000E-01	6.315458E-02	8.940800E-03	UNKNOW	3
4.19080000E-01	6.307534E-02	8.940800E-03	UNKNOW	3
4.24160000E-01	6.299622E-02	8.940800E-03	UNKNOW	3
4.29240000E-01	6.291721E-02	8.940800E-03	UNKNOW	3
4.34320000E-01	6.283831E-02	8.940800E-03	UNKNOW	3
4.39400000E-01	6.275953E-02	8.940800E-03	UNKNOW	3
4.44480000E-01	6.268085E-02	8.940800E-03	UNKNOW	3
4.49560000E-01	6.260229E-02	8.940800E-03	UNKNOW	3
4.81560000E-01	6.249000E-02	7.618356E-05	UNKNOW	4
5.40480000E-01	6.248933E-02	7.618356E-05	UNKNOW	4
5.99400000E-01	6.248867E-02	7.618356E-05	UNKNOW	4
6.58320000E-01	6.248800E-02	7.618356E-05	UNKNOW	4
7.17240000E-01	6.248733E-02	7.618356E-05	UNKNOW	4
7.76160000E-01	6.248667E-02	7.618356E-05	UNKNOW	4
8.35080000E-01	6.248600E-02	7.618356E-05	UNKNOW	4
8.94000000E-01	6.248533E-02	7.618356E-05	UNKNOW	4
9.52920000E-01	6.248466E-02	7.618356E-05	UNKNOW	4
1.01184000E+00	6.248400E-02	7.618356E-05	UNKNOW	4

1.04384000E+00	6.251716E-02	8.940800E-03	UNKNOW	5
1.04892000E+00	6.243882E-02	8.940800E-03	UNKNOW	5
1.05400000E+00	6.236059E-02	8.940800E-03	UNKNOW	5
1.05908000E+00	6.228246E-02	8.940800E-03	UNKNOW	5
1.06416000E+00	6.220444E-02	8.940800E-03	UNKNOW	5
1.06924000E+00	6.212653E-02	8.940800E-03	UNKNOW	5
1.07432000E+00	6.204872E-02	8.940800E-03	UNKNOW	5
1.07940000E+00	6.197102E-02	8.940800E-03	UNKNOW	5
1.08448000E+00	6.189343E-02	8.940800E-03	UNKNOW	5
1.08956000E+00	6.181595E-02	8.940800E-03	UNKNOW	5
1.09362500E+00	6.173545E-02	5.368000E-03	C	6
1.09667500E+00	6.168899E-02	5.368000E-03	C	6
1.09972500E+00	6.164257E-02	5.368000E-03	C	6
1.10277500E+00	6.159617E-02	5.368000E-03	C	6
1.10582500E+00	6.154981E-02	5.368000E-03	C	6
1.10887500E+00	6.150347E-02	5.368000E-03	C	6
1.11192500E+00	6.145717E-02	5.368000E-03	C	6
1.11497500E+00	6.141089E-02	5.368000E-03	C	6
1.11802500E+00	6.136465E-02	5.368000E-03	C	6
1.12107500E+00	6.131843E-02	5.368000E-03	C	6
1.14114000E+00	6.514438E-02	5.254236E-02	UNKNOW	7
1.17822000E+00	6.463310E-02	5.254236E-02	UNKNOW	7
1.21530000E+00	6.412501E-02	5.254236E-02	UNKNOW	7
1.25238000E+00	6.361987E-02	5.254236E-02	UNKNOW	7
1.28946000E+00	6.311745E-02	5.254236E-02	UNKNOW	7
1.32654000E+00	6.261751E-02	5.254236E-02	UNKNOW	7
1.36362000E+00	6.211978E-02	5.254236E-02	UNKNOW	7
1.40070000E+00	6.162397E-02	5.254236E-02	UNKNOW	7
1.43778000E+00	6.112980E-02	5.254236E-02	UNKNOW	7
1.47486000E+00	6.063696E-02	5.254236E-02	UNKNOW	7

```
**********************************************************************
*                                                                    *
*             INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                    *
**********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 1.253 MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.08126
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.08126
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 1.253
COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


**********************************************************************
*                                                                    *
*                PROBLEM DEFINITION                                  *
*                                                                    *
**********************************************************************

   LAYER         THICKNESS      MATERIAL       DENSITY       XMESH

     1           8.1260E-02     1  UNKNOW      1.4170E+00    10
     2           3.0500E-02     2  C           1.7600E+00    10
     3           5.0800E-02     3  UNKNOW      1.7600E+00    10
     4           5.8920E-01     4  UNKNOW      1.2930E-03    10
     5           5.0800E-02     3  UNKNOW      1.7600E+00    10
     6           3.0500E-02     2  C           1.7600E+00    10
     7           8.1260E-02     1  UNKNOW      1.4170E+00    10

Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order = 16
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0000E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1           9.9999E-01
        2           1.0000E+00
        3           9.9999E-01
        4           1.0000E+00
        5           1.0000E+00
        6           9.9999E-01
        7           1.0000E+00

1*********************************************************************
*                                                                    *
*                        OUTPUT (CRAY)                               *
*                                                                    *
*             AVERAGE SOURCE ENERGY =  1.2530E+00 MeV                *
```

```
*                                                                   *
*          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE    *
*                                                                   *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A       *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                *
*                                                                   *
*       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
*       ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
*                                                                   *
*       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
*                FOR NON-CHARGED-PARTICLE OUTPUT                    *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	1.1515E-01	3.8536E-02
2	C	5.3680E-02	5.4414E-02
3	UNKNOW	8.9408E-02	6.0618E-02
4	UNKNOW	7.6184E-04	6.1690E-02
5	UNKNOW	8.9408E-02	6.2615E-02
6	C	5.3680E-02	6.1946E-02
7	UNKNOW	1.1515E-01	6.0548E-02

TOTAL ENERGY DEPOSITED = 2.8720E-02 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	7.1610E-02
2	C	6.6201E-02
3	UNKNOW	6.5467E-02
4	UNKNOW	6.4932E-02
5	UNKNOW	6.4547E-02
6	C	6.3817E-02
7	UNKNOW	6.7141E-02

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DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
4.06300000E-03	1.655661E-02	1.151454E-02	UNKNOW	1
1.21890000E-02	2.463063E-02	1.151454E-02	UNKNOW	1
2.03150000E-02	3.018213E-02	1.151454E-02	UNKNOW	1
2.84410000E-02	3.481569E-02	1.151454E-02	UNKNOW	1
3.65670000E-02	3.881265E-02	1.151454E-02	UNKNOW	1
4.46930000E-02	4.233721E-02	1.151454E-02	UNKNOW	1
5.28190000E-02	4.548568E-02	1.151454E-02	UNKNOW	1
6.09450000E-02	4.832801E-02	1.151454E-02	UNKNOW	1
6.90710000E-02	5.091049E-02	1.151454E-02	UNKNOW	1
7.71970000E-02	5.329747E-02	1.151454E-02	UNKNOW	1
8.27850000E-02	5.078192E-02	5.368000E-03	C	2
8.58350000E-02	5.169913E-02	5.368000E-03	C	2
8.88850000E-02	5.255363E-02	5.368000E-03	C	2
9.19350000E-02	5.337136E-02	5.368000E-03	C	2
9.49850000E-02	5.415646E-02	5.368000E-03	C	2
9.80350000E-02	5.491167E-02	5.368000E-03	C	2
1.01085000E-01	5.563905E-02	5.368000E-03	C	2
1.04135000E-01	5.634036E-02	5.368000E-03	C	2
1.07185000E-01	5.701691E-02	5.368000E-03	C	2
1.10235000E-01	5.767038E-02	5.368000E-03	C	2
1.14300000E-01	5.829085E-02	8.940800E-03	UNKNOW	3
1.19380000E-01	5.891515E-02	8.940800E-03	UNKNOW	3
1.24460000E-01	5.951955E-02	8.940800E-03	UNKNOW	3
1.29540000E-01	6.007953E-02	8.940800E-03	UNKNOW	3
1.34620000E-01	6.058965E-02	8.940800E-03	UNKNOW	3
1.39700000E-01	6.104767E-02	8.940800E-03	UNKNOW	3
1.44780000E-01	6.145324E-02	8.940800E-03	UNKNOW	3
1.49860000E-01	6.180699E-02	8.940800E-03	UNKNOW	3
1.54940000E-01	6.210969E-02	8.940800E-03	UNKNOW	3
1.60020000E-01	6.236900E-02	8.940800E-03	UNKNOW	3
1.92020000E-01	6.166235E-02	7.618356E-05	UNKNOW	4
2.50940000E-01	6.168041E-02	7.618356E-05	UNKNOW	4
3.09860000E-01	6.169022E-02	7.618356E-05	UNKNOW	4
3.68780000E-01	6.169650E-02	7.618356E-05	UNKNOW	4
4.27700000E-01	6.170022E-02	7.618356E-05	UNKNOW	4
4.86620000E-01	6.170176E-02	7.618356E-05	UNKNOW	4
5.45540000E-01	6.170114E-02	7.618356E-05	UNKNOW	4

6.04460000E-01	6.169796E-02	7.618356E-05	UNKNOW	4
6.63380000E-01	6.169129E-02	7.618356E-05	UNKNOW	4
7.22300000E-01	6.167640E-02	7.618356E-05	UNKNOW	4
7.54300000E-01	6.258489E-02	8.940800E-03	UNKNOW	5
7.59380000E-01	6.272623E-02	8.940800E-03	UNKNOW	5
7.64460000E-01	6.282442E-02	8.940800E-03	UNKNOW	5
7.69540000E-01	6.287223E-02	8.940800E-03	UNKNOW	5
7.74620000E-01	6.286868E-02	8.940800E-03	UNKNOW	5
7.79700000E-01	6.281194E-02	8.940800E-03	UNKNOW	5
7.84780000E-01	6.269939E-02	8.940800E-03	UNKNOW	5
7.89860000E-01	6.252664E-02	8.940800E-03	UNKNOW	5
7.94940000E-01	6.228617E-02	8.940800E-03	UNKNOW	5
8.00020000E-01	6.195258E-02	8.940800E-03	UNKNOW	5
8.04085000E-01	6.181519E-02	5.368000E-03	C	6
8.07135000E-01	6.192528E-02	5.368000E-03	C	6
8.10185000E-01	6.199041E-02	5.368000E-03	C	6
8.13235000E-01	6.202789E-02	5.368000E-03	C	6
8.16285000E-01	6.204180E-02	5.368000E-03	C	6
8.19335000E-01	6.203419E-02	5.368000E-03	C	6
8.22385000E-01	6.200601E-02	5.368000E-03	C	6
8.25435000E-01	6.195727E-02	5.368000E-03	C	6
8.28485000E-01	6.188692E-02	5.368000E-03	C	6
8.31535000E-01	6.177508E-02	5.368000E-03	C	6
8.37123000E-01	6.649750E-02	1.151454E-02	UNKNOW	7
8.45249000E-01	6.587887E-02	1.151454E-02	UNKNOW	7
8.53375000E-01	6.517444E-02	1.151454E-02	UNKNOW	7
8.61501000E-01	6.431463E-02	1.151454E-02	UNKNOW	7
8.69627000E-01	6.324671E-02	1.151454E-02	UNKNOW	7
8.77753000E-01	6.189286E-02	1.151454E-02	UNKNOW	7
8.85879000E-01	6.012777E-02	1.151454E-02	UNKNOW	7
8.94005000E-01	5.770961E-02	1.151454E-02	UNKNOW	7
9.02131000E-01	5.421498E-02	1.151454E-02	UNKNOW	7
9.10257000E-01	4.641964E-02	1.151454E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
4.06300000E-03	7.222960E-02	1.151454E-02	UNKNOW	1
1.21890000E-02	7.209110E-02	1.151454E-02	UNKNOW	1
2.03150000E-02	7.195288E-02	1.151454E-02	UNKNOW	1
2.84410000E-02	7.181493E-02	1.151454E-02	UNKNOW	1
3.65670000E-02	7.167725E-02	1.151454E-02	UNKNOW	1
4.46930000E-02	7.153982E-02	1.151454E-02	UNKNOW	1
5.28190000E-02	7.140264E-02	1.151454E-02	UNKNOW	1
6.09450000E-02	7.126571E-02	1.151454E-02	UNKNOW	1
6.90710000E-02	7.112902E-02	1.151454E-02	UNKNOW	1
7.71970000E-02	7.099256E-02	1.151454E-02	UNKNOW	1
8.27850000E-02	6.645125E-02	5.368000E-03	C	2
8.58350000E-02	6.639543E-02	5.368000E-03	C	2
8.88850000E-02	6.633965E-02	5.368000E-03	C	2
9.19350000E-02	6.628392E-02	5.368000E-03	C	2
9.49850000E-02	6.622822E-02	5.368000E-03	C	2
9.80350000E-02	6.617257E-02	5.368000E-03	C	2
1.01085000E-01	6.611695E-02	5.368000E-03	C	2
1.04135000E-01	6.606137E-02	5.368000E-03	C	2
1.07185000E-01	6.600584E-02	5.368000E-03	C	2
1.10235000E-01	6.595034E-02	5.368000E-03	C	2
1.14300000E-01	6.588067E-02	8.940800E-03	UNKNOW	3
1.19380000E-01	6.578851E-02	8.940800E-03	UNKNOW	3
1.24460000E-01	6.569646E-02	8.940800E-03	UNKNOW	3
1.29540000E-01	6.560451E-02	8.940800E-03	UNKNOW	3
1.34620000E-01	6.551266E-02	8.940800E-03	UNKNOW	3
1.39700000E-01	6.542091E-02	8.940800E-03	UNKNOW	3
1.44780000E-01	6.532926E-02	8.940800E-03	UNKNOW	3
1.49860000E-01	6.523771E-02	8.940800E-03	UNKNOW	3
1.54940000E-01	6.514625E-02	8.940800E-03	UNKNOW	3
1.60020000E-01	6.505490E-02	8.940800E-03	UNKNOW	3
1.92020000E-01	6.493553E-02	7.618356E-05	UNKNOW	4
2.50940000E-01	6.493475E-02	7.618356E-05	UNKNOW	4
3.09860000E-01	6.493397E-02	7.618356E-05	UNKNOW	4
3.68780000E-01	6.493320E-02	7.618356E-05	UNKNOW	4
4.27700000E-01	6.493242E-02	7.618356E-05	UNKNOW	4
4.86620000E-01	6.493165E-02	7.618356E-05	UNKNOW	4
5.45540000E-01	6.493087E-02	7.618356E-05	UNKNOW	4
6.04460000E-01	6.493009E-02	7.618356E-05	UNKNOW	4
6.63380000E-01	6.492932E-02	7.618356E-05	UNKNOW	4
7.22300000E-01	6.492854E-02	7.618356E-05	UNKNOW	4
7.54300000E-01	6.495587E-02	8.940800E-03	UNKNOW	5
7.59380000E-01	6.486471E-02	8.940800E-03	UNKNOW	5
7.64460000E-01	6.477364E-02	8.940800E-03	UNKNOW	5
7.69540000E-01	6.468267E-02	8.940800E-03	UNKNOW	5
7.74620000E-01	6.459178E-02	8.940800E-03	UNKNOW	5

7.79700000E-01	6.450099E-02	8.940800E-03	UNKNOW	5
7.84780000E-01	6.441029E-02	8.940800E-03	UNKNOW	5
7.89860000E-01	6.431968E-02	8.940800E-03	UNKNOW	5
7.94940000E-01	6.422915E-02	8.940800E-03	UNKNOW	5
8.00020000E-01	6.413872E-02	8.940800E-03	UNKNOW	5
8.04085000E-01	6.406054E-02	5.368000E-03	C	6
8.07135000E-01	6.400633E-02	5.368000E-03	C	6
8.10185000E-01	6.395215E-02	5.368000E-03	C	6
8.13235000E-01	6.389800E-02	5.368000E-03	C	6
8.16285000E-01	6.384389E-02	5.368000E-03	C	6
8.19335000E-01	6.378980E-02	5.368000E-03	C	6
8.22385000E-01	6.373574E-02	5.368000E-03	C	6
8.25435000E-01	6.368172E-02	5.368000E-03	C	6
8.28485000E-01	6.362772E-02	5.368000E-03	C	6
8.31535000E-01	6.357375E-02	5.368000E-03	C	6
8.37123000E-01	6.773135E-02	1.151454E-02	UNKNOW	7
8.45249000E-01	6.759973E-02	1.151454E-02	UNKNOW	7
8.53375000E-01	6.746826E-02	1.151454E-02	UNKNOW	7
8.61501000E-01	6.733693E-02	1.151454E-02	UNKNOW	7
8.69627000E-01	6.720574E-02	1.151454E-02	UNKNOW	7
8.77753000E-01	6.707469E-02	1.151454E-02	UNKNOW	7
8.85879000E-01	6.694378E-02	1.151454E-02	UNKNOW	7
8.94005000E-01	6.681300E-02	1.151454E-02	UNKNOW	7
9.02131000E-01	6.668235E-02	1.151454E-02	UNKNOW	7
9.10257000E-01	6.655184E-02	1.151454E-02	UNKNOW	7

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*******************************************************************
*                                                                 *
*           INPUT TO ADEPT  (AUGUST 1, 1992 )                     *
*                                                                 *
*******************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 1.253 MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.3708
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.3708
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 1.253
PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


*******************************************************************
*                                                                 *
*               PROBLEM DEFINITION                                *
*                                                                 *
*******************************************************************

   LAYER        THICKNESS       MATERIAL        DENSITY      XMESH

     1          3.7080E-01      1  UNKNOW       1.4170E+00    10
     2          3.0500E-02      2  C            1.7600E+00    10
     3          5.0800E-02      3  UNKNOW       1.7600E+00    10
     4          5.8920E-01      4  UNKNOW       1.2930E-03    10
     5          5.0800E-02      3  UNKNOW       1.7600E+00    10
     6          3.0500E-02      2  C            1.7600E+00    10
     7          3.7080E-01      1  UNKNOW       1.4170E+00    10

Plane-Wave at Angle of Incidence =    8.3494E+00 Degrees
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0000E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1            1.0000E+00
        2            1.0013E+00
        3            9.9943E-01
        4            1.0001E+00
        5            1.0033E+00
        6            9.9921E-01
        7            1.0000E+00

1*******************************************************************
*                                                                 *
*                       OUTPUT (CRAY)                             *
*                                                                 *
*             AVERAGE SOURCE ENERGY =  1.2530E+00 MeV             *
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*                                                                      *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE        *
*                                                                      *
*           FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A           *
*           UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                    *
*                                                                      *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                    *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                         *
*                                                                      *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                    *
*              FOR NON-CHARGED-PARTICLE OUTPUT                         *
*                                                                      *
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LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	5.2542E-01	2.8103E-02
2	C	5.3680E-02	3.4269E-02
3	UNKNOW	8.9408E-02	3.4964E-02
4	UNKNOW	7.6184E-04	3.4243E-02
5	UNKNOW	8.9408E-02	3.4103E-02
6	C	5.3680E-02	3.3050E-02
7	UNKNOW	5.2542E-01	3.5541E-02

TOTAL ENERGY DEPOSITED = 4.3255E-02 MeV/source

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RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	3.6448E-02
2	C	3.3977E-02
3	UNKNOW	3.3933E-02
4	UNKNOW	3.3859E-02
5	UNKNOW	3.3862E-02
6	C	3.3794E-02
7	UNKNOW	3.5743E-02

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DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.85400000E-02	6.459845E-03	5.254236E-02	UNKNOW	1
5.56200000E-02	1.473535E-02	5.254236E-02	UNKNOW	1
9.27000000E-02	2.155706E-02	5.254236E-02	UNKNOW	1
1.29780000E-01	2.717029E-02	5.254236E-02	UNKNOW	1
1.66860000E-01	3.142490E-02	5.254236E-02	UNKNOW	1
2.03940000E-01	3.427374E-02	5.254236E-02	UNKNOW	1
2.41020000E-01	3.583621E-02	5.254236E-02	UNKNOW	1
2.78100000E-01	3.644167E-02	5.254236E-02	UNKNOW	1
3.15180000E-01	3.656119E-02	5.254236E-02	UNKNOW	1
3.52260000E-01	3.657274E-02	5.254236E-02	UNKNOW	1
3.72325000E-01	3.383194E-02	5.368000E-03	C	2
3.75375000E-01	3.391260E-02	5.368000E-03	C	2
3.78425000E-01	3.398544E-02	5.368000E-03	C	2
3.81475000E-01	3.406513E-02	5.368000E-03	C	2
3.84525000E-01	3.415426E-02	5.368000E-03	C	2
3.87575000E-01	3.425588E-02	5.368000E-03	C	2
3.90625000E-01	3.437336E-02	5.368000E-03	C	2
3.93675000E-01	3.451212E-02	5.368000E-03	C	2
3.96725000E-01	3.468182E-02	5.368000E-03	C	2
3.99775000E-01	3.492100E-02	5.368000E-03	C	2
4.03840000E-01	3.510215E-02	8.940800E-03	UNKNOW	3
4.08920000E-01	3.510613E-02	8.940800E-03	UNKNOW	3
4.14000000E-01	3.508671E-02	8.940800E-03	UNKNOW	3
4.19080000E-01	3.505502E-02	8.940800E-03	UNKNOW	3
4.24160000E-01	3.501488E-02	8.940800E-03	UNKNOW	3
4.29240000E-01	3.496813E-02	8.940800E-03	UNKNOW	3
4.34320000E-01	3.491579E-02	8.940800E-03	UNKNOW	3
4.39400000E-01	3.485855E-02	8.940800E-03	UNKNOW	3
4.44480000E-01	3.479644E-02	8.940800E-03	UNKNOW	3
4.49560000E-01	3.473330E-02	8.940800E-03	UNKNOW	3
4.81560000E-01	3.423534E-02	7.618356E-05	UNKNOW	4
5.40480000E-01	3.424341E-02	7.618356E-05	UNKNOW	4
5.99400000E-01	3.424709E-02	7.618356E-05	UNKNOW	4
6.58320000E-01	3.424886E-02	7.618356E-05	UNKNOW	4
7.17240000E-01	3.424921E-02	7.618356E-05	UNKNOW	4
7.76160000E-01	3.424834E-02	7.618356E-05	UNKNOW	4
8.35080000E-01	3.424625E-02	7.618356E-05	UNKNOW	4

8.94000000E-01	3.424273E-02	7.618356E-05	UNKNOW	4
9.52920000E-01	3.423727E-02	7.618356E-05	UNKNOW	4
1.01184000E+00	3.422738E-02	7.618356E-05	UNKNOW	4
1.04384000E+00	3.465135E-02	8.940800E-03	UNKNOW	5
1.04892000E+00	3.456606E-02	8.940800E-03	UNKNOW	5
1.05400000E+00	3.447610E-02	8.940800E-03	UNKNOW	5
1.05908000E+00	3.437587E-02	8.940800E-03	UNKNOW	5
1.06416000E+00	3.426281E-02	8.940800E-03	UNKNOW	5
1.06924000E+00	3.413307E-02	8.940800E-03	UNKNOW	5
1.07432000E+00	3.398101E-02	8.940800E-03	UNKNOW	5
1.07940000E+00	3.379725E-02	8.940800E-03	UNKNOW	5
1.08448000E+00	3.356519E-02	8.940800E-03	UNKNOW	5
1.08956000E+00	3.322195E-02	8.940800E-03	UNKNOW	5
1.09362500E+00	3.296905E-02	5.368000E-03	C	6
1.09667500E+00	3.297487E-02	5.368000E-03	C	6
1.09972500E+00	3.298503E-02	5.368000E-03	C	6
1.10277500E+00	3.299992E-02	5.368000E-03	C	6
1.10582500E+00	3.301943E-02	5.368000E-03	C	6
1.10887500E+00	3.304346E-02	5.368000E-03	C	6
1.11192500E+00	3.307203E-02	5.368000E-03	C	6
1.11497500E+00	3.310541E-02	5.368000E-03	C	6
1.11802500E+00	3.314442E-02	5.368000E-03	C	6
1.12107500E+00	3.318413E-02	5.368000E-03	C	6
1.14114000E+00	3.593492E-02	5.254236E-02	UNKNOW	7
1.17822000E+00	3.597511E-02	5.254236E-02	UNKNOW	7
1.21530000E+00	3.602408E-02	5.254236E-02	UNKNOW	7
1.25238000E+00	3.604158E-02	5.254236E-02	UNKNOW	7
1.28946000E+00	3.601810E-02	5.254236E-02	UNKNOW	7
1.32654000E+00	3.596071E-02	5.254236E-02	UNKNOW	7
1.36362000E+00	3.587855E-02	5.254236E-02	UNKNOW	7
1.40070000E+00	3.573367E-02	5.254236E-02	UNKNOW	7
1.43778000E+00	3.539560E-02	5.254236E-02	UNKNOW	7
1.47486000E+00	3.245114E-02	5.254236E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.85400000E-02	3.657908E-02	5.254236E-02	UNKNOW	1
5.56200000E-02	3.655547E-02	5.254236E-02	UNKNOW	1
9.27000000E-02	3.652983E-02	5.254236E-02	UNKNOW	1
1.29780000E-01	3.650215E-02	5.254236E-02	UNKNOW	1
1.66860000E-01	3.647241E-02	5.254236E-02	UNKNOW	1
2.03940000E-01	3.644061E-02	5.254236E-02	UNKNOW	1
2.41020000E-01	3.640674E-02	5.254236E-02	UNKNOW	1
2.78100000E-01	3.637083E-02	5.254236E-02	UNKNOW	1
3.15180000E-01	3.633292E-02	5.254236E-02	UNKNOW	1
3.52260000E-01	3.629304E-02	5.254236E-02	UNKNOW	1
3.72325000E-01	3.399433E-02	5.368000E-03	C	2
3.75375000E-01	3.399055E-02	5.368000E-03	C	2
3.78425000E-01	3.398675E-02	5.368000E-03	C	2
3.81475000E-01	3.398293E-02	5.368000E-03	C	2
3.84525000E-01	3.397909E-02	5.368000E-03	C	2
3.87575000E-01	3.397524E-02	5.368000E-03	C	2
3.90625000E-01	3.397137E-02	5.368000E-03	C	2
3.93675000E-01	3.396749E-02	5.368000E-03	C	2
3.96725000E-01	3.396358E-02	5.368000E-03	C	2
3.99775000E-01	3.395966E-02	5.368000E-03	C	2
4.03840000E-01	3.396304E-02	8.940800E-03	UNKNOW	3
4.08920000E-01	3.395642E-02	8.940800E-03	UNKNOW	3
4.14000000E-01	3.394978E-02	8.940800E-03	UNKNOW	3
4.19080000E-01	3.394309E-02	8.940800E-03	UNKNOW	3
4.24160000E-01	3.393636E-02	8.940800E-03	UNKNOW	3
4.29240000E-01	3.392959E-02	8.940800E-03	UNKNOW	3
4.34320000E-01	3.392277E-02	8.940800E-03	UNKNOW	3
4.39400000E-01	3.391592E-02	8.940800E-03	UNKNOW	3
4.44480000E-01	3.390903E-02	8.940800E-03	UNKNOW	3
4.49560000E-01	3.390209E-02	8.940800E-03	UNKNOW	3
4.81560000E-01	3.385936E-02	7.618356E-05	UNKNOW	4
5.40480000E-01	3.385930E-02	7.618356E-05	UNKNOW	4
5.99400000E-01	3.385924E-02	7.618356E-05	UNKNOW	4
6.58320000E-01	3.385918E-02	7.618356E-05	UNKNOW	4
7.17240000E-01	3.385912E-02	7.618356E-05	UNKNOW	4
7.76160000E-01	3.385906E-02	7.618356E-05	UNKNOW	4
8.35080000E-01	3.385900E-02	7.618356E-05	UNKNOW	4
8.94000000E-01	3.385894E-02	7.618356E-05	UNKNOW	4
9.52920000E-01	3.385888E-02	7.618356E-05	UNKNOW	4
1.01184000E+00	3.385883E-02	7.618356E-05	UNKNOW	4
1.04384000E+00	3.389452E-02	8.940800E-03	UNKNOW	5
1.04892000E+00	3.388750E-02	8.940800E-03	UNKNOW	5
1.05400000E+00	3.388044E-02	8.940800E-03	UNKNOW	5
1.05908000E+00	3.387333E-02	8.940800E-03	UNKNOW	5
1.06416000E+00	3.386619E-02	8.940800E-03	UNKNOW	5

1.06924000E+00	3.385900E-02	8.940800E-03	UNKNOW	5
1.07432000E+00	3.385178E-02	8.940800E-03	UNKNOW	5
1.07940000E+00	3.384451E-02	8.940800E-03	UNKNOW	5
1.08448000E+00	3.383721E-02	8.940800E-03	UNKNOW	5
1.08956000E+00	3.382987E-02	8.940800E-03	UNKNOW	5
1.09362500E+00	3.381480E-02	5.368000E-03	C	6
1.09667500E+00	3.381033E-02	5.368000E-03	C	6
1.09972500E+00	3.380583E-02	5.368000E-03	C	6
1.10277500E+00	3.380132E-02	5.368000E-03	C	6
1.10582500E+00	3.379680E-02	5.368000E-03	C	6
1.10887500E+00	3.379226E-02	5.368000E-03	C	6
1.11192500E+00	3.378770E-02	5.368000E-03	C	6
1.11497500E+00	3.378312E-02	5.368000E-03	C	6
1.11802500E+00	3.377853E-02	5.368000E-03	C	6
1.12107500E+00	3.377392E-02	5.368000E-03	C	6
1.14114000E+00	3.600722E-02	5.254236E-02	UNKNOW	7
1.17822000E+00	3.595379E-02	5.254236E-02	UNKNOW	7
1.21530000E+00	3.589846E-02	5.254236E-02	UNKNOW	7
1.25238000E+00	3.584121E-02	5.254236E-02	UNKNOW	7
1.28946000E+00	3.578202E-02	5.254236E-02	UNKNOW	7
1.32654000E+00	3.572087E-02	5.254236E-02	UNKNOW	7
1.36362000E+00	3.565770E-02	5.254236E-02	UNKNOW	7
1.40070000E+00	3.559246E-02	5.254236E-02	UNKNOW	7
1.43778000E+00	3.552510E-02	5.254236E-02	UNKNOW	7
1.47486000E+00	3.545552E-02	5.254236E-02	UNKNOW	7

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 2.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 4.0
DIRECTION
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


*********************************************************************
*                                                                   *
*                PROBLEM DEFINITION                                 *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	6.7224E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	6.7224E-01	1 UNKNOW	1.4170E+00	10

```
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order =  8
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0005E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	9.9999E-01
2	1.0002E+00
3	1.0001E+00
4	1.0000E+00
5	9.9987E-01
6	9.9983E-01
7	1.0000E+00

```
1*********************************************************************
 *                                                                   *
 *                      OUTPUT (CRAY)                                *
 *                                                                   *
```

```
*              AVERAGE SOURCE ENERGY =  4.0000E+00 MeV                  *
*                                                                        *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE          *
*                                                                        *
*           FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A             *
*           UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                      *
*                                                                        *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                      *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                           *
*                                                                        *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                      *
*             FOR NON-CHARGED-PARTICLE OUTPUT                            *
*                                                                        *
**************************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	1.0324E-01
2	C	5.3680E-02	1.3262E-01
3	UNKNOW	8.9408E-02	1.3405E-01
4	UNKNOW	7.6184E-04	1.3571E-01
5	UNKNOW	8.9408E-02	1.3402E-01
6	C	5.3680E-02	1.3409E-01
7	UNKNOW	9.5256E-01	1.3844E-01

TOTAL ENERGY DEPOSITED =   2.6861E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.5399E-01
2	C	1.3909E-01
3	UNKNOW	1.3997E-01
4	UNKNOW	1.3932E-01
5	UNKNOW	1.3916E-01
6	C	1.3702E-01
7	UNKNOW	1.4170E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	3.708491E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	6.366399E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	8.156665E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	9.569610E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	1.071863E-01	9.525641E-02	UNKNOW	1
3.69732000E-01	1.165966E-01	9.525641E-02	UNKNOW	1
4.36956000E-01	1.243065E-01	9.525641E-02	UNKNOW	1
5.04180000E-01	1.306085E-01	9.525641E-02	UNKNOW	1
5.71404000E-01	1.357406E-01	9.525641E-02	UNKNOW	1
6.38628000E-01	1.399790E-01	9.525641E-02	UNKNOW	1
6.73765000E-01	1.314627E-01	5.368000E-03	C	2
6.76815000E-01	1.318159E-01	5.368000E-03	C	2
6.79865000E-01	1.320534E-01	5.368000E-03	C	2
6.82915000E-01	1.322886E-01	5.368000E-03	C	2
6.85965000E-01	1.325190E-01	5.368000E-03	C	2
6.89015000E-01	1.327468E-01	5.368000E-03	C	2
6.92065000E-01	1.329733E-01	5.368000E-03	C	2
6.95115000E-01	1.331996E-01	5.368000E-03	C	2
6.98165000E-01	1.334241E-01	5.368000E-03	C	2
7.01215000E-01	1.336889E-01	5.368000E-03	C	2
7.05280000E-01	1.338909E-01	8.940800E-03	UNKNOW	3
7.10360000E-01	1.339167E-01	8.940800E-03	UNKNOW	3
7.15440000E-01	1.339574E-01	8.940800E-03	UNKNOW	3
7.20520000E-01	1.340000E-01	8.940800E-03	UNKNOW	3
7.25600000E-01	1.340415E-01	8.940800E-03	UNKNOW	3
7.30680000E-01	1.340798E-01	8.940800E-03	UNKNOW	3
7.35760000E-01	1.341136E-01	8.940800E-03	UNKNOW	3
7.40840000E-01	1.341421E-01	8.940800E-03	UNKNOW	3
7.45920000E-01	1.341623E-01	8.940800E-03	UNKNOW	3
7.51000000E-01	1.342023E-01	8.940800E-03	UNKNOW	3
7.83000000E-01	1.356647E-01	7.618356E-05	UNKNOW	4
8.41920000E-01	1.356974E-01	7.618356E-05	UNKNOW	4
9.00840000E-01	1.357173E-01	7.618356E-05	UNKNOW	4
9.59760000E-01	1.357290E-01	7.618356E-05	UNKNOW	4
1.01868000E+00	1.357348E-01	7.618356E-05	UNKNOW	4
1.07760000E+00	1.357355E-01	7.618356E-05	UNKNOW	4

1.13652000E+00	1.357311E-01	7.618356E-05	UNKNOW	4
1.19544000E+00	1.357208E-01	7.618356E-05	UNKNOW	4
1.25436000E+00	1.357023E-01	7.618356E-05	UNKNOW	4
1.31328000E+00	1.356709E-01	7.618356E-05	UNKNOW	4
1.34528000E+00	1.342089E-01	8.940800E-03	UNKNOW	5
1.35036000E+00	1.341778E-01	8.940800E-03	UNKNOW	5
1.35544000E+00	1.341653E-01	8.940800E-03	UNKNOW	5
1.36052000E+00	1.341402E-01	8.940800E-03	UNKNOW	5
1.36560000E+00	1.341037E-01	8.940800E-03	UNKNOW	5
1.37068000E+00	1.340540E-01	8.940800E-03	UNKNOW	5
1.37576000E+00	1.339891E-01	8.940800E-03	UNKNOW	5
1.38084000E+00	1.339057E-01	8.940800E-03	UNKNOW	5
1.38592000E+00	1.338031E-01	8.940800E-03	UNKNOW	5
1.39100000E+00	1.336460E-01	8.940800E-03	UNKNOW	5
1.39506500E+00	1.335508E-01	5.368000E-03	C	6
1.39811500E+00	1.337000E-01	5.368000E-03	C	6
1.40116500E+00	1.338305E-01	5.368000E-03	C	6
1.40421500E+00	1.339524E-01	5.368000E-03	C	6
1.40726500E+00	1.340674E-01	5.368000E-03	C	6
1.41031500E+00	1.341761E-01	5.368000E-03	C	6
1.41336500E+00	1.342789E-01	5.368000E-03	C	6
1.41641500E+00	1.343750E-01	5.368000E-03	C	6
1.41946500E+00	1.344676E-01	5.368000E-03	C	6
1.42251500E+00	1.344664E-01	5.368000E-03	C	6
1.45765200E+00	1.455612E-01	9.525641E-02	UNKNOW	7
1.52487600E+00	1.457856E-01	9.525641E-02	UNKNOW	7
1.59210000E+00	1.455051E-01	9.525641E-02	UNKNOW	7
1.65932400E+00	1.447308E-01	9.525641E-02	UNKNOW	7
1.72654800E+00	1.434837E-01	9.525641E-02	UNKNOW	7
1.79377200E+00	1.417098E-01	9.525641E-02	UNKNOW	7
1.86099600E+00	1.392179E-01	9.525641E-02	UNKNOW	7
1.92822000E+00	1.355265E-01	9.525641E-02	UNKNOW	7
1.99544400E+00	1.296633E-01	9.525641E-02	UNKNOW	7
2.06266800E+00	1.132606E-01	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	1.584134E-01	9.525641E-02	UNKNOW	1
1.00836000E-01	1.574183E-01	9.525641E-02	UNKNOW	1
1.68060000E-01	1.564291E-01	9.525641E-02	UNKNOW	1
2.35284000E-01	1.554446E-01	9.525641E-02	UNKNOW	1
3.02508000E-01	1.544643E-01	9.525641E-02	UNKNOW	1
3.69732000E-01	1.534879E-01	9.525641E-02	UNKNOW	1
4.36956000E-01	1.525150E-01	9.525641E-02	UNKNOW	1
5.04180000E-01	1.515455E-01	9.525641E-02	UNKNOW	1
5.71404000E-01	1.505791E-01	9.525641E-02	UNKNOW	1
6.38628000E-01	1.496158E-01	9.525641E-02	UNKNOW	1
6.73765000E-01	1.393045E-01	5.368000E-03	C	2
6.76815000E-01	1.392572E-01	5.368000E-03	C	2
6.79865000E-01	1.392099E-01	5.368000E-03	C	2
6.82915000E-01	1.391626E-01	5.368000E-03	C	2
6.85965000E-01	1.391154E-01	5.368000E-03	C	2
6.89015000E-01	1.390681E-01	5.368000E-03	C	2
6.92065000E-01	1.390208E-01	5.368000E-03	C	2
6.95115000E-01	1.389736E-01	5.368000E-03	C	2
6.98165000E-01	1.389264E-01	5.368000E-03	C	2
7.01215000E-01	1.388791E-01	5.368000E-03	C	2
7.05280000E-01	1.403267E-01	8.940800E-03	UNKNOW	3
7.10360000E-01	1.402463E-01	8.940800E-03	UNKNOW	3
7.15440000E-01	1.401660E-01	8.940800E-03	UNKNOW	3
7.20520000E-01	1.400857E-01	8.940800E-03	UNKNOW	3
7.25600000E-01	1.400055E-01	8.940800E-03	UNKNOW	3
7.30680000E-01	1.399252E-01	8.940800E-03	UNKNOW	3
7.35760000E-01	1.398450E-01	8.940800E-03	UNKNOW	3
7.40840000E-01	1.397648E-01	8.940800E-03	UNKNOW	3
7.45920000E-01	1.396846E-01	8.940800E-03	UNKNOW	3
7.51000000E-01	1.396045E-01	8.940800E-03	UNKNOW	3
7.83000000E-01	1.393241E-01	7.618356E-05	UNKNOW	4
8.41920000E-01	1.393235E-01	7.618356E-05	UNKNOW	4
9.00840000E-01	1.393228E-01	7.618356E-05	UNKNOW	4
9.59760000E-01	1.393221E-01	7.618356E-05	UNKNOW	4
1.01868000E+00	1.393214E-01	7.618356E-05	UNKNOW	4
1.07760000E+00	1.393207E-01	7.618356E-05	UNKNOW	4
1.13652000E+00	1.393201E-01	7.618356E-05	UNKNOW	4
1.19544000E+00	1.393194E-01	7.618356E-05	UNKNOW	4
1.25436000E+00	1.393187E-01	7.618356E-05	UNKNOW	4
1.31328000E+00	1.393180E-01	7.618356E-05	UNKNOW	4
1.34528000E+00	1.395175E-01	8.940800E-03	UNKNOW	5
1.35036000E+00	1.394374E-01	8.940800E-03	UNKNOW	5
1.35544000E+00	1.393573E-01	8.940800E-03	UNKNOW	5
1.36052000E+00	1.392773E-01	8.940800E-03	UNKNOW	5

1.36560000E+00	1.391972E-01	8.940800E-03	UNKNOW	5
1.37068000E+00	1.391172E-01	8.940800E-03	UNKNOW	5
1.37576000E+00	1.390372E-01	8.940800E-03	UNKNOW	5
1.38084000E+00	1.389572E-01	8.940800E-03	UNKNOW	5
1.38592000E+00	1.388772E-01	8.940800E-03	UNKNOW	5
1.39100000E+00	1.387973E-01	8.940800E-03	UNKNOW	5
1.39506500E+00	1.372361E-01	5.368000E-03	C	6
1.39811500E+00	1.371892E-01	5.368000E-03	C	6
1.40116500E+00	1.371423E-01	5.368000E-03	C	6
1.40421500E+00	1.370953E-01	5.368000E-03	C	6
1.40726500E+00	1.370484E-01	5.368000E-03	C	6
1.41031500E+00	1.370015E-01	5.368000E-03	C	6
1.41336500E+00	1.369546E-01	5.368000E-03	C	6
1.41641500E+00	1.369077E-01	5.368000E-03	C	6
1.41946500E+00	1.368608E-01	5.368000E-03	C	6
1.42251500E+00	1.368140E-01	5.368000E-03	C	6
1.45765200E+00	1.459466E-01	9.525641E-02	UNKNOW	7
1.52487600E+00	1.449964E-01	9.525641E-02	UNKNOW	7
1.59210000E+00	1.440486E-01	9.525641E-02	UNKNOW	7
1.65932400E+00	1.431031E-01	9.525641E-02	UNKNOW	7
1.72654800E+00	1.421597E-01	9.525641E-02	UNKNOW	7
1.79377200E+00	1.412184E-01	9.525641E-02	UNKNOW	7
1.86099600E+00	1.402790E-01	9.525641E-02	UNKNOW	7
1.92822000E+00	1.393414E-01	9.525641E-02	UNKNOW	7
1.99544400E+00	1.384055E-01	9.525641E-02	UNKNOW	7
2.06266800E+00	1.374715E-01	9.525641E-02	UNKNOW	7

```
************************************************************************
*                                                                      *
*              INPUT TO ADEPT  (AUGUST 1, 1992 )                       *
*                                                                      *
************************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 2.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 4.0
DIRECTION
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


************************************************************************
*                                                                      *
*                    PROBLEM DEFINITION                                *
*                                                                      *
************************************************************************

   LAYER         THICKNESS       MATERIAL        DENSITY       XMESH

     1           6.7224E-01      1  UNKNOW       1.4170E+00     10
     2           3.0500E-02      2  C            1.7600E+00     10
     3           5.0800E-02      3  UNKNOW       1.7600E+00     10
     4           5.8920E-01      4  UNKNOW       1.2930E-03     10
     5           5.0800E-02      3  UNKNOW       1.7600E+00     10
     6           3.0500E-02      2  C            1.7600E+00     10
     7           6.7224E-01      1  UNKNOW       1.4170E+00     10

Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0003E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1             1.0000E+00
        2             9.9998E-01
        3             1.0000E+00
        4             1.0001E+00
        5             1.0001E+00
        6             1.0001E+00
        7             1.0000E+00

1***********************************************************************
*                                                                      *
*                        OUTPUT (CRAY)                                 *
*                                                                      *
```

```
*            AVERAGE SOURCE ENERGY =  4.0000E+00 MeV                  *
*                                                                     *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE       *
*                                                                     *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A         *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                  *
*                                                                     *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                   *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                        *
*                                                                     *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                   *
*               FOR NON-CHARGED-PARTICLE OUTPUT                       *
*                                                                     *
***********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	3.4448E-02
2	C	5.3680E-02	5.9754E-02
3	UNKNOW	8.9408E-02	6.2887E-02
4	UNKNOW	7.6184E-04	6.5279E-02
5	UNKNOW	8.9408E-02	6.5500E-02
6	C	5.3680E-02	6.6866E-02
7	UNKNOW	9.5256E-01	7.7260E-02

TOTAL ENERGY DEPOSITED = 1.2474E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	7.9826E-02
2	C	7.4079E-02
3	UNKNOW	7.4795E-02
4	UNKNOW	7.4621E-02
5	UNKNOW	7.4697E-02
6	C	7.3825E-02
7	UNKNOW	7.8320E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	5.056721E-03	9.525641E-02	UNKNOW	1
1.00836000E-01	1.225298E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	1.915029E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	2.585273E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	3.234522E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	3.860578E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	4.460159E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	5.029467E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	5.565192E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	6.067272E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	5.852103E-02	5.368000E-03	C	2
6.76815000E-01	5.882535E-02	5.368000E-03	C	2
6.79865000E-01	5.908211E-02	5.368000E-03	C	2
6.82915000E-01	5.934113E-02	5.368000E-03	C	2
6.85965000E-01	5.960181E-02	5.368000E-03	C	2
6.89015000E-01	5.986599E-02	5.368000E-03	C	2
6.92065000E-01	6.013554E-02	5.368000E-03	C	2
6.95115000E-01	6.041316E-02	5.368000E-03	C	2
6.98165000E-01	6.070074E-02	5.368000E-03	C	2
7.01215000E-01	6.105605E-02	5.368000E-03	C	2
7.05280000E-01	6.140118E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	6.175853E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	6.210489E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	6.244128E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	6.276751E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	6.308395E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	6.339068E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	6.368781E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	6.397413E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	6.426298E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	6.524734E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	6.526575E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	6.527657E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	6.528417E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	6.528921E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	6.529196E-02	7.618356E-05	UNKNOW	4

1.13652000E+00	6.529240E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	6.529024E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	6.528476E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	6.527151E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	6.455193E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	6.479276E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	6.503579E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	6.526503E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	6.548034E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	6.567966E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	6.585997E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	6.601594E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	6.614219E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	6.617665E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	6.623490E-02	5.368000E-03	C	6
1.39811500E+00	6.637826E-02	5.368000E-03	C	6
1.40116500E+00	6.651885E-02	5.368000E-03	C	6
1.40421500E+00	6.665875E-02	5.368000E-03	C	6
1.40726500E+00	6.679844E-02	5.368000E-03	C	6
1.41031500E+00	6.693826E-02	5.368000E-03	C	6
1.41336500E+00	6.707839E-02	5.368000E-03	C	6
1.41641500E+00	6.721882E-02	5.368000E-03	C	6
1.41946500E+00	6.736154E-02	5.368000E-03	C	6
1.42251500E+00	6.747519E-02	5.368000E-03	C	6
1.45765200E+00	7.409672E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	7.611578E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	7.761803E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	7.858729E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	7.909778E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	7.925224E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	7.911763E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	7.863317E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	7.755521E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	7.252827E-02	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	8.024472E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	8.016027E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	8.007243E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	7.998134E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	7.988713E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	7.978987E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	7.968962E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	7.958641E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	7.948023E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	7.937105E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	7.410470E-02	5.368000E-03	C	2
6.76815000E-01	7.409912E-02	5.368000E-03	C	2
6.79865000E-01	7.409353E-02	5.368000E-03	C	2
6.82915000E-01	7.408794E-02	5.368000E-03	C	2
6.85965000E-01	7.408234E-02	5.368000E-03	C	2
6.89015000E-01	7.407673E-02	5.368000E-03	C	2
6.92065000E-01	7.407111E-02	5.368000E-03	C	2
6.95115000E-01	7.406548E-02	5.368000E-03	C	2
6.98165000E-01	7.405985E-02	5.368000E-03	C	2
7.01215000E-01	7.405420E-02	5.368000E-03	C	2
7.05280000E-01	7.483771E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	7.482821E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	7.481870E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	7.480916E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	7.479960E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	7.479002E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	7.478043E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	7.477081E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	7.476117E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	7.475151E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	7.462158E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	7.462150E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	7.462142E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	7.462133E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	7.462125E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	7.462117E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	7.462109E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	7.462100E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	7.462092E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	7.462084E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	7.474100E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	7.473130E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	7.472157E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	7.471182E-02	8.940800E-03	UNKNOW	5

1.36560000E+00	7.470206E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	7.469227E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	7.468246E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	7.467263E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	7.466278E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	7.465290E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	7.385192E-02	5.368000E-03	C	6
1.39811500E+00	7.384600E-02	5.368000E-03	C	6
1.40116500E+00	7.384006E-02	5.368000E-03	C	6
1.40421500E+00	7.383412E-02	5.368000E-03	C	6
1.40726500E+00	7.382817E-02	5.368000E-03	C	6
1.41031500E+00	7.382222E-02	5.368000E-03	C	6
1.41336500E+00	7.381625E-02	5.368000E-03	C	6
1.41641500E+00	7.381027E-02	5.368000E-03	C	6
1.41946500E+00	7.380429E-02	5.368000E-03	C	6
1.42251500E+00	7.379830E-02	5.368000E-03	C	6
1.45765200E+00	7.892337E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	7.879882E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	7.867087E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	7.853942E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	7.840435E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	7.826555E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	7.812284E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	7.797603E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	7.782488E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	7.766913E-02	9.525641E-02	UNKNOW	7

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 4.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 4.0
DIRECTION
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE
```

```
*********************************************************************
*                                                                   *
*                PROBLEM DEFINITION                                 *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	6.7224E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	6.7224E-01	1 UNKNOW	1.4170E+00	10

```
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order =  8
Default Source Truncation Angle =   0.9000E+02


ENERGY CONSERVATION RATIO =   1.0005E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	9.9999E-01
2	1.0002E+00
3	1.0001E+00
4	1.0000E+00
5	9.9987E-01
6	9.9983E-01
7	1.0000E+00

```
1*********************************************************************
 *                                                                   *
 *                       OUTPUT (CRAY)                               *
 *                                                                   *
```

```
*              AVERAGE SOURCE ENERGY =  4.0000E+00 MeV                   *
*                                                                         *
*        ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE           *
*                                                                         *
*           FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A             *
*           UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                      *
*                                                                         *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                      *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                           *
*                                                                         *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                      *
*              FOR NON-CHARGED-PARTICLE OUTPUT                           *
*                                                                         *
***************************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	1.0324E-01
2	C	5.3680E-02	1.3262E-01
3	UNKNOW	8.9408E-02	1.3405E-01
4	UNKNOW	7.6184E-04	1.3571E-01
5	UNKNOW	8.9408E-02	1.3402E-01
6	C	5.3680E-02	1.3409E-01
7	UNKNOW	9.5256E-01	1.3844E-01

TOTAL ENERGY DEPOSITED =   2.6861E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.5399E-01
2	C	1.3909E-01
3	UNKNOW	1.3997E-01
4	UNKNOW	1.3932E-01
5	UNKNOW	1.3916E-01
6	C	1.3702E-01
7	UNKNOW	1.4170E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	3.708491E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	6.366399E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	8.156665E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	9.569610E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	1.071863E-01	9.525641E-02	UNKNOW	1
3.69732000E-01	1.165966E-01	9.525641E-02	UNKNOW	1
4.36956000E-01	1.243065E-01	9.525641E-02	UNKNOW	1
5.04180000E-01	1.306085E-01	9.525641E-02	UNKNOW	1
5.71404000E-01	1.357406E-01	9.525641E-02	UNKNOW	1
6.38628000E-01	1.399790E-01	9.525641E-02	UNKNOW	1
6.73765000E-01	1.314627E-01	5.368000E-03	C	2
6.76815000E-01	1.318159E-01	5.368000E-03	C	2
6.79865000E-01	1.320534E-01	5.368000E-03	C	2
6.82915000E-01	1.322886E-01	5.368000E-03	C	2
6.85965000E-01	1.325190E-01	5.368000E-03	C	2
6.89015000E-01	1.327468E-01	5.368000E-03	C	2
6.92065000E-01	1.329733E-01	5.368000E-03	C	2
6.95115000E-01	1.331996E-01	5.368000E-03	C	2
6.98165000E-01	1.334241E-01	5.368000E-03	C	2
7.01215000E-01	1.336889E-01	5.368000E-03	C	2
7.05280000E-01	1.338909E-01	8.940800E-03	UNKNOW	3
7.10360000E-01	1.339167E-01	8.940800E-03	UNKNOW	3
7.15440000E-01	1.339574E-01	8.940800E-03	UNKNOW	3
7.20520000E-01	1.340000E-01	8.940800E-03	UNKNOW	3
7.25600000E-01	1.340415E-01	8.940800E-03	UNKNOW	3
7.30680000E-01	1.340798E-01	8.940800E-03	UNKNOW	3
7.35760000E-01	1.341136E-01	8.940800E-03	UNKNOW	3
7.40840000E-01	1.341421E-01	8.940800E-03	UNKNOW	3
7.45920000E-01	1.341623E-01	8.940800E-03	UNKNOW	3
7.51000000E-01	1.342023E-01	8.940800E-03	UNKNOW	3
7.83000000E-01	1.356647E-01	7.618356E-05	UNKNOW	4
8.41920000E-01	1.356974E-01	7.618356E-05	UNKNOW	4
9.00840000E-01	1.357173E-01	7.618356E-05	UNKNOW	4
9.59760000E-01	1.357290E-01	7.618356E-05	UNKNOW	4
1.01868000E+00	1.357348E-01	7.618356E-05	UNKNOW	4
1.07760000E+00	1.357355E-01	7.618356E-05	UNKNOW	4

1.13652000E+00	1.357311E-01	7.618356E-05	UNKNOW	4
1.19544000E+00	1.357208E-01	7.618356E-05	UNKNOW	4
1.25436000E+00	1.357023E-01	7.618356E-05	UNKNOW	4
1.31328000E+00	1.356709E-01	7.618356E-05	UNKNOW	4
1.34528000E+00	1.342089E-01	8.940800E-03	UNKNOW	5
1.35036000E+00	1.341778E-01	8.940800E-03	UNKNOW	5
1.35544000E+00	1.341653E-01	8.940800E-03	UNKNOW	5
1.36052000E+00	1.341402E-01	8.940800E-03	UNKNOW	5
1.36560000E+00	1.341037E-01	8.940800E-03	UNKNOW	5
1.37068000E+00	1.340540E-01	8.940800E-03	UNKNOW	5
1.37576000E+00	1.339891E-01	8.940800E-03	UNKNOW	5
1.38084000E+00	1.339057E-01	8.940800E-03	UNKNOW	5
1.38592000E+00	1.338031E-01	8.940800E-03	UNKNOW	5
1.39100000E+00	1.336460E-01	8.940800E-03	UNKNOW	5
1.39506500E+00	1.335508E-01	5.368000E-03	C	6
1.39811500E+00	1.337000E-01	5.368000E-03	C	6
1.40116500E+00	1.338305E-01	5.368000E-03	C	6
1.40421500E+00	1.339524E-01	5.368000E-03	C	6
1.40726500E+00	1.340674E-01	5.368000E-03	C	6
1.41031500E+00	1.341761E-01	5.368000E-03	C	6
1.41336500E+00	1.342789E-01	5.368000E-03	C	6
1.41641500E+00	1.343750E-01	5.368000E-03	C	6
1.41946500E+00	1.344676E-01	5.368000E-03	C	6
1.42251500E+00	1.344664E-01	5.368000E-03	C	6
1.45765200E+00	1.455612E-01	9.525641E-02	UNKNOW	7
1.52487600E+00	1.457856E-01	9.525641E-02	UNKNOW	7
1.59210000E+00	1.455051E-01	9.525641E-02	UNKNOW	7
1.65932400E+00	1.447308E-01	9.525641E-02	UNKNOW	7
1.72654800E+00	1.434837E-01	9.525641E-02	UNKNOW	7
1.79377200E+00	1.417098E-01	9.525641E-02	UNKNOW	7
1.86099600E+00	1.392179E-01	9.525641E-02	UNKNOW	7
1.92822000E+00	1.355265E-01	9.525641E-02	UNKNOW	7
1.99544400E+00	1.296633E-01	9.525641E-02	UNKNOW	7
2.06266800E+00	1.132606E-01	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	1.584134E-01	9.525641E-02	UNKNOW	1
1.00836000E-01	1.574183E-01	9.525641E-02	UNKNOW	1
1.68060000E-01	1.564291E-01	9.525641E-02	UNKNOW	1
2.35284000E-01	1.554446E-01	9.525641E-02	UNKNOW	1
3.02508000E-01	1.544643E-01	9.525641E-02	UNKNOW	1
3.69732000E-01	1.534879E-01	9.525641E-02	UNKNOW	1
4.36956000E-01	1.525150E-01	9.525641E-02	UNKNOW	1
5.04180000E-01	1.515455E-01	9.525641E-02	UNKNOW	1
5.71404000E-01	1.505791E-01	9.525641E-02	UNKNOW	1
6.38628000E-01	1.496158E-01	9.525641E-02	UNKNOW	1
6.73765000E-01	1.393045E-01	5.368000E-03	C	2
6.76815000E-01	1.392572E-01	5.368000E-03	C	2
6.79865000E-01	1.392099E-01	5.368000E-03	C	2
6.82915000E-01	1.391626E-01	5.368000E-03	C	2
6.85965000E-01	1.391154E-01	5.368000E-03	C	2
6.89015000E-01	1.390681E-01	5.368000E-03	C	2
6.92065000E-01	1.390208E-01	5.368000E-03	C	2
6.95115000E-01	1.389736E-01	5.368000E-03	C	2
6.98165000E-01	1.389264E-01	5.368000E-03	C	2
7.01215000E-01	1.388791E-01	5.368000E-03	C	2
7.05280000E-01	1.403267E-01	8.940800E-03	UNKNOW	3
7.10360000E-01	1.402463E-01	8.940800E-03	UNKNOW	3
7.15440000E-01	1.401660E-01	8.940800E-03	UNKNOW	3
7.20520000E-01	1.400857E-01	8.940800E-03	UNKNOW	3
7.25600000E-01	1.400055E-01	8.940800E-03	UNKNOW	3
7.30680000E-01	1.399252E-01	8.940800E-03	UNKNOW	3
7.35760000E-01	1.398450E-01	8.940800E-03	UNKNOW	3
7.40840000E-01	1.397648E-01	8.940800E-03	UNKNOW	3
7.45920000E-01	1.396846E-01	8.940800E-03	UNKNOW	3
7.51000000E-01	1.396045E-01	8.940800E-03	UNKNOW	3
7.83000000E-01	1.393241E-01	7.618356E-05	UNKNOW	4
8.41920000E-01	1.393235E-01	7.618356E-05	UNKNOW	4
9.00840000E-01	1.393228E-01	7.618356E-05	UNKNOW	4
9.59760000E-01	1.393221E-01	7.618356E-05	UNKNOW	4
1.01868000E+00	1.393214E-01	7.618356E-05	UNKNOW	4
1.07760000E+00	1.393207E-01	7.618356E-05	UNKNOW	4
1.13652000E+00	1.393201E-01	7.618356E-05	UNKNOW	4
1.19544000E+00	1.393194E-01	7.618356E-05	UNKNOW	4
1.25436000E+00	1.393187E-01	7.618356E-05	UNKNOW	4
1.31328000E+00	1.393180E-01	7.618356E-05	UNKNOW	4
1.34528000E+00	1.395175E-01	8.940800E-03	UNKNOW	5
1.35036000E+00	1.394374E-01	8.940800E-03	UNKNOW	5
1.35544000E+00	1.393573E-01	8.940800E-03	UNKNOW	5
1.36052000E+00	1.392773E-01	8.940800E-03	UNKNOW	5

1.36560000E+00	1.391972E-01	8.940800E-03	UNKNOW	5
1.37068000E+00	1.391172E-01	8.940800E-03	UNKNOW	5
1.37576000E+00	1.390372E-01	8.940800E-03	UNKNOW	5
1.38084000E+00	1.389572E-01	8.940800E-03	UNKNOW	5
1.38592000E+00	1.388772E-01	8.940800E-03	UNKNOW	5
1.39100000E+00	1.387973E-01	8.940800E-03	UNKNOW	5
1.39506500E+00	1.372361E-01	5.368000E-03	C	6
1.39811500E+00	1.371892E-01	5.368000E-03	C	6
1.40116500E+00	1.371423E-01	5.368000E-03	C	6
1.40421500E+00	1.370953E-01	5.368000E-03	C	6
1.40726500E+00	1.370484E-01	5.368000E-03	C	6
1.41031500E+00	1.370015E-01	5.368000E-03	C	6
1.41336500E+00	1.369546E-01	5.368000E-03	C	6
1.41641500E+00	1.369077E-01	5.368000E-03	C	6
1.41946500E+00	1.368608E-01	5.368000E-03	C	6
1.42251500E+00	1.368140E-01	5.368000E-03	C	6
1.45765200E+00	1.459466E-01	9.525641E-02	UNKNOW	7
1.52487600E+00	1.449964E-01	9.525641E-02	UNKNOW	7
1.59210000E+00	1.440486E-01	9.525641E-02	UNKNOW	7
1.65932400E+00	1.431031E-01	9.525641E-02	UNKNOW	7
1.72654800E+00	1.421597E-01	9.525641E-02	UNKNOW	7
1.79377200E+00	1.412184E-01	9.525641E-02	UNKNOW	7
1.86099600E+00	1.402790E-01	9.525641E-02	UNKNOW	7
1.92822000E+00	1.393414E-01	9.525641E-02	UNKNOW	7
1.99544400E+00	1.384055E-01	9.525641E-02	UNKNOW	7
2.06266800E+00	1.374715E-01	9.525641E-02	UNKNOW	7

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 4.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 4.0
DIRECTION
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE
```

```
*********************************************************************
*                                                                   *
*                   PROBLEM DEFINITION                              *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	6.7224E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	6.7224E-01	1 UNKNOW	1.4170E+00	10

```
Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  21
Default Photon Groups =  21
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0003E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	1.0000E+00
2	9.9998E-01
3	1.0000E+00
4	1.0001E+00
5	1.0001E+00
6	1.0001E+00
7	1.0000E+00

```
1*********************************************************************
*                                                                   *
*                      OUTPUT (CRAY)                                *
*                                                                   *
```

```
*            AVERAGE SOURCE ENERGY =  4.0000E+00 MeV                *
*                                                                   *
*        ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE      *
*                                                                   *
*          FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A         *
*          UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                  *
*                                                                   *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                 *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                      *
*                                                                   *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                 *
*              FOR NON-CHARGED-PARTICLE OUTPUT                      *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	3.4448E-02
2	C	5.3680E-02	5.9754E-02
3	UNKNOW	8.9408E-02	6.2887E-02
4	UNKNOW	7.6184E-04	6.5279E-02
5	UNKNOW	8.9408E-02	6.5500E-02
6	C	5.3680E-02	6.6866E-02
7	UNKNOW	9.5256E-01	7.7260E-02

TOTAL ENERGY DEPOSITED = 1.2474E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	7.9826E-02
2	C	7.4079E-02
3	UNKNOW	7.4795E-02
4	UNKNOW	7.4621E-02
5	UNKNOW	7.4697E-02
6	C	7.3825E-02
7	UNKNOW	7.8320E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	5.056721E-03	9.525641E-02	UNKNOW	1
1.00836000E-01	1.225298E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	1.915029E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	2.585273E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	3.234522E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	3.860578E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	4.460159E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	5.029467E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	5.565192E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	6.067272E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	5.852103E-02	5.368000E-03	C	2
6.76815000E-01	5.882535E-02	5.368000E-03	C	2
6.79865000E-01	5.908211E-02	5.368000E-03	C	2
6.82915000E-01	5.934113E-02	5.368000E-03	C	2
6.85965000E-01	5.960181E-02	5.368000E-03	C	2
6.89015000E-01	5.986599E-02	5.368000E-03	C	2
6.92065000E-01	6.013554E-02	5.368000E-03	C	2
6.95115000E-01	6.041316E-02	5.368000E-03	C	2
6.98165000E-01	6.070074E-02	5.368000E-03	C	2
7.01215000E-01	6.105605E-02	5.368000E-03	C	2
7.05280000E-01	6.140118E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	6.175853E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	6.210489E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	6.244128E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	6.276751E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	6.308395E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	6.339068E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	6.368781E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	6.397413E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	6.426298E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	6.524734E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	6.526575E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	6.527657E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	6.528417E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	6.528921E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	6.529196E-02	7.618356E-05	UNKNOW	4

1.13652000E+00	6.529240E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	6.529024E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	6.528476E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	6.527151E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	6.455193E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	6.479276E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	6.503579E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	6.526503E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	6.548034E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	6.567966E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	6.585997E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	6.601594E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	6.614219E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	6.617665E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	6.623490E-02	5.368000E-03	C	6
1.39811500E+00	6.637826E-02	5.368000E-03	C	6
1.40116500E+00	6.651885E-02	5.368000E-03	C	6
1.40421500E+00	6.665875E-02	5.368000E-03	C	6
1.40726500E+00	6.679844E-02	5.368000E-03	C	6
1.41031500E+00	6.693826E-02	5.368000E-03	C	6
1.41336500E+00	6.707839E-02	5.368000E-03	C	6
1.41641500E+00	6.721882E-02	5.368000E-03	C	6
1.41946500E+00	6.736154E-02	5.368000E-03	C	6
1.42251500E+00	6.747519E-02	5.368000E-03	C	6
1.45765200E+00	7.409672E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	7.611578E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	7.761803E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	7.858729E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	7.909778E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	7.925224E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	7.911763E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	7.863317E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	7.755521E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	7.252827E-02	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	8.024472E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	8.016027E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	8.007243E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	7.998134E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	7.988713E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	7.978987E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	7.968962E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	7.958641E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	7.948023E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	7.937105E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	7.410470E-02	5.368000E-03	C	2
6.76815000E-01	7.409912E-02	5.368000E-03	C	2
6.79865000E-01	7.409353E-02	5.368000E-03	C	2
6.82915000E-01	7.408794E-02	5.368000E-03	C	2
6.85965000E-01	7.408234E-02	5.368000E-03	C	2
6.89015000E-01	7.407673E-02	5.368000E-03	C	2
6.92065000E-01	7.407111E-02	5.368000E-03	C	2
6.95115000E-01	7.406548E-02	5.368000E-03	C	2
6.98165000E-01	7.405985E-02	5.368000E-03	C	2
7.01215000E-01	7.405420E-02	5.368000E-03	C	2
7.05280000E-01	7.483771E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	7.482821E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	7.481870E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	7.480916E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	7.479960E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	7.479002E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	7.478043E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	7.477081E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	7.476117E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	7.475151E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	7.462158E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	7.462150E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	7.462142E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	7.462133E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	7.462125E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	7.462117E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	7.462109E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	7.462100E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	7.462092E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	7.462084E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	7.474100E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	7.473130E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	7.472157E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	7.471182E-02	8.940800E-03	UNKNOW	5

1.36560000E+00	7.470206E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	7.469227E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	7.468246E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	7.467263E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	7.466278E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	7.465290E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	7.385192E-02	5.368000E-03	C	6
1.39811500E+00	7.384600E-02	5.368000E-03	C	6
1.40116500E+00	7.384006E-02	5.368000E-03	C	6
1.40421500E+00	7.383412E-02	5.368000E-03	C	6
1.40726500E+00	7.382817E-02	5.368000E-03	C	6
1.41031500E+00	7.382222E-02	5.368000E-03	C	6
1.41336500E+00	7.381625E-02	5.368000E-03	C	6
1.41641500E+00	7.381027E-02	5.368000E-03	C	6
1.41946500E+00	7.380429E-02	5.368000E-03	C	6
1.42251500E+00	7.379830E-02	5.368000E-03	C	6
1.45765200E+00	7.892337E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	7.879882E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	7.867087E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	7.853942E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	7.840435E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	7.826555E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	7.812284E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	7.797603E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	7.782488E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	7.766913E-02	9.525641E-02	UNKNOW	7

```
**********************************************************************
*                                                                    *
*              INPUT TO ADEPT  (AUGUST 1, 1992 )                     *
*                                                                    *
**********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 4.0 MEV BASED SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 16
  1.0 0.9975 0.9753 0.9531 0.9309 0.9137 0.8767 0.8335
  0.7718 0.7078 0.6215 0.4858 0.3526 0.2170 0.0444 0.0
ENERGIES
  4.0 3.75 3.5 3.25 3.0 2.75 2.5 2.25 2.0
  1.75 1.5 1.25 1.0 0.75 0.5 0.25
DIRECTION
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


**********************************************************************
*                                                                    *
*                 PROBLEM DEFINITION                                 *
*                                                                    *
**********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	6.7224E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	6.7224E-01	1 UNKNOW	1.4170E+00	10

```
Default Electron Groups =  59
Default Photon Groups =  59
Default SN Order =  8
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0022E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	9.9999E-01
2	9.9991E-01
3	9.9940E-01
4	9.9917E-01
5	9.9998E-01
6	9.9954E-01
7	1.0000E+00

```
1*********************************************************************
*                                                                   *
*                          OUTPUT (CRAY)                            *
*                                                                   *
*              AVERAGE SOURCE ENERGY =  1.4546E+00 MeV              *
*                                                                   *
*          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE    *
*                                                                   *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A       *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                *
*                                                                   *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                 *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                      *
*                                                                   *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                 *
*               FOR NON-CHARGED-PARTICLE OUTPUT                     *
*                                                                   *
*********************************************************************
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LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	6.4413E-02
2	C	5.3680E-02	6.6093E-02
3	UNKNOW	8.9408E-02	6.5755E-02
4	UNKNOW	7.6184E-04	6.4551E-02
5	UNKNOW	8.9408E-02	6.4150E-02
6	C	5.3680E-02	6.3336E-02
7	UNKNOW	9.5256E-01	6.3887E-02

TOTAL ENERGY DEPOSITED = 1.4083E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	7.3751E-02
2	C	6.5380E-02
3	UNKNOW	6.5036E-02
4	UNKNOW	6.4662E-02
5	UNKNOW	6.4432E-02
6	C	6.3821E-02
7	UNKNOW	6.4439E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	3.473291E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	5.485552E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	6.291143E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	6.721077E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	6.949030E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	7.064177E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	7.112710E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	7.120837E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	7.106234E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	7.089265E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	6.561343E-02	5.368000E-03	C	2
6.76815000E-01	6.574665E-02	5.368000E-03	C	2
6.79865000E-01	6.584373E-02	5.368000E-03	C	2
6.82915000E-01	6.593560E-02	5.368000E-03	C	2
6.85965000E-01	6.602689E-02	5.368000E-03	C	2
6.89015000E-01	6.612135E-02	5.368000E-03	C	2
6.92065000E-01	6.622237E-02	5.368000E-03	C	2
6.95115000E-01	6.633411E-02	5.368000E-03	C	2
6.98165000E-01	6.646277E-02	5.368000E-03	C	2
7.01215000E-01	6.662705E-02	5.368000E-03	C	2
7.05280000E-01	6.658714E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	6.633547E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	6.613255E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	6.595308E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	6.578870E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	6.563461E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	6.548767E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	6.534559E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	6.520634E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	6.507438E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	6.454069E-02	7.618356E-05	UNKNOW	4

8.41920000E-01	6.455368E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	6.455859E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	6.456079E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	6.456099E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	6.455953E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	6.455641E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	6.455130E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	6.454343E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	6.452752E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	6.492083E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	6.477128E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	6.462304E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	6.446831E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	6.430469E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	6.412892E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	6.393664E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	6.372124E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	6.347133E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	6.315267E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	6.301389E-02	5.368000E-03	C	6
1.39811500E+00	6.313288E-02	5.368000E-03	C	6
1.40116500E+00	6.322017E-02	5.368000E-03	C	6
1.40421500E+00	6.329114E-02	5.368000E-03	C	6
1.40726500E+00	6.335052E-02	5.368000E-03	C	6
1.41031500E+00	6.340104E-02	5.368000E-03	C	6
1.41336500E+00	6.344424E-02	5.368000E-03	C	6
1.41641500E+00	6.348065E-02	5.368000E-03	C	6
1.41946500E+00	6.351019E-02	5.368000E-03	C	6
1.42251500E+00	6.351184E-02	5.368000E-03	C	6
1.45765200E+00	6.824457E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	6.752814E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	6.682611E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	6.610392E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	6.535962E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	6.457097E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	6.368171E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	6.251915E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	6.076696E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	5.326511E-02	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	7.723284E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	7.643974E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	7.565441E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	7.487648E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	7.410573E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	7.334199E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	7.258505E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	7.183473E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	7.109082E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	7.035312E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	6.554221E-02	5.368000E-03	C	2
6.76815000E-01	6.550604E-02	5.368000E-03	C	2
6.79865000E-01	6.546987E-02	5.368000E-03	C	2
6.82915000E-01	6.543373E-02	5.368000E-03	C	2
6.85965000E-01	6.539759E-02	5.368000E-03	C	2
6.89015000E-01	6.536147E-02	5.368000E-03	C	2
6.92065000E-01	6.532536E-02	5.368000E-03	C	2
6.95115000E-01	6.528927E-02	5.368000E-03	C	2
6.98165000E-01	6.525318E-02	5.368000E-03	C	2
7.01215000E-01	6.521712E-02	5.368000E-03	C	2
7.05280000E-01	6.530729E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	6.524690E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	6.518658E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	6.512632E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	6.506612E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	6.500598E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	6.494589E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	6.488586E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	6.482588E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	6.476596E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	6.466392E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	6.466341E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	6.466290E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	6.466239E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	6.466189E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	6.466138E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	6.466087E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	6.466036E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	6.465985E-02	7.618356E-05	UNKNOW	4

1.31328000E+00	6.465934E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	6.470099E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	6.464117E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	6.458141E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	6.452169E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	6.446203E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	6.440243E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	6.434287E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	6.428338E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	6.422394E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	6.416456E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	6.398090E-02	5.368000E-03	C	6
1.39811500E+00	6.394538E-02	5.368000E-03	C	6
1.40116500E+00	6.390988E-02	5.368000E-03	C	6
1.40421500E+00	6.387439E-02	5.368000E-03	C	6
1.40726500E+00	6.383891E-02	5.368000E-03	C	6
1.41031500E+00	6.380345E-02	5.368000E-03	C	6
1.41336500E+00	6.376800E-02	5.368000E-03	C	6
1.41641500E+00	6.373256E-02	5.368000E-03	C	6
1.41946500E+00	6.369713E-02	5.368000E-03	C	6
1.42251500E+00	6.366171E-02	5.368000E-03	C	6
1.45765200E+00	6.758404E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	6.687326E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	6.616737E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	6.546611E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	6.476923E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	6.407646E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	6.338751E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	6.270209E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	6.201984E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	6.134031E-02	9.525641E-02	UNKNOW	7

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*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 4.0 MEV BASED SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 0.67224
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 0.67224
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 16
1.0 0.9975 0.9753 0.9531 0.9309 0.9137 0.8767 0.8335
0.7718 0.7078 0.6215 0.4858 0.3526 0.2170 0.0444 0.0
ENERGIES
4.0 3.75 3.5 3.25 3.0 2.75 2.5 2.25 2.0
1.75 1.5 1.25 1.0 0.75 0.5 0.25
DIRECTION
   PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
   DOSE
```

```
*********************************************************************
*                                                                   *
*                   PROBLEM DEFINITION                              *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	6.7224E-01	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	6.7224E-01	1 UNKNOW	1.4170E+00	10

Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups = 59
Default Photon Groups = 59
Default SN Order = 16

ENERGY CONSERVATION RATIO =   1.0021E+00

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	1.0000E+00
2	1.0036E+00
3	9.9910E-01
4	9.9873E-01
5	1.0017E+00
6	9.9936E-01
7	1.0000E+00

```
1*********************************************************************
*                                                                   *
*                          OUTPUT (CRAY)                            *
*                                                                   *
*               AVERAGE SOURCE ENERGY =  1.4546E+00 MeV             *
*                                                                   *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE     *
*                                                                   *
*           FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A        *
*           UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                 *
*                                                                   *
*       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
*       ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
*                                                                   *
*       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
*                FOR NON-CHARGED-PARTICLE OUTPUT                    *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	9.5256E-01	3.0183E-02
2	C	5.3680E-02	3.5752E-02
3	UNKNOW	8.9408E-02	3.6492E-02
4	UNKNOW	7.6184E-04	3.6083E-02
5	UNKNOW	8.9408E-02	3.5949E-02
6	C	5.3680E-02	3.5186E-02
7	UNKNOW	9.5256E-01	3.7651E-02

TOTAL ENERGY DEPOSITED = 7.4929E-02 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	3.8713E-02
2	C	3.5951E-02
3	UNKNOW	3.5972E-02
4	UNKNOW	3.5897E-02
5	UNKNOW	3.5901E-02
6	C	3.5767E-02
7	UNKNOW	3.7622E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	9.748648E-03	9.525641E-02	UNKNOW	1
1.00836000E-01	2.006855E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	2.613451E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	3.013512E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	3.282988E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	3.467391E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	3.595588E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	3.685106E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	3.747933E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	3.795227E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	3.530954E-02	5.368000E-03	C	2
6.76815000E-01	3.539677E-02	5.368000E-03	C	2
6.79865000E-01	3.547478E-02	5.368000E-03	C	2
6.82915000E-01	3.555681E-02	5.368000E-03	C	2
6.85965000E-01	3.564573E-02	5.368000E-03	C	2
6.89015000E-01	3.574484E-02	5.368000E-03	C	2
6.92065000E-01	3.585840E-02	5.368000E-03	C	2
6.95115000E-01	3.599271E-02	5.368000E-03	C	2
6.98165000E-01	3.615715E-02	5.368000E-03	C	2
7.01215000E-01	3.638719E-02	5.368000E-03	C	2
7.05280000E-01	3.656654E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	3.657347E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	3.656411E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	3.654578E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	3.652183E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	3.649408E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	3.646345E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	3.643045E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	3.639509E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	3.636085E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	3.607679E-02	7.618356E-05	UNKNOW	4

8.41920000E-01	3.608401E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	3.608703E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	3.608846E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	3.608876E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	3.608809E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	3.608645E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	3.608365E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	3.607922E-02	7.618356E-05	UNKNOW	4
1.31328000E+00	3.607039E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	3.631327E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	3.626232E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	3.620874E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	3.614761E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	3.607654E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	3.599183E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	3.588779E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	3.575423E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	3.557236E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	3.528028E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	3.505811E-02	5.368000E-03	C	6
1.39811500E+00	3.508115E-02	5.368000E-03	C	6
1.40116500E+00	3.510488E-02	5.368000E-03	C	6
1.40421500E+00	3.513079E-02	5.368000E-03	C	6
1.40726500E+00	3.515937E-02	5.368000E-03	C	6
1.41031500E+00	3.519071E-02	5.368000E-03	C	6
1.41336500E+00	3.522494E-02	5.368000E-03	C	6
1.41641500E+00	3.526240E-02	5.368000E-03	C	6
1.41946500E+00	3.530388E-02	5.368000E-03	C	6
1.42251500E+00	3.534421E-02	5.368000E-03	C	6
1.45765200E+00	3.823302E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	3.822224E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	3.818706E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	3.812073E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	3.803159E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	3.792469E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	3.779771E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	3.762034E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	3.736903E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	3.500620E-02	9.525641E-02	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
3.36120000E-02	3.892323E-02	9.525641E-02	UNKNOW	1
1.00836000E-01	3.889179E-02	9.525641E-02	UNKNOW	1
1.68060000E-01	3.885417E-02	9.525641E-02	UNKNOW	1
2.35284000E-01	3.881060E-02	9.525641E-02	UNKNOW	1
3.02508000E-01	3.876136E-02	9.525641E-02	UNKNOW	1
3.69732000E-01	3.870670E-02	9.525641E-02	UNKNOW	1
4.36956000E-01	3.864683E-02	9.525641E-02	UNKNOW	1
5.04180000E-01	3.858197E-02	9.525641E-02	UNKNOW	1
5.71404000E-01	3.851227E-02	9.525641E-02	UNKNOW	1
6.38628000E-01	3.843789E-02	9.525641E-02	UNKNOW	1
6.73765000E-01	3.596919E-02	5.368000E-03	C	2
6.76815000E-01	3.596527E-02	5.368000E-03	C	2
6.79865000E-01	3.596134E-02	5.368000E-03	C	2
6.82915000E-01	3.595739E-02	5.368000E-03	C	2
6.85965000E-01	3.595343E-02	5.368000E-03	C	2
6.89015000E-01	3.594946E-02	5.368000E-03	C	2
6.92065000E-01	3.594548E-02	5.368000E-03	C	2
6.95115000E-01	3.594148E-02	5.368000E-03	C	2
6.98165000E-01	3.593747E-02	5.368000E-03	C	2
7.01215000E-01	3.593345E-02	5.368000E-03	C	2
7.05280000E-01	3.600330E-02	8.940800E-03	UNKNOW	3
7.10360000E-01	3.599644E-02	8.940800E-03	UNKNOW	3
7.15440000E-01	3.598956E-02	8.940800E-03	UNKNOW	3
7.20520000E-01	3.598266E-02	8.940800E-03	UNKNOW	3
7.25600000E-01	3.597575E-02	8.940800E-03	UNKNOW	3
7.30680000E-01	3.596880E-02	8.940800E-03	UNKNOW	3
7.35760000E-01	3.596184E-02	8.940800E-03	UNKNOW	3
7.40840000E-01	3.595484E-02	8.940800E-03	UNKNOW	3
7.45920000E-01	3.594782E-02	8.940800E-03	UNKNOW	3
7.51000000E-01	3.594078E-02	8.940800E-03	UNKNOW	3
7.83000000E-01	3.589741E-02	7.618356E-05	UNKNOW	4
8.41920000E-01	3.589735E-02	7.618356E-05	UNKNOW	4
9.00840000E-01	3.589729E-02	7.618356E-05	UNKNOW	4
9.59760000E-01	3.589723E-02	7.618356E-05	UNKNOW	4
1.01868000E+00	3.589717E-02	7.618356E-05	UNKNOW	4
1.07760000E+00	3.589711E-02	7.618356E-05	UNKNOW	4
1.13652000E+00	3.589705E-02	7.618356E-05	UNKNOW	4
1.19544000E+00	3.589699E-02	7.618356E-05	UNKNOW	4
1.25436000E+00	3.589693E-02	7.618356E-05	UNKNOW	4

1.31328000E+00	3.589687E-02	7.618356E-05	UNKNOW	4
1.34528000E+00	3.593310E-02	8.940800E-03	UNKNOW	5
1.35036000E+00	3.592599E-02	8.940800E-03	UNKNOW	5
1.35544000E+00	3.591886E-02	8.940800E-03	UNKNOW	5
1.36052000E+00	3.591170E-02	8.940800E-03	UNKNOW	5
1.36560000E+00	3.590451E-02	8.940800E-03	UNKNOW	5
1.37068000E+00	3.589730E-02	8.940800E-03	UNKNOW	5
1.37576000E+00	3.589006E-02	8.940800E-03	UNKNOW	5
1.38084000E+00	3.588281E-02	8.940800E-03	UNKNOW	5
1.38592000E+00	3.587553E-02	8.940800E-03	UNKNOW	5
1.39100000E+00	3.586824E-02	8.940800E-03	UNKNOW	5
1.39506500E+00	3.578733E-02	5.368000E-03	C	6
1.39811500E+00	3.578291E-02	5.368000E-03	C	6
1.40116500E+00	3.577848E-02	5.368000E-03	C	6
1.40421500E+00	3.577404E-02	5.368000E-03	C	6
1.40726500E+00	3.576958E-02	5.368000E-03	C	6
1.41031500E+00	3.576512E-02	5.368000E-03	C	6
1.41336500E+00	3.576064E-02	5.368000E-03	C	6
1.41641500E+00	3.575614E-02	5.368000E-03	C	6
1.41946500E+00	3.575164E-02	5.368000E-03	C	6
1.42251500E+00	3.574712E-02	5.368000E-03	C	6
1.45765200E+00	3.811126E-02	9.525641E-02	UNKNOW	7
1.52487600E+00	3.801512E-02	9.525641E-02	UNKNOW	7
1.59210000E+00	3.791448E-02	9.525641E-02	UNKNOW	7
1.65932400E+00	3.780925E-02	9.525641E-02	UNKNOW	7
1.72654800E+00	3.769932E-02	9.525641E-02	UNKNOW	7
1.79377200E+00	3.758455E-02	9.525641E-02	UNKNOW	7
1.86099600E+00	3.746476E-02	9.525641E-02	UNKNOW	7
1.92822000E+00	3.733970E-02	9.525641E-02	UNKNOW	7
1.99544400E+00	3.720908E-02	9.525641E-02	UNKNOW	7
2.06266800E+00	3.707246E-02	9.525641E-02	UNKNOW	7

```
***********************************************************************
*                                                                     *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                        *
*                                                                     *
***********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 6.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 1.01024
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 1.01024
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 6.0
DIRECTION
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


***********************************************************************
*                                                                     *
*                PROBLEM DEFINITION                                   *
*                                                                     *
***********************************************************************

   LAYER        THICKNESS     MATERIAL       DENSITY      XMESH

     1          1.0102E+00    1  UNKNOW      1.4170E+00   10
     2          3.0500E-02    2  C           1.7600E+00   10
     3          5.0800E-02    3  UNKNOW      1.7600E+00   10
     4          5.8920E-01    4  UNKNOW      1.2930E-03   10
     5          5.0800E-02    3  UNKNOW      1.7600E+00   10
     6          3.0500E-02    2  C           1.7600E+00   10
     7          1.0102E+00    1  UNKNOW      1.4170E+00   10

Default Electron Groups =  22
Default Photon Groups =  22
Default SN Order =  8
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0008E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1          9.9999E-01
        2          1.0002E+00
        3          1.0001E+00
        4          1.0000E+00
        5          9.9993E-01
        6          9.9986E-01
        7          1.0000E+00

1**********************************************************************
*                                                                     *
*                        OUTPUT (CRAY)                                *
*                                                                     *
```

```
*              AVERAGE SOURCE ENERGY =  6.0000E+00 MeV                  *
*                                                                       *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE         *
*                                                                       *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A           *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                    *
*                                                                       *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                     *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                          *
*                                                                       *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                     *
*               FOR NON-CHARGED-PARTICLE OUTPUT                         *
*                                                                       *
*************************************************************************
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LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	1.4315E+00	1.3205E-01
2	C	5.3680E-02	1.6992E-01
3	UNKNOW	8.9408E-02	1.7128E-01
4	UNKNOW	7.6184E-04	1.7622E-01
5	UNKNOW	8.9408E-02	1.7140E-01
6	C	5.3680E-02	1.7161E-01
7	UNKNOW	1.4315E+00	1.7943E-01

TOTAL ENERGY DEPOSITED =   4.9499E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.9995E-01
2	C	1.7860E-01
3	UNKNOW	1.8213E-01
4	UNKNOW	1.8122E-01
5	UNKNOW	1.8125E-01
6	C	1.7641E-01
7	UNKNOW	1.8182E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	4.520749E-02	1.431510E-01	UNKNOW	1
1.51536000E-01	8.020787E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	1.039188E-01	1.431510E-01	UNKNOW	1
3.53584000E-01	1.224332E-01	1.431510E-01	UNKNOW	1
4.54608000E-01	1.374479E-01	1.431510E-01	UNKNOW	1
5.55632000E-01	1.497073E-01	1.431510E-01	UNKNOW	1
6.56656000E-01	1.596920E-01	1.431510E-01	UNKNOW	1
7.57680000E-01	1.677908E-01	1.431510E-01	UNKNOW	1
8.58704000E-01	1.743331E-01	1.431510E-01	UNKNOW	1
9.59728000E-01	1.797129E-01	1.431510E-01	UNKNOW	1
1.01176500E+00	1.688739E-01	5.368000E-03	C	2
1.01481500E+00	1.691824E-01	5.368000E-03	C	2
1.01786500E+00	1.694076E-01	5.368000E-03	C	2
1.02091500E+00	1.696216E-01	5.368000E-03	C	2
1.02396500E+00	1.698292E-01	5.368000E-03	C	2
1.02701500E+00	1.700343E-01	5.368000E-03	C	2
1.03006500E+00	1.702387E-01	5.368000E-03	C	2
1.03311500E+00	1.704447E-01	5.368000E-03	C	2
1.03616500E+00	1.706559E-01	5.368000E-03	C	2
1.03921500E+00	1.709024E-01	5.368000E-03	C	2
1.04328000E+00	1.711115E-01	8.940800E-03	UNKNOW	3
1.04836000E+00	1.711241E-01	8.940800E-03	UNKNOW	3
1.05344000E+00	1.711681E-01	8.940800E-03	UNKNOW	3
1.05852000E+00	1.712167E-01	8.940800E-03	UNKNOW	3
1.06360000E+00	1.712647E-01	8.940800E-03	UNKNOW	3
1.06868000E+00	1.713102E-01	8.940800E-03	UNKNOW	3
1.07376000E+00	1.713522E-01	8.940800E-03	UNKNOW	3
1.07884000E+00	1.713901E-01	8.940800E-03	UNKNOW	3
1.08392000E+00	1.714225E-01	8.940800E-03	UNKNOW	3
1.08900000E+00	1.714672E-01	8.940800E-03	UNKNOW	3
1.12100000E+00	1.761685E-01	7.618356E-05	UNKNOW	4
1.17992000E+00	1.762118E-01	7.618356E-05	UNKNOW	4
1.23884000E+00	1.762338E-01	7.618356E-05	UNKNOW	4
1.29776000E+00	1.762465E-01	7.618356E-05	UNKNOW	4
1.35668000E+00	1.762526E-01	7.618356E-05	UNKNOW	4
1.41560000E+00	1.762529E-01	7.618356E-05	UNKNOW	4

1.47452000E+00	1.762473E-01	7.618356E-05	UNKNOW	4
1.53344000E+00	1.762351E-01	7.618356E-05	UNKNOW	4
1.59236000E+00	1.762136E-01	7.618356E-05	UNKNOW	4
1.65128000E+00	1.761708E-01	7.618356E-05	UNKNOW	4
1.68328000E+00	1.714875E-01	8.940800E-03	UNKNOW	5
1.68836000E+00	1.714798E-01	8.940800E-03	UNKNOW	5
1.69344000E+00	1.714822E-01	8.940800E-03	UNKNOW	5
1.69852000E+00	1.714756E-01	8.940800E-03	UNKNOW	5
1.70360000E+00	1.714594E-01	8.940800E-03	UNKNOW	5
1.70868000E+00	1.714321E-01	8.940800E-03	UNKNOW	5
1.71376000E+00	1.713924E-01	8.940800E-03	UNKNOW	5
1.71884000E+00	1.713383E-01	8.940800E-03	UNKNOW	5
1.72392000E+00	1.712659E-01	8.940800E-03	UNKNOW	5
1.72900000E+00	1.711388E-01	8.940800E-03	UNKNOW	5
1.73306500E+00	1.710444E-01	5.368000E-03	C	6
1.73611500E+00	1.712116E-01	5.368000E-03	C	6
1.73916500E+00	1.713491E-01	5.368000E-03	C	6
1.74221500E+00	1.714738E-01	5.368000E-03	C	6
1.74526500E+00	1.715910E-01	5.368000E-03	C	6
1.74831500E+00	1.717027E-01	5.368000E-03	C	6
1.75136500E+00	1.718088E-01	5.368000E-03	C	6
1.75441500E+00	1.719079E-01	5.368000E-03	C	6
1.75746500E+00	1.719985E-01	5.368000E-03	C	6
1.76051500E+00	1.720243E-01	5.368000E-03	C	6
1.81255200E+00	1.863754E-01	1.431510E-01	UNKNOW	7
1.91357600E+00	1.872813E-01	1.431510E-01	UNKNOW	7
2.01460000E+00	1.874426E-01	1.431510E-01	UNKNOW	7
2.11562400E+00	1.868842E-01	1.431510E-01	UNKNOW	7
2.21664800E+00	1.856318E-01	1.431510E-01	UNKNOW	7
2.31767200E+00	1.836471E-01	1.431510E-01	UNKNOW	7
2.41869600E+00	1.807622E-01	1.431510E-01	UNKNOW	7
2.51972000E+00	1.764771E-01	1.431510E-01	UNKNOW	7
2.62074400E+00	1.696545E-01	1.431510E-01	UNKNOW	7
2.72176800E+00	1.501428E-01	1.431510E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	2.070615E-01	1.431510E-01	UNKNOW	1
1.51536000E-01	2.054522E-01	1.431510E-01	UNKNOW	1
2.52560000E-01	2.038565E-01	1.431510E-01	UNKNOW	1
3.53584000E-01	2.022714E-01	1.431510E-01	UNKNOW	1
4.54608000E-01	2.006958E-01	1.431510E-01	UNKNOW	1
5.55632000E-01	1.991291E-01	1.431510E-01	UNKNOW	1
6.56656000E-01	1.975706E-01	1.431510E-01	UNKNOW	1
7.57680000E-01	1.960201E-01	1.431510E-01	UNKNOW	1
8.58704000E-01	1.944773E-01	1.431510E-01	UNKNOW	1
9.59728000E-01	1.929417E-01	1.431510E-01	UNKNOW	1
1.01176500E+00	1.788213E-01	5.368000E-03	C	2
1.01481500E+00	1.787717E-01	5.368000E-03	C	2
1.01786500E+00	1.787221E-01	5.368000E-03	C	2
1.02091500E+00	1.786725E-01	5.368000E-03	C	2
1.02396500E+00	1.786230E-01	5.368000E-03	C	2
1.02701500E+00	1.785734E-01	5.368000E-03	C	2
1.03006500E+00	1.785238E-01	5.368000E-03	C	2
1.03311500E+00	1.784743E-01	5.368000E-03	C	2
1.03616500E+00	1.784247E-01	5.368000E-03	C	2
1.03921500E+00	1.783752E-01	5.368000E-03	C	2
1.04328000E+00	1.825178E-01	8.940800E-03	UNKNOW	3
1.04836000E+00	1.824307E-01	8.940800E-03	UNKNOW	3
1.05344000E+00	1.823437E-01	8.940800E-03	UNKNOW	3
1.05852000E+00	1.822568E-01	8.940800E-03	UNKNOW	3
1.06360000E+00	1.821699E-01	8.940800E-03	UNKNOW	3
1.06868000E+00	1.820830E-01	8.940800E-03	UNKNOW	3
1.07376000E+00	1.819962E-01	8.940800E-03	UNKNOW	3
1.07884000E+00	1.819095E-01	8.940800E-03	UNKNOW	3
1.08392000E+00	1.818228E-01	8.940800E-03	UNKNOW	3
1.08900000E+00	1.817361E-01	8.940800E-03	UNKNOW	3
1.12100000E+00	1.812200E-01	7.618356E-05	UNKNOW	4
1.17992000E+00	1.812193E-01	7.618356E-05	UNKNOW	4
1.23884000E+00	1.812185E-01	7.618356E-05	UNKNOW	4
1.29776000E+00	1.812178E-01	7.618356E-05	UNKNOW	4
1.35668000E+00	1.812171E-01	7.618356E-05	UNKNOW	4
1.41560000E+00	1.812163E-01	7.618356E-05	UNKNOW	4
1.47452000E+00	1.812156E-01	7.618356E-05	UNKNOW	4
1.53344000E+00	1.812149E-01	7.618356E-05	UNKNOW	4
1.59236000E+00	1.812141E-01	7.618356E-05	UNKNOW	4
1.65128000E+00	1.812134E-01	7.618356E-05	UNKNOW	4
1.68328000E+00	1.816421E-01	8.940800E-03	UNKNOW	5
1.68836000E+00	1.815555E-01	8.940800E-03	UNKNOW	5
1.69344000E+00	1.814690E-01	8.940800E-03	UNKNOW	5
1.69852000E+00	1.813825E-01	8.940800E-03	UNKNOW	5

1.70360000E+00	1.812960E-01	8.940800E-03	UNKNOW	5
1.70868000E+00	1.812096E-01	8.940800E-03	UNKNOW	5
1.71376000E+00	1.811232E-01	8.940800E-03	UNKNOW	5
1.71884000E+00	1.810369E-01	8.940800E-03	UNKNOW	5
1.72392000E+00	1.809506E-01	8.940800E-03	UNKNOW	5
1.72900000E+00	1.808644E-01	8.940800E-03	UNKNOW	5
1.73306500E+00	1.766287E-01	5.368000E-03	C	6
1.73611500E+00	1.765795E-01	5.368000E-03	C	6
1.73916500E+00	1.765303E-01	5.368000E-03	C	6
1.74221500E+00	1.764811E-01	5.368000E-03	C	6
1.74526500E+00	1.764319E-01	5.368000E-03	C	6
1.74831500E+00	1.763828E-01	5.368000E-03	C	6
1.75136500E+00	1.763336E-01	5.368000E-03	C	6
1.75441500E+00	1.762844E-01	5.368000E-03	C	6
1.75746500E+00	1.762353E-01	5.368000E-03	C	6
1.76051500E+00	1.761861E-01	5.368000E-03	C	6
1.81255200E+00	1.885358E-01	1.431510E-01	UNKNOW	7
1.91357600E+00	1.870277E-01	1.431510E-01	UNKNOW	7
2.01460000E+00	1.855258E-01	1.431510E-01	UNKNOW	7
2.11562400E+00	1.840298E-01	1.431510E-01	UNKNOW	7
2.21664800E+00	1.825395E-01	1.431510E-01	UNKNOW	7
2.31767200E+00	1.810545E-01	1.431510E-01	UNKNOW	7
2.41869600E+00	1.795744E-01	1.431510E-01	UNKNOW	7
2.51972000E+00	1.780986E-01	1.431510E-01	UNKNOW	7
2.62074400E+00	1.766266E-01	1.431510E-01	UNKNOW	7
2.72176800E+00	1.751582E-01	1.431510E-01	UNKNOW	7

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***********************************************************************
*                                                                     *
*              INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                     *
***********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 6.0 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 1.01024
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 1.01024
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 6.0
DIRECTION
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


***********************************************************************
*                                                                     *
*                  PROBLEM DEFINITION                                 *
*                                                                     *
***********************************************************************

   LAYER         THICKNESS      MATERIAL        DENSITY      XMESH

     1          1.0102E+00    1  UNKNOW      1.4170E+00     10
     2          3.0500E-02    2  C           1.7600E+00     10
     3          5.0800E-02    3  UNKNOW      1.7600E+00     10
     4          5.8920E-01    4  UNKNOW      1.2930E-03     10
     5          5.0800E-02    3  UNKNOW      1.7600E+00     10
     6          3.0500E-02    2  C           1.7600E+00     10
     7          1.0102E+00    1  UNKNOW      1.4170E+00     10

Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  22
Default Photon Groups =  22
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0005E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1            1.0000E+00
        2            1.0000E+00
        3            1.0000E+00
        4            1.0002E+00
        5            1.0001E+00
        6            1.0001E+00
        7            1.0000E+00

1**********************************************************************
 *                                                                    *
 *                       OUTPUT (CRAY)                                *
 *                                                                    *
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*              AVERAGE SOURCE ENERGY =  6.0000E+00 MeV                  *
*                                                                       *
*          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE       *
*                                                                       *
*             FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A          *
*             UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                   *
*                                                                       *
*       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                    *
*       ELECTRONS ARE THE SAME CHARGED-PARTICLE                         *
*                                                                       *
*       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                    *
*                FOR NON-CHARGED-PARTICLE OUTPUT                        *
*                                                                       *
*************************************************************************
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LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	1.4315E+00	4.2715E-02
2	C	5.3680E-02	7.4562E-02
3	UNKNOW	8.9408E-02	7.7429E-02
4	UNKNOW	7.6184E-04	8.1390E-02
5	UNKNOW	8.9408E-02	8.0057E-02
6	C	5.3680E-02	8.1652E-02
7	UNKNOW	1.4315E+00	9.9299E-02

TOTAL ENERGY DEPOSITED =   2.2582E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.0418E-01
2	C	9.6047E-02
3	UNKNOW	9.8226E-02
4	UNKNOW	9.7914E-02
5	UNKNOW	9.8107E-02
6	C	9.5747E-02
7	UNKNOW	1.0171E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	5.879077E-03	1.431510E-01	UNKNOW	1
1.51536000E-01	1.472337E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	2.335073E-02	1.431510E-01	UNKNOW	1
3.53584000E-01	3.177717E-02	1.431510E-01	UNKNOW	1
4.54608000E-01	3.995661E-02	1.431510E-01	UNKNOW	1
5.55632000E-01	4.785423E-02	1.431510E-01	UNKNOW	1
6.56656000E-01	5.543524E-02	1.431510E-01	UNKNOW	1
7.57680000E-01	6.266350E-02	1.431510E-01	UNKNOW	1
8.58704000E-01	6.951138E-02	1.431510E-01	UNKNOW	1
9.59728000E-01	7.599857E-02	1.431510E-01	UNKNOW	1
1.01176500E+00	7.344442E-02	5.368000E-03	C	2
1.01481500E+00	7.371680E-02	5.368000E-03	C	2
1.01786500E+00	7.395263E-02	5.368000E-03	C	2
1.02091500E+00	7.418669E-02	5.368000E-03	C	2
1.02396500E+00	7.442136E-02	5.368000E-03	C	2
1.02701500E+00	7.465919E-02	5.368000E-03	C	2
1.03006500E+00	7.490254E-02	5.368000E-03	C	2
1.03311500E+00	7.515547E-02	5.368000E-03	C	2
1.03616500E+00	7.542512E-02	5.368000E-03	C	2
1.03921500E+00	7.575374E-02	5.368000E-03	C	2
1.04328000E+00	7.606498E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	7.636835E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	7.668301E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	7.699317E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	7.729844E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	7.759823E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	7.789230E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	7.818050E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	7.846225E-02	8.940800E-03	UNKNOW	3
1.08900000E+00	7.874598E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	8.135581E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	8.137661E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	8.138875E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	8.139693E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	8.140199E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	8.140430E-02	7.618356E-05	UNKNOW	4

1.47452000E+00	8.140385E-02	7.618356E-05	UNKNOW	4
1.53344000E+00	8.140023E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	8.139245E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	8.137548E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	7.903619E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	7.928735E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	7.953859E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	7.978037E-02	8.940800E-03	UNKNOW	5
1.70360000E+00	8.001190E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	8.023139E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	8.043618E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	8.062175E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	8.077827E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	8.084518E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	8.092818E-02	5.368000E-03	C	6
1.73611500E+00	8.111027E-02	5.368000E-03	C	6
1.73916500E+00	8.126944E-02	5.368000E-03	C	6
1.74221500E+00	8.142605E-02	5.368000E-03	C	6
1.74526500E+00	8.158122E-02	5.368000E-03	C	6
1.74831500E+00	8.173577E-02	5.368000E-03	C	6
1.75136500E+00	8.189012E-02	5.368000E-03	C	6
1.75441500E+00	8.204431E-02	5.368000E-03	C	6
1.75746500E+00	8.219924E-02	5.368000E-03	C	6
1.76051500E+00	8.233599E-02	5.368000E-03	C	6
1.81255200E+00	9.094394E-02	1.431510E-01	UNKNOW	7
1.91357600E+00	9.465659E-02	1.431510E-01	UNKNOW	7
2.01460000E+00	9.774341E-02	1.431510E-01	UNKNOW	7
2.11562400E+00	1.001452E-01	1.431510E-01	UNKNOW	7
2.21664800E+00	1.018294E-01	1.431510E-01	UNKNOW	7
2.31767200E+00	1.028188E-01	1.431510E-01	UNKNOW	7
2.41869600E+00	1.031949E-01	1.431510E-01	UNKNOW	7
2.51972000E+00	1.029831E-01	1.431510E-01	UNKNOW	7
2.62074400E+00	1.020514E-01	1.431510E-01	UNKNOW	7
2.72176800E+00	9.662276E-02	1.431510E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	1.049645E-01	1.431510E-01	UNKNOW	1
1.51536000E-01	1.048032E-01	1.431510E-01	UNKNOW	1
2.52560000E-01	1.046364E-01	1.431510E-01	UNKNOW	1
3.53584000E-01	1.044644E-01	1.431510E-01	UNKNOW	1
4.54608000E-01	1.042876E-01	1.431510E-01	UNKNOW	1
5.55632000E-01	1.041063E-01	1.431510E-01	UNKNOW	1
6.56656000E-01	1.039208E-01	1.431510E-01	UNKNOW	1
7.57680000E-01	1.037310E-01	1.431510E-01	UNKNOW	1
8.58704000E-01	1.035371E-01	1.431510E-01	UNKNOW	1
9.59728000E-01	1.033391E-01	1.431510E-01	UNKNOW	1
1.01176500E+00	9.607624E-02	5.368000E-03	C	2
1.01481500E+00	9.606966E-02	5.368000E-03	C	2
1.01786500E+00	9.606308E-02	5.368000E-03	C	2
1.02091500E+00	9.605649E-02	5.368000E-03	C	2
1.02396500E+00	9.604989E-02	5.368000E-03	C	2
1.02701500E+00	9.604329E-02	5.368000E-03	C	2
1.03006500E+00	9.603668E-02	5.368000E-03	C	2
1.03311500E+00	9.603007E-02	5.368000E-03	C	2
1.03616500E+00	9.602345E-02	5.368000E-03	C	2
1.03921500E+00	9.601683E-02	5.368000E-03	C	2
1.04328000E+00	9.827873E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	9.826702E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	9.825531E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	9.824359E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	9.823187E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	9.822014E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	9.820840E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	9.819666E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	9.818492E-02	8.940800E-03	UNKNOW	3
1.08900000E+00	9.817316E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	9.791409E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	9.791399E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	9.791389E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	9.791379E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	9.791369E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	9.791359E-02	7.618356E-05	UNKNOW	4
1.47452000E+00	9.791350E-02	7.618356E-05	UNKNOW	4
1.53344000E+00	9.791340E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	9.791330E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	9.791320E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	9.816041E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	9.814864E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	9.813687E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	9.812509E-02	8.940800E-03	UNKNOW	5

1.70360000E+00	9.811330E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	9.810152E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	9.808972E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	9.807792E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	9.806612E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	9.805432E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	9.577796E-02	5.368000E-03	C	6
1.73611500E+00	9.577117E-02	5.368000E-03	C	6
1.73916500E+00	9.576438E-02	5.368000E-03	C	6
1.74221500E+00	9.575758E-02	5.368000E-03	C	6
1.74526500E+00	9.575077E-02	5.368000E-03	C	6
1.74831500E+00	9.574396E-02	5.368000E-03	C	6
1.75136500E+00	9.573715E-02	5.368000E-03	C	6
1.75441500E+00	9.573032E-02	5.368000E-03	C	6
1.75746500E+00	9.572350E-02	5.368000E-03	C	6
1.76051500E+00	9.571666E-02	5.368000E-03	C	6
1.81255200E+00	1.027409E-01	1.431510E-01	UNKNOW	7
1.91357600E+00	1.025259E-01	1.431510E-01	UNKNOW	7
2.01460000E+00	1.023061E-01	1.431510E-01	UNKNOW	7
2.11562400E+00	1.020815E-01	1.431510E-01	UNKNOW	7
2.21664800E+00	1.018516E-01	1.431510E-01	UNKNOW	7
2.31767200E+00	1.016164E-01	1.431510E-01	UNKNOW	7
2.41869600E+00	1.013753E-01	1.431510E-01	UNKNOW	7
2.51972000E+00	1.011280E-01	1.431510E-01	UNKNOW	7
2.62074400E+00	1.008738E-01	1.431510E-01	UNKNOW	7
2.72176800E+00	1.006116E-01	1.431510E-01	UNKNOW	7

```
**********************************************************************
*                                                                    *
*             INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                    *
**********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 6.0 MEV BASED SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 1.01024
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 1.01024
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 25
  1.0000 0.9957 0.9922 0.9852 0.9807 0.9681 0.9581 0.9443
  0.9217 0.8966 0.8639 0.8401 0.8049 0.7723 0.7384 0.6957
  0.6329 0.5752 0.4747 0.3743 0.2614 0.1459 0.0329 0.000251 0.0
ENERGIES
  6.0 5.75 5.5 5.25 5.0 4.75 4.5 4.25
  4.0 3.75 3.5 3.25 3.0 2.75 2.5 2.25
  2.0 1.75 1.5 1.25 1.0 0.75 0.5 0.25 0.0
DIRECTION
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE
```

```
**********************************************************************
*                                                                    *
*                   PROBLEM DEFINITION                               *
*                                                                    *
**********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	1.0102E+00	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	1.0102E+00	1 UNKNOW	1.4170E+00	10

```
Default Electron Groups =  62
Default Photon Groups =  62
Default SN Order =  8
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0016E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	9.9999E-01
2	9.9995E-01
3	9.9900E-01
4	9.9916E-01
5	1.0000E+00

6	9.9927E-01
7	1.0000E+00

```
1*********************************************************************
*                                                                   *
*                        OUTPUT (CRAY)                              *
*                                                                   *
*            AVERAGE SOURCE ENERGY =  1.9111E+00 MeV                *
*                                                                   *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE     *
*                                                                   *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A       *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                *
*                                                                   *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                 *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                      *
*                                                                   *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                 *
*               FOR NON-CHARGED-PARTICLE OUTPUT                     *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	1.4315E+00	7.6555E-02
2	C	5.3680E-02	7.7594E-02
3	UNKNOW	8.9408E-02	7.7256E-02
4	UNKNOW	7.6184E-04	7.6392E-02
5	UNKNOW	8.9408E-02	7.5576E-02
6	C	5.3680E-02	7.4689E-02
7	UNKNOW	1.4315E+00	7.4585E-02

TOTAL ENERGY DEPOSITED = 2.3826E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	8.7670E-02
2	C	7.6588E-02
3	UNKNOW	7.6492E-02
4	UNKNOW	7.6093E-02
5	UNKNOW	7.5894E-02
6	C	7.5049E-02
7	UNKNOW	7.4844E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	4.174656E-02	1.431510E-01	UNKNOW	1
1.51536000E-01	6.600153E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	7.536484E-02	1.431510E-01	UNKNOW	1
3.53584000E-01	8.020979E-02	1.431510E-01	UNKNOW	1
4.54608000E-01	8.270268E-02	1.431510E-01	UNKNOW	1
5.55632000E-01	8.388820E-02	1.431510E-01	UNKNOW	1
6.56656000E-01	8.428214E-02	1.431510E-01	UNKNOW	1
7.57680000E-01	8.418116E-02	1.431510E-01	UNKNOW	1
8.58704000E-01	8.379075E-02	1.431510E-01	UNKNOW	1
9.59728000E-01	8.338205E-02	1.431510E-01	UNKNOW	1
1.01176500E+00	7.712718E-02	5.368000E-03	C	2
1.01481500E+00	7.726063E-02	5.368000E-03	C	2
1.01786500E+00	7.735460E-02	5.368000E-03	C	2
1.02091500E+00	7.744363E-02	5.368000E-03	C	2
1.02396500E+00	7.753202E-02	5.368000E-03	C	2
1.02701500E+00	7.762322E-02	5.368000E-03	C	2
1.03006500E+00	7.772027E-02	5.368000E-03	C	2
1.03311500E+00	7.782688E-02	5.368000E-03	C	2
1.03616500E+00	7.794849E-02	5.368000E-03	C	2
1.03921500E+00	7.810400E-02	5.368000E-03	C	2
1.04328000E+00	7.808075E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	7.784445E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	7.764740E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	7.746874E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	7.730187E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	7.714295E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	7.698947E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	7.683958E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	7.669152E-02	8.940800E-03	UNKNOW	3

1.08900000E+00	7.655064E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	7.637879E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	7.639443E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	7.640037E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	7.640305E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	7.640343E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	7.640192E-02	7.618356E-05	UNKNOW	4
1.47452000E+00	7.639850E-02	7.618356E-05	UNKNOW	4
1.53344000E+00	7.639278E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	7.638377E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	7.636510E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	7.638655E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	7.622623E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	7.606787E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	7.590319E-02	8.940800E-03	UNKNOW	5
1.70360000E+00	7.573004E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	7.554549E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	7.534571E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	7.512497E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	7.487337E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	7.455860E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	7.440456E-02	5.368000E-03	C	6
1.73611500E+00	7.450757E-02	5.368000E-03	C	6
1.73916500E+00	7.458384E-02	5.368000E-03	C	6
1.74221500E+00	7.464685E-02	5.368000E-03	C	6
1.74526500E+00	7.470026E-02	5.368000E-03	C	6
1.74831500E+00	7.474620E-02	5.368000E-03	C	6
1.75136500E+00	7.478588E-02	5.368000E-03	C	6
1.75441500E+00	7.481954E-02	5.368000E-03	C	6
1.75746500E+00	7.484684E-02	5.368000E-03	C	6
1.76051500E+00	7.484400E-02	5.368000E-03	C	6
1.81255200E+00	8.033411E-02	1.431510E-01	UNKNOW	7
1.91357600E+00	7.933508E-02	1.431510E-01	UNKNOW	7
2.01460000E+00	7.831755E-02	1.431510E-01	UNKNOW	7
2.11562400E+00	7.727534E-02	1.431510E-01	UNKNOW	7
2.21664800E+00	7.621309E-02	1.431510E-01	UNKNOW	7
2.31767200E+00	7.511244E-02	1.431510E-01	UNKNOW	7
2.41869600E+00	7.392159E-02	1.431510E-01	UNKNOW	7
2.51972000E+00	7.247399E-02	1.431510E-01	UNKNOW	7
2.62074400E+00	7.048130E-02	1.431510E-01	UNKNOW	7
2.72176800E+00	6.238445E-02	1.431510E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	9.295382E-02	1.431510E-01	UNKNOW	1
1.51536000E-01	9.173731E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	9.053780E-02	1.431510E-01	UNKNOW	1
3.53584000E-01	8.935442E-02	1.431510E-01	UNKNOW	1
4.54608000E-01	8.818664E-02	1.431510E-01	UNKNOW	1
5.55632000E-01	8.703398E-02	1.431510E-01	UNKNOW	1
6.56656000E-01	8.589593E-02	1.431510E-01	UNKNOW	1
7.57680000E-01	8.477199E-02	1.431510E-01	UNKNOW	1
8.58704000E-01	8.366165E-02	1.431510E-01	UNKNOW	1
9.59728000E-01	8.256435E-02	1.431510E-01	UNKNOW	1
1.01176500E+00	7.674829E-02	5.368000E-03	C	2
1.01481500E+00	7.671266E-02	5.368000E-03	C	2
1.01786500E+00	7.667704E-02	5.368000E-03	C	2
1.02091500E+00	7.664143E-02	5.368000E-03	C	2
1.02396500E+00	7.660583E-02	5.368000E-03	C	2
1.02701500E+00	7.657024E-02	5.368000E-03	C	2
1.03006500E+00	7.653467E-02	5.368000E-03	C	2
1.03311500E+00	7.649911E-02	5.368000E-03	C	2
1.03616500E+00	7.646356E-02	5.368000E-03	C	2
1.03921500E+00	7.642802E-02	5.368000E-03	C	2
1.04328000E+00	7.676079E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	7.670094E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	7.664115E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	7.658143E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	7.652178E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	7.646218E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	7.640264E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	7.634315E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	7.628372E-02	8.940800E-03	UNKNOW	3
1.08900000E+00	7.622435E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	7.609561E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	7.609511E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	7.609460E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	7.609410E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	7.609360E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	7.609309E-02	7.618356E-05	UNKNOW	4
1.47452000E+00	7.609259E-02	7.618356E-05	UNKNOW	4

1.53344000E+00	7.609208E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	7.609158E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	7.609108E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	7.615998E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	7.610071E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	7.604150E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	7.598233E-02	8.940800E-03	UNKNOW	5
1.70360000E+00	7.592322E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	7.586417E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	7.580517E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	7.574623E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	7.568735E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	7.562853E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	7.520646E-02	5.368000E-03	C	6
1.73611500E+00	7.517144E-02	5.368000E-03	C	6
1.73916500E+00	7.513643E-02	5.368000E-03	C	6
1.74221500E+00	7.510144E-02	5.368000E-03	C	6
1.74526500E+00	7.506645E-02	5.368000E-03	C	6
1.74831500E+00	7.503148E-02	5.368000E-03	C	6
1.75136500E+00	7.499652E-02	5.368000E-03	C	6
1.75441500E+00	7.496156E-02	5.368000E-03	C	6
1.75746500E+00	7.492663E-02	5.368000E-03	C	6
1.76051500E+00	7.489170E-02	5.368000E-03	C	6
1.81255200E+00	7.946978E-02	1.431510E-01	UNKNOW	7
1.91357600E+00	7.841789E-02	1.431510E-01	UNKNOW	7
2.01460000E+00	7.737619E-02	1.431510E-01	UNKNOW	7
2.11562400E+00	7.634404E-02	1.431510E-01	UNKNOW	7
2.21664800E+00	7.532079E-02	1.431510E-01	UNKNOW	7
2.31767200E+00	7.430575E-02	1.431510E-01	UNKNOW	7
2.41869600E+00	7.329820E-02	1.431510E-01	UNKNOW	7
2.51972000E+00	7.229738E-02	1.431510E-01	UNKNOW	7
2.62074400E+00	7.130238E-02	1.431510E-01	UNKNOW	7
2.72176800E+00	7.031213E-02	1.431510E-01	UNKNOW	7

```
**********************************************************************
*                                                                    *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                       *
*                                                                    *
**********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 6.0 MEV BASED SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 10 1.01024
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 10 1.01024
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 25
  1.0000 0.9957 0.9922 0.9852 0.9807 0.9681 0.9581 0.9443
  0.9217 0.8966 0.8639 0.8401 0.8049 0.7723 0.7384 0.6957
  0.6329 0.5752 0.4747 0.3743 0.2614 0.1459 0.0329 0.000251 0.0
ENERGIES
  6.0 5.75 5.5 5.25 5.0 4.75 4.5 4.25
  4.0 3.75 3.5 3.25 3.0 2.75 2.5 2.25
  2.0 1.75 1.5 1.25 1.0 0.75 0.5 0.25 0.0
DIRECTION
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
  DOSE


**********************************************************************
*                                                                    *
*                 PROBLEM DEFINITION                                 *
*                                                                    *
**********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	1.0102E+00	1 UNKNOW	1.4170E+00	10
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	1.0102E+00	1 UNKNOW	1.4170E+00	10

```
Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  62
Default Photon Groups =  62
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0015E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	1.0000E+00
2	1.0029E+00
3	9.9888E-01
4	9.9926E-01
5	1.0019E+00

6	9.9932E-01
7	9.9999E-01

```
1*********************************************************************
*                                                                   *
*                         OUTPUT (CRAY)                             *
*                                                                   *
*               AVERAGE SOURCE ENERGY =  1.9111E+00 MeV             *
*                                                                   *
*           ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE   *
*                                                                   *
*              FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A     *
*              UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)              *
*                                                                   *
*        PAIR SECONDARIES PRODUCED, AND POSITRONS AND               *
*        ELECTRONS ARE THE SAME CHARGED-PARTICLE                    *
*                                                                   *
*        WARNING: POSITRON TREATMENT APPROPRIATE ONLY               *
*                 FOR NON-CHARGED-PARTICLE OUTPUT                   *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	1.4315E+00	3.6070E-02
2	C	5.3680E-02	4.2789E-02
3	UNKNOW	8.9408E-02	4.3520E-02
4	UNKNOW	7.6184E-04	4.3321E-02
5	UNKNOW	8.9408E-02	4.2974E-02
6	C	5.3680E-02	4.2190E-02
7	UNKNOW	1.4315E+00	4.4968E-02

TOTAL ENERGY DEPOSITED =   1.2833E-01 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	4.6457E-02
2	C	4.2950E-02
3	UNKNOW	4.3099E-02
4	UNKNOW	4.3004E-02
5	UNKNOW	4.3020E-02
6	C	4.2747E-02
7	UNKNOW	4.4781E-02

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	1.164948E-02	1.431510E-01	UNKNOW	1
1.51536000E-01	2.407332E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	3.126125E-02	1.431510E-01	UNKNOW	1
3.53584000E-01	3.593339E-02	1.431510E-01	UNKNOW	1
4.54608000E-01	3.910941E-02	1.431510E-01	UNKNOW	1
5.55632000E-01	4.134411E-02	1.431510E-01	UNKNOW	1
6.56656000E-01	4.293856E-02	1.431510E-01	UNKNOW	1
7.57680000E-01	4.406870E-02	1.431510E-01	UNKNOW	1
8.58704000E-01	4.485868E-02	1.431510E-01	UNKNOW	1
9.59728000E-01	4.545939E-02	1.431510E-01	UNKNOW	1
1.01176500E+00	4.234800E-02	5.368000E-03	C	2
1.01481500E+00	4.243873E-02	5.368000E-03	C	2
1.01786500E+00	4.251685E-02	5.368000E-03	C	2
1.02091500E+00	4.259868E-02	5.368000E-03	C	2
1.02396500E+00	4.268709E-02	5.368000E-03	C	2
1.02701500E+00	4.278529E-02	5.368000E-03	C	2
1.03006500E+00	4.289712E-02	5.368000E-03	C	2
1.03311500E+00	4.302777E-02	5.368000E-03	C	2
1.03616500E+00	4.318523E-02	5.368000E-03	C	2
1.03921500E+00	4.340357E-02	5.368000E-03	C	2
1.04328000E+00	4.357547E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	4.358647E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	4.358339E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	4.357103E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	4.355211E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	4.352843E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	4.350086E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	4.346984E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	4.343531E-02	8.940800E-03	UNKNOW	3

1.08900000E+00	4.340118E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	4.331311E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	4.332190E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	4.332560E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	4.332740E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	4.332786E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	4.332721E-02	7.618356E-05	UNKNOW	4
1.47452000E+00	4.332544E-02	7.618356E-05	UNKNOW	4
1.53344000E+00	4.332231E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	4.331723E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	4.330684E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	4.335250E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	4.329905E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	4.324262E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	4.317790E-02	8.940800E-03	UNKNOW	5
1.70360000E+00	4.310263E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	4.301329E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	4.290450E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	4.276688E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	4.258426E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	4.230049E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	4.208513E-02	5.368000E-03	C	6
1.73611500E+00	4.210427E-02	5.368000E-03	C	6
1.73916500E+00	4.212291E-02	5.368000E-03	C	6
1.74221500E+00	4.214349E-02	5.368000E-03	C	6
1.74526500E+00	4.216659E-02	5.368000E-03	C	6
1.74831500E+00	4.219251E-02	5.368000E-03	C	6
1.75136500E+00	4.222135E-02	5.368000E-03	C	6
1.75441500E+00	4.225319E-02	5.368000E-03	C	6
1.75746500E+00	4.228853E-02	5.368000E-03	C	6
1.76051500E+00	4.231978E-02	5.368000E-03	C	6
1.81255200E+00	4.574181E-02	1.431510E-01	UNKNOW	7
1.91357600E+00	4.572214E-02	1.431510E-01	UNKNOW	7
2.01460000E+00	4.565836E-02	1.431510E-01	UNKNOW	7
2.11562400E+00	4.554719E-02	1.431510E-01	UNKNOW	7
2.21664800E+00	4.540322E-02	1.431510E-01	UNKNOW	7
2.31767200E+00	4.523433E-02	1.431510E-01	UNKNOW	7
2.41869600E+00	4.504138E-02	1.431510E-01	UNKNOW	7
2.51972000E+00	4.479926E-02	1.431510E-01	UNKNOW	7
2.62074400E+00	4.450986E-02	1.431510E-01	UNKNOW	7
2.72176800E+00	4.202707E-02	1.431510E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
5.05120000E-02	4.682474E-02	1.431510E-01	UNKNOW	1
1.51536000E-01	4.677063E-02	1.431510E-01	UNKNOW	1
2.52560000E-01	4.670470E-02	1.431510E-01	UNKNOW	1
3.53584000E-01	4.662785E-02	1.431510E-01	UNKNOW	1
4.54608000E-01	4.654095E-02	1.431510E-01	UNKNOW	1
5.55632000E-01	4.644475E-02	1.431510E-01	UNKNOW	1
6.56656000E-01	4.633992E-02	1.431510E-01	UNKNOW	1
7.57680000E-01	4.622698E-02	1.431510E-01	UNKNOW	1
8.58704000E-01	4.610637E-02	1.431510E-01	UNKNOW	1
9.59728000E-01	4.597844E-02	1.431510E-01	UNKNOW	1
1.01176500E+00	4.297015E-02	5.368000E-03	C	2
1.01481500E+00	4.296571E-02	5.368000E-03	C	2
1.01786500E+00	4.296126E-02	5.368000E-03	C	2
1.02091500E+00	4.295680E-02	5.368000E-03	C	2
1.02396500E+00	4.295233E-02	5.368000E-03	C	2
1.02701500E+00	4.294785E-02	5.368000E-03	C	2
1.03006500E+00	4.294336E-02	5.368000E-03	C	2
1.03311500E+00	4.293887E-02	5.368000E-03	C	2
1.03616500E+00	4.293436E-02	5.368000E-03	C	2
1.03921500E+00	4.292984E-02	5.368000E-03	C	2
1.04328000E+00	4.313389E-02	8.940800E-03	UNKNOW	3
1.04836000E+00	4.312613E-02	8.940800E-03	UNKNOW	3
1.05344000E+00	4.311838E-02	8.940800E-03	UNKNOW	3
1.05852000E+00	4.311062E-02	8.940800E-03	UNKNOW	3
1.06360000E+00	4.310285E-02	8.940800E-03	UNKNOW	3
1.06868000E+00	4.309507E-02	8.940800E-03	UNKNOW	3
1.07376000E+00	4.308728E-02	8.940800E-03	UNKNOW	3
1.07884000E+00	4.307947E-02	8.940800E-03	UNKNOW	3
1.08392000E+00	4.307165E-02	8.940800E-03	UNKNOW	3
1.08900000E+00	4.306381E-02	8.940800E-03	UNKNOW	3
1.12100000E+00	4.300431E-02	7.618356E-05	UNKNOW	4
1.17992000E+00	4.300424E-02	7.618356E-05	UNKNOW	4
1.23884000E+00	4.300418E-02	7.618356E-05	UNKNOW	4
1.29776000E+00	4.300411E-02	7.618356E-05	UNKNOW	4
1.35668000E+00	4.300404E-02	7.618356E-05	UNKNOW	4
1.41560000E+00	4.300398E-02	7.618356E-05	UNKNOW	4
1.47452000E+00	4.300391E-02	7.618356E-05	UNKNOW	4

1.53344000E+00	4.300384E-02	7.618356E-05	UNKNOW	4
1.59236000E+00	4.300378E-02	7.618356E-05	UNKNOW	4
1.65128000E+00	4.300371E-02	7.618356E-05	UNKNOW	4
1.68328000E+00	4.305529E-02	8.940800E-03	UNKNOW	5
1.68836000E+00	4.304742E-02	8.940800E-03	UNKNOW	5
1.69344000E+00	4.303953E-02	8.940800E-03	UNKNOW	5
1.69852000E+00	4.303163E-02	8.940800E-03	UNKNOW	5
1.70360000E+00	4.302371E-02	8.940800E-03	UNKNOW	5
1.70868000E+00	4.301578E-02	8.940800E-03	UNKNOW	5
1.71376000E+00	4.300784E-02	8.940800E-03	UNKNOW	5
1.71884000E+00	4.299989E-02	8.940800E-03	UNKNOW	5
1.72392000E+00	4.299193E-02	8.940800E-03	UNKNOW	5
1.72900000E+00	4.298398E-02	8.940800E-03	UNKNOW	5
1.73306500E+00	4.276833E-02	5.368000E-03	C	6
1.73611500E+00	4.276356E-02	5.368000E-03	C	6
1.73916500E+00	4.275877E-02	5.368000E-03	C	6
1.74221500E+00	4.275397E-02	5.368000E-03	C	6
1.74526500E+00	4.274917E-02	5.368000E-03	C	6
1.74831500E+00	4.274435E-02	5.368000E-03	C	6
1.75136500E+00	4.273953E-02	5.368000E-03	C	6
1.75441500E+00	4.273470E-02	5.368000E-03	C	6
1.75746500E+00	4.272985E-02	5.368000E-03	C	6
1.76051500E+00	4.272500E-02	5.368000E-03	C	6
1.81255200E+00	4.557020E-02	1.431510E-01	UNKNOW	7
1.91357600E+00	4.541520E-02	1.431510E-01	UNKNOW	7
2.01460000E+00	4.525319E-02	1.431510E-01	UNKNOW	7
2.11562400E+00	4.508397E-02	1.431510E-01	UNKNOW	7
2.21664800E+00	4.490722E-02	1.431510E-01	UNKNOW	7
2.31767200E+00	4.472253E-02	1.431510E-01	UNKNOW	7
2.41869600E+00	4.452937E-02	1.431510E-01	UNKNOW	7
2.51972000E+00	4.432703E-02	1.431510E-01	UNKNOW	7
2.62074400E+00	4.411464E-02	1.431510E-01	UNKNOW	7
2.72176800E+00	4.389095E-02	1.431510E-01	UNKNOW	7

Appendix B, Range Data for Delrin.

SUMMARY OF RANGE DATA (cm)

ENERGY (MEV)	MATERIAL 1	MATERIAL 2	MATERIAL 3	MATERIAL 4
1.81971E+01	6.31000E+00	5.47630E+00	5.40597E+00	6.75678E+03
1.64641E+01	5.76965E+00	5.00648E+00	4.94784E+00	6.20724E+03
1.48961E+01	5.27109E+00	4.57322E+00	4.52442E+00	5.69768E+03
1.34774E+01	4.81161E+00	4.17407E+00	4.13354E+00	5.22556E+03
1.21938E+01	4.38866E+00	3.80680E+00	3.77318E+00	4.78865E+03
1.10325E+01	3.99975E+00	3.46919E+00	3.44136E+00	4.38470E+03
9.98180E+00	3.64248E+00	3.15915E+00	3.13614E+00	4.01156E+03
9.03116E+00	3.31459E+00	2.87468E+00	2.85566E+00	3.66717E+03
8.17105E+00	3.01390E+00	2.61387E+00	2.59818E+00	3.34959E+03
7.39285E+00	2.73834E+00	2.37491E+00	2.36197E+00	3.05688E+03
6.68877E+00	2.48600E+00	2.15612E+00	2.14546E+00	2.78730E+03
6.05174E+00	2.25508E+00	1.95591E+00	1.94715E+00	2.53919E+03
5.47539E+00	2.04387E+00	1.77283E+00	1.76562E+00	2.31099E+03
4.95392E+00	1.85081E+00	1.60549E+00	1.59957E+00	2.10123E+03
4.48212E+00	1.67445E+00	1.45263E+00	1.44776E+00	1.90855E+03
4.05525E+00	1.51341E+00	1.31306E+00	1.30906E+00	1.73164E+03
3.66904E+00	1.36645E+00	1.18569E+00	1.18241E+00	1.56932E+03
3.31961E+00	1.23241E+00	1.06951E+00	1.06683E+00	1.42049E+03
3.00345E+00	1.11023E+00	9.63616E-01	9.61414E-01	1.28412E+03
2.71741E+00	9.98927E-01	8.67141E-01	8.65339E-01	1.15927E+03
2.45861E+00	8.97607E-01	7.79311E-01	7.77837E-01	1.04504E+03
2.22446E+00	8.05437E-01	6.99405E-01	6.98201E-01	9.40636E+02
2.01260E+00	7.21665E-01	6.26772E-01	6.25789E-01	8.45293E+02
1.82093E+00	6.45595E-01	5.60807E-01	5.60006E-01	7.58322E+02
1.64750E+00	5.76590E-01	5.00960E-01	5.00308E-01	6.79081E+02
1.49060E+00	5.14064E-01	4.46724E-01	4.46194E-01	6.06976E+02
1.34864E+00	4.57481E-01	3.97634E-01	3.97204E-01	5.41459E+02
1.22020E+00	4.06341E-01	3.53258E-01	3.52910E-01	4.82012E+02
1.10399E+00	3.60204E-01	3.13215E-01	3.12934E-01	4.28179E+02
9.98845E-01	3.18648E-01	2.77139E-01	2.76913E-01	3.79516E+02
9.03717E-01	2.81286E-01	2.44697E-01	2.44516E-01	3.35615E+02
8.17649E-01	2.47762E-01	2.15581E-01	2.15436E-01	2.96096E+02
7.39777E-01	2.17747E-01	1.89505E-01	1.89389E-01	2.60603E+02
6.69322E-01	1.90934E-01	1.66205E-01	1.66113E-01	2.28804E+02
6.05577E-01	1.67032E-01	1.45429E-01	1.45356E-01	2.00380E+02
5.47903E-01	1.45793E-01	1.26962E-01	1.26904E-01	1.75058E+02
4.95722E-01	1.26964E-01	1.10585E-01	1.10539E-01	1.52555E+02
4.48510E-01	1.10318E-01	9.61018E-02	9.60658E-02	1.32615E+02
4.05795E-01	9.56290E-02	8.33193E-02	8.32909E-02	1.14998E+02
3.67148E-01	8.26954E-02	7.20621E-02	7.20399E-02	9.94802E+01
3.32182E-01	7.13364E-02	6.21740E-02	6.21567E-02	8.58463E+01
3.00545E-01	6.13986E-02	5.35216E-02	5.35082E-02	7.39140E+01
2.71922E-01	5.27268E-02	4.59703E-02	4.59601E-02	6.34980E+01
2.46025E-01	4.51819E-02	3.93992E-02	3.93915E-02	5.44324E+01
2.22594E-01	3.86364E-02	3.36975E-02	3.36918E-02	4.65646E+01
2.01394E-01	3.29736E-02	2.87640E-02	2.87598E-02	3.97554E+01
1.82214E-01	2.80878E-02	2.45067E-02	2.45036E-02	3.38784E+01
1.64860E-01	2.38819E-02	2.08411E-02	2.08390E-02	2.88172E+01
1.49159E-01	2.02732E-02	1.76955E-02	1.76941E-02	2.44731E+01
1.34954E-01	1.71831E-02	1.50014E-02	1.50005E-02	2.07518E+01
1.22101E-01	1.45429E-02	1.26992E-02	1.26987E-02	1.75711E+01
1.09825E-01	1.21705E-02	1.06301E-02	1.06299E-02	1.47119E+01
9.74826E-02	9.94396E-03	8.68777E-03	8.68779E-03	1.20272E+01
8.51406E-02	7.89088E-03	6.89630E-03	6.89648E-03	9.55034E+00
7.27985E-02	6.02491E-03	5.26760E-03	5.26789E-03	7.29784E+00
6.04564E-02	4.36348E-03	3.81690E-03	3.81723E-03	5.29071E+00
4.81143E-02	2.92575E-03	2.56094E-03	2.56126E-03	3.55216E+00
3.57722E-02	1.73491E-03	1.51999E-03	1.52026E-03	2.11028E+00
2.34301E-02	8.19052E-04	7.18647E-04	7.18824E-04	9.99223E-01
1.10881E-02	2.16297E-04	1.90352E-04	1.90423E-04	2.65469E-01

Appendix C, Proposed 18 MeV Buildup Cap Data.

```
*******************************************************************
*                                                                 *
*           INPUT TO ADEPT  (AUGUST 1, 1992 )                     *
*                                                                 *
*******************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Geometry specification.
GEOMETRY 1
 1 50 20.00
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 18.0
  PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


*******************************************************************
*                                                                 *
*               PROBLEM DEFINITION                                *
*                                                                 *
*******************************************************************

   LAYER        THICKNESS      MATERIAL       DENSITY      XMESH

     1          2.0000E+01     1  UNKNOW      1.4170E+00    50

Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  23
Default Photon Groups =  23
Default SN Order = 16


ENERGY CONSERVATION RATIO =   1.0163E+00

 ERROR: energy not conserved!
      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1           1.0000E+00

1*******************************************************************
*                                                                 *
*                       OUTPUT (CRAY)                             *
*                                                                 *
*            AVERAGE SOURCE ENERGY =  1.8000E+01 MeV              *
*                                                                 *
*        ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE    *
*                                                                 *
*           FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A      *
*           UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)               *
*                                                                 *
*       PAIR SECONDARIES PRODUCED, AND POSITRONS AND              *
*       ELECTRONS ARE THE SAME CHARGED-PARTICLE                   *
*                                                                 *
*       WARNING: POSITRON TREATMENT APPROPRIATE ONLY              *
*                FOR NON-CHARGED-PARTICLE OUTPUT                  *
*                                                                 *
*******************************************************************

   LAYER     MATERIAL       MASS-THICKNESS       DOSE DEPOSITION
                               (g/cm2)            (MeV-cm2/g)

     1        UNKNOW         2.8340E+01           1.9691E-01

TOTAL ENERGY DEPOSITED =   5.5805E+00 MeV/source

*******************************************************************


RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)
```

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	2.0456E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
2.00000000E-01	2.051260E-02	5.668000E-01	UNKNOW	1
6.00000000E-01	4.806596E-02	5.668000E-01	UNKNOW	1
1.00000000E+00	7.467078E-02	5.668000E-01	UNKNOW	1
1.40000000E+00	9.985348E-02	5.668000E-01	UNKNOW	1
1.80000000E+00	1.233420E-01	5.668000E-01	UNKNOW	1
2.20000000E+00	1.449787E-01	5.668000E-01	UNKNOW	1
2.60000000E+00	1.646375E-01	5.668000E-01	UNKNOW	1
3.00000000E+00	1.821965E-01	5.668000E-01	UNKNOW	1
3.40000000E+00	1.975312E-01	5.668000E-01	UNKNOW	1
3.80000000E+00	2.105120E-01	5.668000E-01	UNKNOW	1
4.20000000E+00	2.210199E-01	5.668000E-01	UNKNOW	1
4.60000000E+00	2.290109E-01	5.668000E-01	UNKNOW	1
5.00000000E+00	2.344814E-01	5.668000E-01	UNKNOW	1
5.40000000E+00	2.375121E-01	5.668000E-01	UNKNOW	1
5.80000000E+00	2.385006E-01	5.668000E-01	UNKNOW	1
6.20000000E+00	2.381365E-01	5.668000E-01	UNKNOW	1
6.60000000E+00	2.370772E-01	5.668000E-01	UNKNOW	1
7.00000000E+00	2.357338E-01	5.668000E-01	UNKNOW	1
7.40000000E+00	2.342919E-01	5.668000E-01	UNKNOW	1
7.80000000E+00	2.328159E-01	5.668000E-01	UNKNOW	1
8.20000000E+00	2.313241E-01	5.668000E-01	UNKNOW	1
8.60000000E+00	2.298211E-01	5.668000E-01	UNKNOW	1
9.00000000E+00	2.283083E-01	5.668000E-01	UNKNOW	1
9.40000000E+00	2.267860E-01	5.668000E-01	UNKNOW	1
9.80000000E+00	2.252548E-01	5.668000E-01	UNKNOW	1
1.02000000E+01	2.237147E-01	5.668000E-01	UNKNOW	1
1.06000000E+01	2.221659E-01	5.668000E-01	UNKNOW	1
1.10000000E+01	2.206087E-01	5.668000E-01	UNKNOW	1
1.14000000E+01	2.190431E-01	5.668000E-01	UNKNOW	1
1.18000000E+01	2.174689E-01	5.668000E-01	UNKNOW	1
1.22000000E+01	2.158864E-01	5.668000E-01	UNKNOW	1
1.26000000E+01	2.142951E-01	5.668000E-01	UNKNOW	1
1.30000000E+01	2.126951E-01	5.668000E-01	UNKNOW	1
1.34000000E+01	2.110861E-01	5.668000E-01	UNKNOW	1
1.38000000E+01	2.094676E-01	5.668000E-01	UNKNOW	1
1.42000000E+01	2.078393E-01	5.668000E-01	UNKNOW	1
1.46000000E+01	2.062005E-01	5.668000E-01	UNKNOW	1
1.50000000E+01	2.045505E-01	5.668000E-01	UNKNOW	1
1.54000000E+01	2.028884E-01	5.668000E-01	UNKNOW	1
1.58000000E+01	2.012128E-01	5.668000E-01	UNKNOW	1
1.62000000E+01	1.995222E-01	5.668000E-01	UNKNOW	1
1.66000000E+01	1.978143E-01	5.668000E-01	UNKNOW	1
1.70000000E+01	1.960860E-01	5.668000E-01	UNKNOW	1
1.74000000E+01	1.943331E-01	5.668000E-01	UNKNOW	1
1.78000000E+01	1.925489E-01	5.668000E-01	UNKNOW	1
1.82000000E+01	1.907232E-01	5.668000E-01	UNKNOW	1
1.86000000E+01	1.888400E-01	5.668000E-01	UNKNOW	1
1.90000000E+01	1.868483E-01	5.668000E-01	UNKNOW	1
1.94000000E+01	1.847772E-01	5.668000E-01	UNKNOW	1
1.98000000E+01	1.786387E-01	5.668000E-01	UNKNOW	1

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
2.00000000E-01	2.393636E-01	5.668000E-01	UNKNOW	1
6.00000000E-01	2.381142E-01	5.668000E-01	UNKNOW	1
1.00000000E+00	2.368022E-01	5.668000E-01	UNKNOW	1
1.40000000E+00	2.354547E-01	5.668000E-01	UNKNOW	1
1.80000000E+00	2.340868E-01	5.668000E-01	UNKNOW	1
2.20000000E+00	2.327073E-01	5.668000E-01	UNKNOW	1
2.60000000E+00	2.313210E-01	5.668000E-01	UNKNOW	1
3.00000000E+00	2.299302E-01	5.668000E-01	UNKNOW	1
3.40000000E+00	2.285355E-01	5.668000E-01	UNKNOW	1
3.80000000E+00	2.271368E-01	5.668000E-01	UNKNOW	1
4.20000000E+00	2.257332E-01	5.668000E-01	UNKNOW	1
4.60000000E+00	2.243240E-01	5.668000E-01	UNKNOW	1
5.00000000E+00	2.229083E-01	5.668000E-01	UNKNOW	1
5.40000000E+00	2.214858E-01	5.668000E-01	UNKNOW	1
5.80000000E+00	2.200566E-01	5.668000E-01	UNKNOW	1
6.20000000E+00	2.186212E-01	5.668000E-01	UNKNOW	1
6.60000000E+00	2.171808E-01	5.668000E-01	UNKNOW	1

7.00000000E+00	2.157360E-01	5.668000E-01	UNKNOW	1
7.40000000E+00	2.142878E-01	5.668000E-01	UNKNOW	1
7.80000000E+00	2.128368E-01	5.668000E-01	UNKNOW	1
8.20000000E+00	2.113835E-01	5.668000E-01	UNKNOW	1
8.60000000E+00	2.099282E-01	5.668000E-01	UNKNOW	1
9.00000000E+00	2.084714E-01	5.668000E-01	UNKNOW	1
9.40000000E+00	2.070132E-01	5.668000E-01	UNKNOW	1
9.80000000E+00	2.055539E-01	5.668000E-01	UNKNOW	1
1.02000000E+01	2.040936E-01	5.668000E-01	UNKNOW	1
1.06000000E+01	2.026325E-01	5.668000E-01	UNKNOW	1
1.10000000E+01	2.011707E-01	5.668000E-01	UNKNOW	1
1.14000000E+01	1.997081E-01	5.668000E-01	UNKNOW	1
1.18000000E+01	1.982449E-01	5.668000E-01	UNKNOW	1
1.22000000E+01	1.967809E-01	5.668000E-01	UNKNOW	1
1.26000000E+01	1.953162E-01	5.668000E-01	UNKNOW	1
1.30000000E+01	1.938505E-01	5.668000E-01	UNKNOW	1
1.34000000E+01	1.923838E-01	5.668000E-01	UNKNOW	1
1.38000000E+01	1.909159E-01	5.668000E-01	UNKNOW	1
1.42000000E+01	1.894464E-01	5.668000E-01	UNKNOW	1
1.46000000E+01	1.879750E-01	5.668000E-01	UNKNOW	1
1.50000000E+01	1.865012E-01	5.668000E-01	UNKNOW	1
1.54000000E+01	1.850245E-01	5.668000E-01	UNKNOW	1
1.58000000E+01	1.835440E-01	5.668000E-01	UNKNOW	1
1.62000000E+01	1.820586E-01	5.668000E-01	UNKNOW	1
1.66000000E+01	1.805671E-01	5.668000E-01	UNKNOW	1
1.70000000E+01	1.790676E-01	5.668000E-01	UNKNOW	1
1.74000000E+01	1.775573E-01	5.668000E-01	UNKNOW	1
1.78000000E+01	1.760326E-01	5.668000E-01	UNKNOW	1
1.82000000E+01	1.744880E-01	5.668000E-01	UNKNOW	1
1.86000000E+01	1.729153E-01	5.668000E-01	UNKNOW	1
1.90000000E+01	1.713020E-01	5.668000E-01	UNKNOW	1
1.94000000E+01	1.696280E-01	5.668000E-01	UNKNOW	1
1.98000000E+01	1.678569E-01	5.668000E-01	UNKNOW	1

```
**********************************************************************
*                                                                    *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                       *
*                                                                    *
**********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV MONO ENERGETIC PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Geometry specification.
GEOMETRY 1
 1 100 20.00
* Source.
PHOTON-SOURCE
CUTOFF 0.01
ENERGY 18.0
  COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


**********************************************************************
*                                                                    *
*                PROBLEM DEFINITION                                  *
*                                                                    *
**********************************************************************

   LAYER         THICKNESS        MATERIAL        DENSITY       XMESH

     1           2.0000E+01       1  UNKNOW       1.4170E+00   100

Default Electron Groups =  23
Default Photon Groups =  23
Default SN Order = 16
Default Source Truncation Angle =    0.9000E+02



ENERGY CONSERVATION RATIO =    1.0251E+00

 ERROR: energy not conserved!
      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1           1.0000E+00

1**********************************************************************
 *                                                                    *
 *                         OUTPUT (CRAY)                              *
 *                                                                    *
 *               AVERAGE SOURCE ENERGY =  1.8000E+01 MeV              *
 *                                                                    *
 *            ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE   *
 *                                                                    *
 *              FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A      *
 *              UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)               *
 *                                                                    *
 *        PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
 *        ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
 *                                                                    *
 *        WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
 *                 FOR NON-CHARGED-PARTICLE OUTPUT                    *
 *                                                                    *
 **********************************************************************

   LAYER       MATERIAL          MASS-THICKNESS        DOSE DEPOSITION
                                    (g/cm2)             (MeV-cm2/g)

     1          UNKNOW            2.8340E+01            3.0126E-01

 TOTAL ENERGY DEPOSITED =    8.5378E+00 MeV/source

 **********************************************************************


 RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

   LAYER        MATERIAL       DOSE (MeV-cm2/g)
```

1 UNKNOW 3.0055E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	8.632253E-02	2.834000E-01	UNKNOW	1
3.00000000E-01	1.515127E-01	2.834000E-01	UNKNOW	1
5.00000000E-01	1.976651E-01	2.834000E-01	UNKNOW	1
7.00000000E-01	2.350043E-01	2.834000E-01	UNKNOW	1
9.00000000E-01	2.657896E-01	2.834000E-01	UNKNOW	1
1.10000000E+00	2.914567E-01	2.834000E-01	UNKNOW	1
1.30000000E+00	3.129734E-01	2.834000E-01	UNKNOW	1
1.50000000E+00	3.310291E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	3.461476E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	3.587440E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	3.691524E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	3.776560E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	3.844949E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	3.898666E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	3.939443E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	3.968876E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	3.988350E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	3.999014E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	4.001885E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	3.997949E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	3.988152E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	3.973335E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	3.954203E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	3.931361E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	3.905377E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	3.876832E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	3.846315E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	3.814398E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	3.781598E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	3.748344E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	3.714968E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	3.681711E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	3.648733E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	3.616133E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	3.583969E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	3.552267E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	3.521036E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	3.490275E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	3.459977E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	3.430129E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	3.400720E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	3.371737E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	3.343165E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	3.314993E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	3.287208E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	3.259797E-01	2.834000E-01	UNKNOW	1
9.30000000E+00	3.232748E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	3.206051E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	3.179694E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	3.153666E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	3.127957E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	3.102557E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	3.077457E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	3.052647E-01	2.834000E-01	UNKNOW	1
1.09000000E+01	3.028118E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	3.003862E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	2.979869E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	2.956133E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	2.932645E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	2.909398E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	2.886383E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	2.863594E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	2.841024E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	2.818666E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	2.796513E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	2.774558E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	2.752796E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	2.731220E-01	2.834000E-01	UNKNOW	1
1.37000000E+01	2.709823E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	2.688600E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	2.667545E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	2.646652E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	2.625914E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	2.605327E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	2.584883E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	2.564578E-01	2.834000E-01	UNKNOW	1

1.53000000E+01	2.544404E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	2.524355E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	2.504426E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	2.484608E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	2.464895E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	2.445278E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	2.425750E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	2.406299E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	2.386915E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	2.367583E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	2.348287E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	2.329005E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	2.309709E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	2.290361E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	2.270905E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	2.251259E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	2.231295E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	2.210802E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	2.189414E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	2.166450E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	2.140567E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	2.108340E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	2.063383E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.928164E-01	2.834000E-01	UNKNOW	1

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	4.737962E-01	2.834000E-01	UNKNOW	1
3.00000000E-01	4.676934E-01	2.834000E-01	UNKNOW	1
5.00000000E-01	4.617574E-01	2.834000E-01	UNKNOW	1
7.00000000E-01	4.559657E-01	2.834000E-01	UNKNOW	1
9.00000000E-01	4.503092E-01	2.834000E-01	UNKNOW	1
1.10000000E+00	4.447818E-01	2.834000E-01	UNKNOW	1
1.30000000E+00	4.393796E-01	2.834000E-01	UNKNOW	1
1.50000000E+00	4.340990E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	4.289370E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	4.238907E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	4.189569E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	4.141328E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	4.094154E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	4.048016E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	4.002886E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	3.958734E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	3.915530E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	3.873246E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	3.831852E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	3.791323E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	3.751630E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	3.712746E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	3.674648E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	3.637308E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	3.600704E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	3.564811E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	3.529607E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	3.495070E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	3.461179E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	3.427913E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	3.395253E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	3.363178E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	3.331671E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	3.300714E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	3.270289E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	3.240378E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	3.210967E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	3.182038E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	3.153577E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	3.125570E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	3.098001E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	3.070857E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	3.044125E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	3.017792E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	2.991846E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	2.966276E-01	2.834000E-01	UNKNOW	1
9.30000000E+00	2.941069E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	2.916214E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	2.891702E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	2.867522E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	2.843664E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	2.820118E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	2.796876E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	2.773928E-01	2.834000E-01	UNKNOW	1

1.09000000E+01	2.751267E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	2.728883E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	2.706768E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	2.684916E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	2.663319E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	2.641968E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	2.620859E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	2.599982E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	2.579333E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	2.558905E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	2.538690E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	2.518684E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	2.498881E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	2.479274E-01	2.834000E-01	UNKNOW	1
1.37000000E+01	2.459859E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	2.440629E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	2.421579E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	2.402704E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	2.383998E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	2.365456E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	2.347073E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	2.328845E-01	2.834000E-01	UNKNOW	1
1.53000000E+01	2.310764E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	2.292827E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	2.275027E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	2.257359E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	2.239818E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	2.222397E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	2.205089E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	2.187889E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	2.170789E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	2.153781E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	2.136856E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	2.120005E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	2.103216E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	2.086477E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	2.069773E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	2.053088E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	2.036400E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	2.019687E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	2.002917E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	1.986055E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	1.969055E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	1.951858E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	1.934387E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.916513E-01	2.834000E-01	UNKNOW	1

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Geometry specification.
GEOMETRY 1
 1 100 20.00
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 26
1.0      0.99981  0.999076 0.997455 0.99434  0.989477 0.982515 0.97286
0.960147 0.943797 0.923642 0.898836 0.868814 0.833437 0.791999 0.743796
0.688123 0.624134 0.551407 0.468531 0.373534 0.266698 0.146049 0.00933329
2.597e-7 0.0
ENERGIES
19.107 18.721 18.335 17.949 17.563 17.177 16.791 16.405
16.019 15.633 15.247 14.861 14.475 14.089 13.703 13.317
12.931 12.545 12.159 11.773 11.387 11.001 10.615 10.229
10.018 10.0
PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


*********************************************************************
*                                                                   *
*                PROBLEM DEFINITION                                 *
*                                                                   *
*********************************************************************

   LAYER        THICKNESS      MATERIAL        DENSITY      XMESH

     1          2.0000E+01     1  UNKNOW      1.4170E+00   100

Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  60
Default Photon Groups =  60
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0020E+00

      LAYER     CHARGED-PARTICLE CONSERVATION RATIO

        1            1.0000E+00

1*********************************************************************
 *                                                                   *
 *                         OUTPUT (CRAY)                             *
 *                                                                   *
 *               AVERAGE SOURCE ENERGY =  1.2342E+01 MeV             *
 *                                                                   *
 *           ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE   *
 *                                                                   *
 *             FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A      *
 *             UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)               *
 *                                                                   *
 *       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
 *       ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
 *                                                                   *
 *       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
 *                FOR NON-CHARGED-PARTICLE OUTPUT                    *
 *                                                                   *
 *********************************************************************

   LAYER      MATERIAL         MASS-THICKNESS        DOSE DEPOSITION
                                  (g/cm2)              (MeV-cm2/g)

     1         UNKNOW            2.8340E+01            1.4379E-01
```

TOTAL ENERGY DEPOSITED = 4.0751E+00 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.5226E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	9.950925E-03	2.834000E-01	UNKNOW	1
3.00000000E-01	2.418935E-02	2.834000E-01	UNKNOW	1
5.00000000E-01	3.827326E-02	2.834000E-01	UNKNOW	1
7.00000000E-01	5.200226E-02	2.834000E-01	UNKNOW	1
9.00000000E-01	6.525970E-02	2.834000E-01	UNKNOW	1
1.10000000E+00	7.797144E-02	2.834000E-01	UNKNOW	1
1.30000000E+00	9.008048E-02	2.834000E-01	UNKNOW	1
1.50000000E+00	1.015358E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	1.122863E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	1.222775E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	1.314511E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	1.397481E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	1.471131E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	1.534980E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	1.588689E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	1.632234E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	1.666085E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	1.691201E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	1.708865E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	1.720455E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	1.727270E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	1.730435E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	1.730875E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	1.729323E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	1.726341E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	1.722353E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	1.717668E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	1.712510E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	1.707035E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	1.701349E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	1.695527E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	1.689616E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	1.683647E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	1.677640E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	1.671609E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	1.665562E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	1.659503E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	1.653437E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	1.647364E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	1.641287E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	1.635206E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	1.629123E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	1.623038E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	1.616950E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	1.610862E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	1.604772E-01	2.834000E-01	UNKNOW	1
9.30000000E+00	1.598681E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	1.592590E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	1.586498E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	1.580406E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	1.574314E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	1.568223E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	1.562131E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	1.556040E-01	2.834000E-01	UNKNOW	1
1.09000000E+01	1.549950E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	1.543860E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	1.537770E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	1.531681E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	1.525593E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	1.519506E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	1.513419E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	1.507332E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	1.501247E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	1.495161E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	1.489076E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	1.482990E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	1.476905E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	1.470819E-01	2.834000E-01	UNKNOW	1

1.37000000E+01	1.464733E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	1.458646E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	1.452558E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	1.446468E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	1.440377E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	1.434283E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	1.428186E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	1.422086E-01	2.834000E-01	UNKNOW	1
1.53000000E+01	1.415982E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	1.409874E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	1.403760E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	1.397640E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	1.391512E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	1.385376E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	1.379230E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	1.373073E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	1.366903E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	1.360717E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	1.354513E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	1.348288E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	1.342038E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	1.335756E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	1.329437E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	1.323069E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	1.316640E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	1.310130E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	1.303504E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	1.296690E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	1.289521E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	1.281320E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	1.271111E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.223127E-01	2.834000E-01	UNKNOW	1

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	1.802047E-01	2.834000E-01	UNKNOW	1
3.00000000E-01	1.797395E-01	2.834000E-01	UNKNOW	1
5.00000000E-01	1.792531E-01	2.834000E-01	UNKNOW	1
7.00000000E-01	1.787514E-01	2.834000E-01	UNKNOW	1
9.00000000E-01	1.782387E-01	2.834000E-01	UNKNOW	1
1.10000000E+00	1.777179E-01	2.834000E-01	UNKNOW	1
1.30000000E+00	1.771911E-01	2.834000E-01	UNKNOW	1
1.50000000E+00	1.766597E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	1.761247E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	1.755868E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	1.750465E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	1.745038E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	1.739588E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	1.734117E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	1.728623E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	1.723105E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	1.717565E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	1.712001E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	1.706415E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	1.700807E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	1.695178E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	1.689529E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	1.683863E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	1.678179E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	1.672480E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	1.666766E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	1.661039E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	1.655299E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	1.649548E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	1.643787E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	1.638016E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	1.632236E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	1.626449E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	1.620654E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	1.614852E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	1.609045E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	1.603231E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	1.597413E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	1.591590E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	1.585763E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	1.579933E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	1.574099E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	1.568262E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	1.562423E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	1.556581E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	1.550737E-01	2.834000E-01	UNKNOW	1

9.30000000E+00	1.544891E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	1.539044E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	1.533196E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	1.527346E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	1.521496E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	1.515644E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	1.509792E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	1.503940E-01	2.834000E-01	UNKNOW	1
1.09000000E+01	1.498087E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	1.492234E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	1.486380E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	1.480526E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	1.474672E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	1.468817E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	1.462962E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	1.457107E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	1.451251E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	1.445395E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	1.439538E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	1.433680E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	1.427822E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	1.421962E-01	2.834000E-01	UNKNOW	1
1.37000000E+01	1.416100E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	1.410237E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	1.404372E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	1.398505E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	1.392635E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	1.386761E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	1.380884E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	1.375003E-01	2.834000E-01	UNKNOW	1
1.53000000E+01	1.369117E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	1.363225E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	1.357327E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	1.351422E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	1.345508E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	1.339585E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	1.333651E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	1.327705E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	1.321744E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	1.315767E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	1.309771E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	1.303752E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	1.297707E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	1.291630E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	1.285517E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	1.279358E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	1.273146E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	1.266866E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	1.260504E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	1.254038E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	1.247441E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	1.240674E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	1.233683E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.226388E-01	2.834000E-01	UNKNOW	1

```
************************************************************************
*                                                                      *
*             INPUT TO ADEPT  (AUGUST 1, 1992 )                        *
*                                                                      *
************************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Geometry specification.
GEOMETRY 1
 1 100 20.00
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 26
1.0      0.99981  0.999076 0.997455 0.99434  0.989477 0.982515 0.97286
0.960147 0.943797 0.923642 0.898836 0.868814 0.833437 0.791999 0.743796
0.688123 0.624134 0.551407 0.468531 0.373534 0.266698 0.146049 0.00933329
2.597e-7 0.0
ENERGIES
19.107 18.721 18.335 17.949 17.563 17.177 16.791 16.405
16.019 15.633 15.247 14.861 14.475 14.089 13.703 13.317
12.931 12.545 12.159 11.773 11.387 11.001 10.615 10.229
10.018 10.0
COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE
```

```
************************************************************************
*                                                                      *
*                 PROBLEM DEFINITION                                   *
*                                                                      *
************************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	2.0000E+01	1 UNKNOW	1.4170E+00	100

```
Default Electron Groups =  60
Default Photon Groups =  60
Default SN Order = 16
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0023E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	1.0000E+00

```
1***********************************************************************
 *                                                                     *
 *                         OUTPUT (CRAY)                               *
 *                                                                     *
 *               AVERAGE SOURCE ENERGY =  1.2342E+01 MeV               *
 *                                                                     *
 *          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE      *
 *                                                                     *
 *             FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A        *
 *             UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                 *
 *                                                                     *
 *       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                  *
 *       ELECTRONS ARE THE SAME CHARGED-PARTICLE                       *
 *                                                                     *
 *       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                  *
 *                FOR NON-CHARGED-PARTICLE OUTPUT                      *
 *                                                                     *
 ***********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	2.8340E+01	2.1339E-01

TOTAL ENERGY DEPOSITED = 6.0474E+00 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	2.2021E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	7.378919E-02	2.834000E-01	UNKNOW	1
3.00000000E-01	1.322141E-01	2.834000E-01	UNKNOW	1
5.00000000E-01	1.721061E-01	2.834000E-01	UNKNOW	1
7.00000000E-01	2.029722E-01	2.834000E-01	UNKNOW	1
9.00000000E-01	2.272512E-01	2.834000E-01	UNKNOW	1
1.10000000E+00	2.464841E-01	2.834000E-01	UNKNOW	1
1.30000000E+00	2.616749E-01	2.834000E-01	UNKNOW	1
1.50000000E+00	2.735521E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	2.826734E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	2.894825E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	2.943427E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	2.975584E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	2.993895E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	3.000612E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	2.997742E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	2.987117E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	2.970426E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	2.949182E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	2.924678E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	2.897962E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	2.869848E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	2.840942E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	2.811685E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	2.782385E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	2.753256E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	2.724438E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	2.696020E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	2.668054E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	2.640571E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	2.613580E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	2.587084E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	2.561076E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	2.535546E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	2.510482E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	2.485870E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	2.461696E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	2.437945E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	2.414604E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	2.391659E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	2.369096E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	2.346903E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	2.325067E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	2.303577E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	2.282421E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	2.261588E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	2.241067E-01	2.834000E-01	UNKNOW	1
9.30000000E+00	2.220850E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	2.200926E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	2.181285E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	2.161919E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	2.142820E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	2.123979E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	2.105388E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	2.087040E-01	2.834000E-01	UNKNOW	1
1.09000000E+01	2.068927E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	2.051043E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	2.033381E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	2.015934E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	1.998695E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	1.981660E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	1.964822E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	1.948175E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	1.931714E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	1.915434E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	1.899329E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	1.883395E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	1.867626E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	1.852019E-01	2.834000E-01	UNKNOW	1

1.37000000E+01	1.836567E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	1.821268E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	1.806116E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	1.791106E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	1.776236E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	1.761500E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	1.746894E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	1.732413E-01	2.834000E-01	UNKNOW	1
1.53000000E+01	1.718055E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	1.703814E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	1.689687E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	1.675668E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	1.661753E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	1.647938E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	1.634218E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	1.620587E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	1.607040E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	1.593570E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	1.580170E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	1.566830E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	1.553538E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	1.540279E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	1.527029E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	1.513751E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	1.500382E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	1.486808E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	1.472821E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	1.458001E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	1.441452E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	1.420777E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	1.391422E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.295325E-01	2.834000E-01	UNKNOW	1

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.00000000E-01	3.575699E-01	2.834000E-01	UNKNOW	1
3.00000000E-01	3.525780E-01	2.834000E-01	UNKNOW	1
5.00000000E-01	3.477161E-01	2.834000E-01	UNKNOW	1
7.00000000E-01	3.429732E-01	2.834000E-01	UNKNOW	1
9.00000000E-01	3.383455E-01	2.834000E-01	UNKNOW	1
1.10000000E+00	3.338304E-01	2.834000E-01	UNKNOW	1
1.30000000E+00	3.294259E-01	2.834000E-01	UNKNOW	1
1.50000000E+00	3.251295E-01	2.834000E-01	UNKNOW	1
1.70000000E+00	3.209389E-01	2.834000E-01	UNKNOW	1
1.90000000E+00	3.168513E-01	2.834000E-01	UNKNOW	1
2.10000000E+00	3.128640E-01	2.834000E-01	UNKNOW	1
2.30000000E+00	3.089741E-01	2.834000E-01	UNKNOW	1
2.50000000E+00	3.051787E-01	2.834000E-01	UNKNOW	1
2.70000000E+00	3.014748E-01	2.834000E-01	UNKNOW	1
2.90000000E+00	2.978596E-01	2.834000E-01	UNKNOW	1
3.10000000E+00	2.943300E-01	2.834000E-01	UNKNOW	1
3.30000000E+00	2.908833E-01	2.834000E-01	UNKNOW	1
3.50000000E+00	2.875166E-01	2.834000E-01	UNKNOW	1
3.70000000E+00	2.842272E-01	2.834000E-01	UNKNOW	1
3.90000000E+00	2.810125E-01	2.834000E-01	UNKNOW	1
4.10000000E+00	2.778699E-01	2.834000E-01	UNKNOW	1
4.30000000E+00	2.747968E-01	2.834000E-01	UNKNOW	1
4.50000000E+00	2.717907E-01	2.834000E-01	UNKNOW	1
4.70000000E+00	2.688494E-01	2.834000E-01	UNKNOW	1
4.90000000E+00	2.659704E-01	2.834000E-01	UNKNOW	1
5.10000000E+00	2.631517E-01	2.834000E-01	UNKNOW	1
5.30000000E+00	2.603909E-01	2.834000E-01	UNKNOW	1
5.50000000E+00	2.576861E-01	2.834000E-01	UNKNOW	1
5.70000000E+00	2.550353E-01	2.834000E-01	UNKNOW	1
5.90000000E+00	2.524365E-01	2.834000E-01	UNKNOW	1
6.10000000E+00	2.498879E-01	2.834000E-01	UNKNOW	1
6.30000000E+00	2.473876E-01	2.834000E-01	UNKNOW	1
6.50000000E+00	2.449341E-01	2.834000E-01	UNKNOW	1
6.70000000E+00	2.425256E-01	2.834000E-01	UNKNOW	1
6.90000000E+00	2.401605E-01	2.834000E-01	UNKNOW	1
7.10000000E+00	2.378375E-01	2.834000E-01	UNKNOW	1
7.30000000E+00	2.355549E-01	2.834000E-01	UNKNOW	1
7.50000000E+00	2.333114E-01	2.834000E-01	UNKNOW	1
7.70000000E+00	2.311057E-01	2.834000E-01	UNKNOW	1
7.90000000E+00	2.289365E-01	2.834000E-01	UNKNOW	1
8.10000000E+00	2.268026E-01	2.834000E-01	UNKNOW	1
8.30000000E+00	2.247027E-01	2.834000E-01	UNKNOW	1
8.50000000E+00	2.226358E-01	2.834000E-01	UNKNOW	1
8.70000000E+00	2.206007E-01	2.834000E-01	UNKNOW	1
8.90000000E+00	2.185965E-01	2.834000E-01	UNKNOW	1
9.10000000E+00	2.166221E-01	2.834000E-01	UNKNOW	1

9.30000000E+00	2.146766E-01	2.834000E-01	UNKNOW	1
9.50000000E+00	2.127591E-01	2.834000E-01	UNKNOW	1
9.70000000E+00	2.108686E-01	2.834000E-01	UNKNOW	1
9.90000000E+00	2.090044E-01	2.834000E-01	UNKNOW	1
1.01000000E+01	2.071655E-01	2.834000E-01	UNKNOW	1
1.03000000E+01	2.053513E-01	2.834000E-01	UNKNOW	1
1.05000000E+01	2.035610E-01	2.834000E-01	UNKNOW	1
1.07000000E+01	2.017939E-01	2.834000E-01	UNKNOW	1
1.09000000E+01	2.000492E-01	2.834000E-01	UNKNOW	1
1.11000000E+01	1.983264E-01	2.834000E-01	UNKNOW	1
1.13000000E+01	1.966247E-01	2.834000E-01	UNKNOW	1
1.15000000E+01	1.949435E-01	2.834000E-01	UNKNOW	1
1.17000000E+01	1.932823E-01	2.834000E-01	UNKNOW	1
1.19000000E+01	1.916404E-01	2.834000E-01	UNKNOW	1
1.21000000E+01	1.900173E-01	2.834000E-01	UNKNOW	1
1.23000000E+01	1.884126E-01	2.834000E-01	UNKNOW	1
1.25000000E+01	1.868255E-01	2.834000E-01	UNKNOW	1
1.27000000E+01	1.852557E-01	2.834000E-01	UNKNOW	1
1.29000000E+01	1.837026E-01	2.834000E-01	UNKNOW	1
1.31000000E+01	1.821658E-01	2.834000E-01	UNKNOW	1
1.33000000E+01	1.806449E-01	2.834000E-01	UNKNOW	1
1.35000000E+01	1.791392E-01	2.834000E-01	UNKNOW	1
1.37000000E+01	1.776485E-01	2.834000E-01	UNKNOW	1
1.39000000E+01	1.761722E-01	2.834000E-01	UNKNOW	1
1.41000000E+01	1.747100E-01	2.834000E-01	UNKNOW	1
1.43000000E+01	1.732614E-01	2.834000E-01	UNKNOW	1
1.45000000E+01	1.718260E-01	2.834000E-01	UNKNOW	1
1.47000000E+01	1.704034E-01	2.834000E-01	UNKNOW	1
1.49000000E+01	1.689932E-01	2.834000E-01	UNKNOW	1
1.51000000E+01	1.675950E-01	2.834000E-01	UNKNOW	1
1.53000000E+01	1.662084E-01	2.834000E-01	UNKNOW	1
1.55000000E+01	1.648329E-01	2.834000E-01	UNKNOW	1
1.57000000E+01	1.634681E-01	2.834000E-01	UNKNOW	1
1.59000000E+01	1.621136E-01	2.834000E-01	UNKNOW	1
1.61000000E+01	1.607690E-01	2.834000E-01	UNKNOW	1
1.63000000E+01	1.594338E-01	2.834000E-01	UNKNOW	1
1.65000000E+01	1.581074E-01	2.834000E-01	UNKNOW	1
1.67000000E+01	1.567895E-01	2.834000E-01	UNKNOW	1
1.69000000E+01	1.554793E-01	2.834000E-01	UNKNOW	1
1.71000000E+01	1.541764E-01	2.834000E-01	UNKNOW	1
1.73000000E+01	1.528801E-01	2.834000E-01	UNKNOW	1
1.75000000E+01	1.515895E-01	2.834000E-01	UNKNOW	1
1.77000000E+01	1.503040E-01	2.834000E-01	UNKNOW	1
1.79000000E+01	1.490224E-01	2.834000E-01	UNKNOW	1
1.81000000E+01	1.477437E-01	2.834000E-01	UNKNOW	1
1.83000000E+01	1.464666E-01	2.834000E-01	UNKNOW	1
1.85000000E+01	1.451894E-01	2.834000E-01	UNKNOW	1
1.87000000E+01	1.439101E-01	2.834000E-01	UNKNOW	1
1.89000000E+01	1.426263E-01	2.834000E-01	UNKNOW	1
1.91000000E+01	1.413349E-01	2.834000E-01	UNKNOW	1
1.93000000E+01	1.400318E-01	2.834000E-01	UNKNOW	1
1.95000000E+01	1.387117E-01	2.834000E-01	UNKNOW	1
1.97000000E+01	1.373674E-01	2.834000E-01	UNKNOW	1
1.99000000E+01	1.359885E-01	2.834000E-01	UNKNOW	1

```
*********************************************************************
*                                                                   *
*             INPUT TO ADEPT  (AUGUST 1, 1992 )                     *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 30 5.4
 2 20 0.0305
 3 20 0.0508
 4 20 0.5892
 3 20 0.0508
 2 20 0.0305
 1 30 5.4
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 26
1.0      0.99981  0.999076 0.997455 0.99434  0.989477 0.982515 0.97286
0.960147 0.943797 0.923642 0.898836 0.868814 0.833437 0.791999 0.743796
0.688123 0.624134 0.551407 0.468531 0.373534 0.266698 0.146049 0.00933329
2.597e-7 0.0
ENERGIES
19.107 18.721 18.335 17.949 17.563 17.177 16.791 16.405
16.019 15.633 15.247 14.861 14.475 14.089 13.703 13.317
12.931 12.545 12.159 11.773 11.387 11.001 10.615 10.229
10.018 10.0
COSINE-LAW
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


*********************************************************************
*                                                                   *
*                  PROBLEM DEFINITION                               *
*                                                                   *
*********************************************************************

   LAYER          THICKNESS        MATERIAL         DENSITY       XMESH

     1            5.4000E+00       1  UNKNOW        1.4170E+00    30
     2            3.0500E-02       2  C             1.7600E+00    20
     3            5.0800E-02       3  UNKNOW        1.7600E+00    20
     4            5.8920E-01       4  UNKNOW        1.2930E-03    20
     5            5.0800E-02       3  UNKNOW        1.7600E+00    20
     6            3.0500E-02       2  C             1.7600E+00    20
     7            5.4000E+00       1  UNKNOW        1.4170E+00    30

Default Electron Groups =  60
Default Photon Groups =  60
Default SN Order = 16
Default Source Truncation Angle =    0.9000E+02


ENERGY CONSERVATION RATIO =    1.0020E+00

      LAYER      CHARGED-PARTICLE CONSERVATION RATIO

        1             1.0000E+00
        2             1.0002E+00
        3             1.0085E+00
        4             1.0009E+00
```

5	1.0004E+00
6	1.0030E+00
7	9.9996E-01

```
1*********************************************************************
*                                                                   *
*                         OUTPUT (CRAY)                             *
*                                                                   *
*              AVERAGE SOURCE ENERGY =  1.2342E+01 MeV              *
*                                                                   *
*         ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE     *
*                                                                   *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A       *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                *
*                                                                   *
*       PAIR SECONDARIES PRODUCED, AND POSITRONS AND                *
*       ELECTRONS ARE THE SAME CHARGED-PARTICLE                     *
*                                                                   *
*       WARNING: POSITRON TREATMENT APPROPRIATE ONLY                *
*                FOR NON-CHARGED-PARTICLE OUTPUT                    *
*                                                                   *
*********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	7.6518E+00	2.6080E-01
2	C	5.3680E-02	2.4886E-01
3	UNKNOW	8.9408E-02	2.4906E-01
4	UNKNOW	7.6184E-04	2.6204E-01
5	UNKNOW	8.9408E-02	2.4722E-01
6	C	5.3680E-02	2.4532E-01
7	UNKNOW	7.6518E+00	2.2928E-01

TOTAL ENERGY DEPOSITED =   3.8210E+00 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	3.0289E-01
2	C	2.3679E-01
3	UNKNOW	2.5072E-01
4	UNKNOW	2.5123E-01
5	UNKNOW	2.4988E-01
6	C	2.3478E-01
7	UNKNOW	2.2234E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
9.00000000E-02	6.978866E-02	2.550600E-01	UNKNOW	1
2.70000000E-01	1.244672E-01	2.550600E-01	UNKNOW	1
4.50000000E-01	1.623869E-01	2.550600E-01	UNKNOW	1
6.30000000E-01	1.922544E-01	2.550600E-01	UNKNOW	1
8.10000000E-01	2.162068E-01	2.550600E-01	UNKNOW	1
9.90000000E-01	2.355995E-01	2.550600E-01	UNKNOW	1
1.17000000E+00	2.513127E-01	2.550600E-01	UNKNOW	1
1.35000000E+00	2.639821E-01	2.550600E-01	UNKNOW	1
1.53000000E+00	2.740936E-01	2.550600E-01	UNKNOW	1
1.71000000E+00	2.820334E-01	2.550600E-01	UNKNOW	1
1.89000000E+00	2.881175E-01	2.550600E-01	UNKNOW	1
2.07000000E+00	2.926106E-01	2.550600E-01	UNKNOW	1
2.25000000E+00	2.957379E-01	2.550600E-01	UNKNOW	1
2.43000000E+00	2.976946E-01	2.550600E-01	UNKNOW	1
2.61000000E+00	2.986516E-01	2.550600E-01	UNKNOW	1
2.79000000E+00	2.987610E-01	2.550600E-01	UNKNOW	1
2.97000000E+00	2.981618E-01	2.550600E-01	UNKNOW	1
3.15000000E+00	2.969835E-01	2.550600E-01	UNKNOW	1
3.33000000E+00	2.953461E-01	2.550600E-01	UNKNOW	1
3.51000000E+00	2.933573E-01	2.550600E-01	UNKNOW	1
3.69000000E+00	2.911100E-01	2.550600E-01	UNKNOW	1
3.87000000E+00	2.886812E-01	2.550600E-01	UNKNOW	1
4.05000000E+00	2.861328E-01	2.550600E-01	UNKNOW	1
4.23000000E+00	2.835138E-01	2.550600E-01	UNKNOW	1
4.41000000E+00	2.808628E-01	2.550600E-01	UNKNOW	1
4.59000000E+00	2.782118E-01	2.550600E-01	UNKNOW	1
4.77000000E+00	2.755911E-01	2.550600E-01	UNKNOW	1
4.95000000E+00	2.730378E-01	2.550600E-01	UNKNOW	1

5.13000000E+00	2.706165E-01	2.550600E-01	UNKNOW	1
5.31000000E+00	2.686084E-01	2.550600E-01	UNKNOW	1
5.40076250E+00	2.483427E-01	2.684000E-03	C	2
5.40228750E+00	2.484834E-01	2.684000E-03	C	2
5.40381250E+00	2.485457E-01	2.684000E-03	C	2
5.40533750E+00	2.485952E-01	2.684000E-03	C	2
5.40686250E+00	2.486374E-01	2.684000E-03	C	2
5.40838750E+00	2.486757E-01	2.684000E-03	C	2
5.40991250E+00	2.487118E-01	2.684000E-03	C	2
5.41143750E+00	2.487470E-01	2.684000E-03	C	2
5.41296250E+00	2.487819E-01	2.684000E-03	C	2
5.41448750E+00	2.488171E-01	2.684000E-03	C	2
5.41601250E+00	2.488531E-01	2.684000E-03	C	2
5.41753750E+00	2.488905E-01	2.684000E-03	C	2
5.41906250E+00	2.489298E-01	2.684000E-03	C	2
5.42058750E+00	2.489716E-01	2.684000E-03	C	2
5.42211250E+00	2.490167E-01	2.684000E-03	C	2
5.42363750E+00	2.490663E-01	2.684000E-03	C	2
5.42516250E+00	2.491223E-01	2.684000E-03	C	2
5.42668750E+00	2.491887E-01	2.684000E-03	C	2
5.42821250E+00	2.492731E-01	2.684000E-03	C	2
5.42973750E+00	2.494612E-01	2.684000E-03	C	2
5.43177000E+00	2.497727E-01	4.470400E-03	UNKNOW	3
5.43431000E+00	2.496957E-01	4.470400E-03	UNKNOW	3
5.43685000E+00	2.496116E-01	4.470400E-03	UNKNOW	3
5.43939000E+00	2.495355E-01	4.470400E-03	UNKNOW	3
5.44193000E+00	2.494625E-01	4.470400E-03	UNKNOW	3
5.44447000E+00	2.493909E-01	4.470400E-03	UNKNOW	3
5.44701000E+00	2.493200E-01	4.470400E-03	UNKNOW	3
5.44955000E+00	2.492490E-01	4.470400E-03	UNKNOW	3
5.45209000E+00	2.491778E-01	4.470400E-03	UNKNOW	3
5.45463000E+00	2.491060E-01	4.470400E-03	UNKNOW	3
5.45717000E+00	2.490335E-01	4.470400E-03	UNKNOW	3
5.45971000E+00	2.489601E-01	4.470400E-03	UNKNOW	3
5.46225000E+00	2.488858E-01	4.470400E-03	UNKNOW	3
5.46479000E+00	2.488104E-01	4.470400E-03	UNKNOW	3
5.46733000E+00	2.487340E-01	4.470400E-03	UNKNOW	3
5.46987000E+00	2.486565E-01	4.470400E-03	UNKNOW	3
5.47241000E+00	2.485779E-01	4.470400E-03	UNKNOW	3
5.47495000E+00	2.484987E-01	4.470400E-03	UNKNOW	3
5.47749000E+00	2.484184E-01	4.470400E-03	UNKNOW	3
5.48003000E+00	2.483614E-01	4.470400E-03	UNKNOW	3
5.49603000E+00	2.619710E-01	3.809178E-05	UNKNOW	4
5.52549000E+00	2.620101E-01	3.809178E-05	UNKNOW	4
5.55495000E+00	2.620318E-01	3.809178E-05	UNKNOW	4
5.58441000E+00	2.620469E-01	3.809178E-05	UNKNOW	4
5.61387000E+00	2.620577E-01	3.809178E-05	UNKNOW	4
5.64333000E+00	2.620656E-01	3.809178E-05	UNKNOW	4
5.67279000E+00	2.620710E-01	3.809178E-05	UNKNOW	4
5.70225000E+00	2.620746E-01	3.809178E-05	UNKNOW	4
5.73171000E+00	2.620766E-01	3.809178E-05	UNKNOW	4
5.76117000E+00	2.620770E-01	3.809178E-05	UNKNOW	4
5.79063000E+00	2.620761E-01	3.809178E-05	UNKNOW	4
5.82009000E+00	2.620738E-01	3.809178E-05	UNKNOW	4
5.84955000E+00	2.620700E-01	3.809178E-05	UNKNOW	4
5.87901000E+00	2.620645E-01	3.809178E-05	UNKNOW	4
5.90847000E+00	2.620571E-01	3.809178E-05	UNKNOW	4
5.93793000E+00	2.620474E-01	3.809178E-05	UNKNOW	4
5.96739000E+00	2.620345E-01	3.809178E-05	UNKNOW	4
5.99685000E+00	2.620172E-01	3.809178E-05	UNKNOW	4
6.02631000E+00	2.619932E-01	3.809178E-05	UNKNOW	4
6.05577000E+00	2.619517E-01	3.809178E-05	UNKNOW	4
6.07177000E+00	2.482605E-01	4.470400E-03	UNKNOW	5
6.07431000E+00	2.481471E-01	4.470400E-03	UNKNOW	5
6.07685000E+00	2.480560E-01	4.470400E-03	UNKNOW	5
6.07939000E+00	2.479631E-01	4.470400E-03	UNKNOW	5
6.08193000E+00	2.478688E-01	4.470400E-03	UNKNOW	5
6.08447000E+00	2.477724E-01	4.470400E-03	UNKNOW	5
6.08701000E+00	2.476737E-01	4.470400E-03	UNKNOW	5
6.08955000E+00	2.475723E-01	4.470400E-03	UNKNOW	5
6.09209000E+00	2.474680E-01	4.470400E-03	UNKNOW	5
6.09463000E+00	2.473604E-01	4.470400E-03	UNKNOW	5
6.09717000E+00	2.472491E-01	4.470400E-03	UNKNOW	5
6.09971000E+00	2.471337E-01	4.470400E-03	UNKNOW	5
6.10225000E+00	2.470137E-01	4.470400E-03	UNKNOW	5
6.10479000E+00	2.468883E-01	4.470400E-03	UNKNOW	5
6.10733000E+00	2.467565E-01	4.470400E-03	UNKNOW	5
6.10987000E+00	2.466167E-01	4.470400E-03	UNKNOW	5
6.11241000E+00	2.464668E-01	4.470400E-03	UNKNOW	5
6.11495000E+00	2.463020E-01	4.470400E-03	UNKNOW	5
6.11749000E+00	2.461158E-01	4.470400E-03	UNKNOW	5
6.12003000E+00	2.458150E-01	4.470400E-03	UNKNOW	5
6.12206250E+00	2.453675E-01	2.684000E-03	C	6
6.12358750E+00	2.453600E-01	2.684000E-03	C	6
6.12511250E+00	2.453704E-01	2.684000E-03	C	6

6.12663750E+00	2.453748E-01	2.684000E-03	C	6
6.12816250E+00	2.453754E-01	2.684000E-03	C	6
6.12968750E+00	2.453731E-01	2.684000E-03	C	6
6.13121250E+00	2.453688E-01	2.684000E-03	C	6
6.13273750E+00	2.453630E-01	2.684000E-03	C	6
6.13426250E+00	2.453559E-01	2.684000E-03	C	6
6.13578750E+00	2.453478E-01	2.684000E-03	C	6
6.13731250E+00	2.453387E-01	2.684000E-03	C	6
6.13883750E+00	2.453287E-01	2.684000E-03	C	6
6.14036250E+00	2.453179E-01	2.684000E-03	C	6
6.14188750E+00	2.453060E-01	2.684000E-03	C	6
6.14341250E+00	2.452930E-01	2.684000E-03	C	6
6.14493750E+00	2.452783E-01	2.684000E-03	C	6
6.14646250E+00	2.452611E-01	2.684000E-03	C	6
6.14798750E+00	2.452395E-01	2.684000E-03	C	6
6.14951250E+00	2.452113E-01	2.684000E-03	C	6
6.15103750E+00	2.451252E-01	2.684000E-03	C	6
6.24180000E+00	2.629306E-01	2.550600E-01	UNKNOW	7
6.42180000E+00	2.602953E-01	2.550600E-01	UNKNOW	7
6.60180000E+00	2.577732E-01	2.550600E-01	UNKNOW	7
6.78180000E+00	2.552908E-01	2.550600E-01	UNKNOW	7
6.96180000E+00	2.528493E-01	2.550600E-01	UNKNOW	7
7.14180000E+00	2.504479E-01	2.550600E-01	UNKNOW	7
7.32180000E+00	2.480859E-01	2.550600E-01	UNKNOW	7
7.50180000E+00	2.457622E-01	2.550600E-01	UNKNOW	7
7.68180000E+00	2.434756E-01	2.550600E-01	UNKNOW	7
7.86180000E+00	2.412246E-01	2.550600E-01	UNKNOW	7
8.04180000E+00	2.390079E-01	2.550600E-01	UNKNOW	7
8.22180000E+00	2.368239E-01	2.550600E-01	UNKNOW	7
8.40180000E+00	2.346710E-01	2.550600E-01	UNKNOW	7
8.58180000E+00	2.325476E-01	2.550600E-01	UNKNOW	7
8.76180000E+00	2.304518E-01	2.550600E-01	UNKNOW	7
8.94180000E+00	2.283818E-01	2.550600E-01	UNKNOW	7
9.12180000E+00	2.263352E-01	2.550600E-01	UNKNOW	7
9.30180000E+00	2.243093E-01	2.550600E-01	UNKNOW	7
9.48180000E+00	2.223010E-01	2.550600E-01	UNKNOW	7
9.66180000E+00	2.203058E-01	2.550600E-01	UNKNOW	7
9.84180000E+00	2.183178E-01	2.550600E-01	UNKNOW	7
1.00218000E+01	2.163275E-01	2.550600E-01	UNKNOW	7
1.02018000E+01	2.143200E-01	2.550600E-01	UNKNOW	7
1.03818000E+01	2.122702E-01	2.550600E-01	UNKNOW	7
1.05618000E+01	2.101332E-01	2.550600E-01	UNKNOW	7
1.07418000E+01	2.078245E-01	2.550600E-01	UNKNOW	7
1.09218000E+01	2.051766E-01	2.550600E-01	UNKNOW	7
1.11018000E+01	2.017828E-01	2.550600E-01	UNKNOW	7
1.12818000E+01	1.968773E-01	2.550600E-01	UNKNOW	7
1.14618000E+01	1.819781E-01	2.550600E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
9.00000000E-02	3.571127E-01	2.550600E-01	UNKNOW	1
2.70000000E-01	3.525647E-01	2.550600E-01	UNKNOW	1
4.50000000E-01	3.481269E-01	2.550600E-01	UNKNOW	1
6.30000000E-01	3.437884E-01	2.550600E-01	UNKNOW	1
8.10000000E-01	3.395452E-01	2.550600E-01	UNKNOW	1
9.90000000E-01	3.353947E-01	2.550600E-01	UNKNOW	1
1.17000000E+00	3.313351E-01	2.550600E-01	UNKNOW	1
1.35000000E+00	3.273644E-01	2.550600E-01	UNKNOW	1
1.53000000E+00	3.234808E-01	2.550600E-01	UNKNOW	1
1.71000000E+00	3.196824E-01	2.550600E-01	UNKNOW	1
1.89000000E+00	3.159671E-01	2.550600E-01	UNKNOW	1
2.07000000E+00	3.123327E-01	2.550600E-01	UNKNOW	1
2.25000000E+00	3.087771E-01	2.550600E-01	UNKNOW	1
2.43000000E+00	3.052982E-01	2.550600E-01	UNKNOW	1
2.61000000E+00	3.018936E-01	2.550600E-01	UNKNOW	1
2.79000000E+00	2.985612E-01	2.550600E-01	UNKNOW	1
2.97000000E+00	2.952988E-01	2.550600E-01	UNKNOW	1
3.15000000E+00	2.921043E-01	2.550600E-01	UNKNOW	1
3.33000000E+00	2.889755E-01	2.550600E-01	UNKNOW	1
3.51000000E+00	2.859104E-01	2.550600E-01	UNKNOW	1
3.69000000E+00	2.829069E-01	2.550600E-01	UNKNOW	1
3.87000000E+00	2.799630E-01	2.550600E-01	UNKNOW	1
4.05000000E+00	2.770768E-01	2.550600E-01	UNKNOW	1
4.23000000E+00	2.742464E-01	2.550600E-01	UNKNOW	1
4.41000000E+00	2.714698E-01	2.550600E-01	UNKNOW	1
4.59000000E+00	2.687454E-01	2.550600E-01	UNKNOW	1
4.77000000E+00	2.660713E-01	2.550600E-01	UNKNOW	1
4.95000000E+00	2.634457E-01	2.550600E-01	UNKNOW	1
5.13000000E+00	2.608670E-01	2.550600E-01	UNKNOW	1
5.31000000E+00	2.583334E-01	2.550600E-01	UNKNOW	1
5.40076250E+00	2.369990E-01	2.684000E-03	C	2

5.40228750E+00	2.369768E-01	2.684000E-03	C	2
5.40381250E+00	2.369546E-01	2.684000E-03	C	2
5.40533750E+00	2.369324E-01	2.684000E-03	C	2
5.40686250E+00	2.369102E-01	2.684000E-03	C	2
5.40838750E+00	2.368880E-01	2.684000E-03	C	2
5.40991250E+00	2.368658E-01	2.684000E-03	C	2
5.41143750E+00	2.368436E-01	2.684000E-03	C	2
5.41296250E+00	2.368214E-01	2.684000E-03	C	2
5.41448750E+00	2.367992E-01	2.684000E-03	C	2
5.41601250E+00	2.367770E-01	2.684000E-03	C	2
5.41753750E+00	2.367548E-01	2.684000E-03	C	2
5.41906250E+00	2.367326E-01	2.684000E-03	C	2
5.42058750E+00	2.367104E-01	2.684000E-03	C	2
5.42211250E+00	2.366882E-01	2.684000E-03	C	2
5.42363750E+00	2.366660E-01	2.684000E-03	C	2
5.42516250E+00	2.366438E-01	2.684000E-03	C	2
5.42668750E+00	2.366216E-01	2.684000E-03	C	2
5.42821250E+00	2.365994E-01	2.684000E-03	C	2
5.42973750E+00	2.365772E-01	2.684000E-03	C	2
5.43177000E+00	2.511220E-01	4.470400E-03	UNKNOW	3
5.43431000E+00	2.510795E-01	4.470400E-03	UNKNOW	3
5.43685000E+00	2.510371E-01	4.470400E-03	UNKNOW	3
5.43939000E+00	2.509948E-01	4.470400E-03	UNKNOW	3
5.44193000E+00	2.509524E-01	4.470400E-03	UNKNOW	3
5.44447000E+00	2.509102E-01	4.470400E-03	UNKNOW	3
5.44701000E+00	2.508679E-01	4.470400E-03	UNKNOW	3
5.44955000E+00	2.508257E-01	4.470400E-03	UNKNOW	3
5.45209000E+00	2.507836E-01	4.470400E-03	UNKNOW	3
5.45463000E+00	2.507415E-01	4.470400E-03	UNKNOW	3
5.45717000E+00	2.506994E-01	4.470400E-03	UNKNOW	3
5.45971000E+00	2.506574E-01	4.470400E-03	UNKNOW	3
5.46225000E+00	2.506154E-01	4.470400E-03	UNKNOW	3
5.46479000E+00	2.505734E-01	4.470400E-03	UNKNOW	3
5.46733000E+00	2.505314E-01	4.470400E-03	UNKNOW	3
5.46987000E+00	2.504895E-01	4.470400E-03	UNKNOW	3
5.47241000E+00	2.504476E-01	4.470400E-03	UNKNOW	3
5.47495000E+00	2.504058E-01	4.470400E-03	UNKNOW	3
5.47749000E+00	2.503639E-01	4.470400E-03	UNKNOW	3
5.48003000E+00	2.503221E-01	4.470400E-03	UNKNOW	3
5.49603000E+00	2.512318E-01	3.809178E-05	UNKNOW	4
5.52549000E+00	2.512314E-01	3.809178E-05	UNKNOW	4
5.55495000E+00	2.512311E-01	3.809178E-05	UNKNOW	4
5.58441000E+00	2.512307E-01	3.809178E-05	UNKNOW	4
5.61387000E+00	2.512304E-01	3.809178E-05	UNKNOW	4
5.64333000E+00	2.512300E-01	3.809178E-05	UNKNOW	4
5.67279000E+00	2.512297E-01	3.809178E-05	UNKNOW	4
5.70225000E+00	2.512293E-01	3.809178E-05	UNKNOW	4
5.73171000E+00	2.512289E-01	3.809178E-05	UNKNOW	4
5.76117000E+00	2.512286E-01	3.809178E-05	UNKNOW	4
5.79063000E+00	2.512282E-01	3.809178E-05	UNKNOW	4
5.82009000E+00	2.512279E-01	3.809178E-05	UNKNOW	4
5.84955000E+00	2.512275E-01	3.809178E-05	UNKNOW	4
5.87901000E+00	2.512272E-01	3.809178E-05	UNKNOW	4
5.90847000E+00	2.512268E-01	3.809178E-05	UNKNOW	4
5.93793000E+00	2.512264E-01	3.809178E-05	UNKNOW	4
5.96739000E+00	2.512261E-01	3.809178E-05	UNKNOW	4
5.99685000E+00	2.512257E-01	3.809178E-05	UNKNOW	4
6.02631000E+00	2.512254E-01	3.809178E-05	UNKNOW	4
6.05577000E+00	2.512250E-01	3.809178E-05	UNKNOW	4
6.07177000E+00	2.502732E-01	4.470400E-03	UNKNOW	5
6.07431000E+00	2.502315E-01	4.470400E-03	UNKNOW	5
6.07685000E+00	2.501898E-01	4.470400E-03	UNKNOW	5
6.07939000E+00	2.501481E-01	4.470400E-03	UNKNOW	5
6.08193000E+00	2.501064E-01	4.470400E-03	UNKNOW	5
6.08447000E+00	2.500648E-01	4.470400E-03	UNKNOW	5
6.08701000E+00	2.500232E-01	4.470400E-03	UNKNOW	5
6.08955000E+00	2.499816E-01	4.470400E-03	UNKNOW	5
6.09209000E+00	2.499400E-01	4.470400E-03	UNKNOW	5
6.09463000E+00	2.498985E-01	4.470400E-03	UNKNOW	5
6.09717000E+00	2.498570E-01	4.470400E-03	UNKNOW	5
6.09971000E+00	2.498155E-01	4.470400E-03	UNKNOW	5
6.10225000E+00	2.497741E-01	4.470400E-03	UNKNOW	5
6.10479000E+00	2.497327E-01	4.470400E-03	UNKNOW	5
6.10733000E+00	2.496914E-01	4.470400E-03	UNKNOW	5
6.10987000E+00	2.496500E-01	4.470400E-03	UNKNOW	5
6.11241000E+00	2.496088E-01	4.470400E-03	UNKNOW	5
6.11495000E+00	2.495675E-01	4.470400E-03	UNKNOW	5
6.11749000E+00	2.495263E-01	4.470400E-03	UNKNOW	5
6.12003000E+00	2.494852E-01	4.470400E-03	UNKNOW	5
6.12206250E+00	2.349868E-01	2.684000E-03	C	6
6.12358750E+00	2.349650E-01	2.684000E-03	C	6
6.12511250E+00	2.349431E-01	2.684000E-03	C	6
6.12663750E+00	2.349213E-01	2.684000E-03	C	6
6.12816250E+00	2.348995E-01	2.684000E-03	C	6
6.12968750E+00	2.348776E-01	2.684000E-03	C	6

6.13121250E+00	2.348558E-01	2.684000E-03	C	6
6.13273750E+00	2.348339E-01	2.684000E-03	C	6
6.13426250E+00	2.348121E-01	2.684000E-03	C	6
6.13578750E+00	2.347903E-01	2.684000E-03	C	6
6.13731250E+00	2.347684E-01	2.684000E-03	C	6
6.13883750E+00	2.347466E-01	2.684000E-03	C	6
6.14036250E+00	2.347247E-01	2.684000E-03	C	6
6.14188750E+00	2.347029E-01	2.684000E-03	C	6
6.14341250E+00	2.346811E-01	2.684000E-03	C	6
6.14493750E+00	2.346593E-01	2.684000E-03	C	6
6.14646250E+00	2.346374E-01	2.684000E-03	C	6
6.14798750E+00	2.346156E-01	2.684000E-03	C	6
6.14951250E+00	2.345938E-01	2.684000E-03	C	6
6.15103750E+00	2.345719E-01	2.684000E-03	C	6
6.24180000E+00	2.532048E-01	2.550600E-01	UNKNOW	7
6.42180000E+00	2.507996E-01	2.550600E-01	UNKNOW	7
6.60180000E+00	2.484331E-01	2.550600E-01	UNKNOW	7
6.78180000E+00	2.461039E-01	2.550600E-01	UNKNOW	7
6.96180000E+00	2.438109E-01	2.550600E-01	UNKNOW	7
7.14180000E+00	2.415526E-01	2.550600E-01	UNKNOW	7
7.32180000E+00	2.393277E-01	2.550600E-01	UNKNOW	7
7.50180000E+00	2.371349E-01	2.550600E-01	UNKNOW	7
7.68180000E+00	2.349730E-01	2.550600E-01	UNKNOW	7
7.86180000E+00	2.328405E-01	2.550600E-01	UNKNOW	7
8.04180000E+00	2.307363E-01	2.550600E-01	UNKNOW	7
8.22180000E+00	2.286591E-01	2.550600E-01	UNKNOW	7
8.40180000E+00	2.266077E-01	2.550600E-01	UNKNOW	7
8.58180000E+00	2.245806E-01	2.550600E-01	UNKNOW	7
8.76180000E+00	2.225767E-01	2.550600E-01	UNKNOW	7
8.94180000E+00	2.205946E-01	2.550600E-01	UNKNOW	7
9.12180000E+00	2.186330E-01	2.550600E-01	UNKNOW	7
9.30180000E+00	2.166903E-01	2.550600E-01	UNKNOW	7
9.48180000E+00	2.147651E-01	2.550600E-01	UNKNOW	7
9.66180000E+00	2.128557E-01	2.550600E-01	UNKNOW	7
9.84180000E+00	2.109604E-01	2.550600E-01	UNKNOW	7
1.00218000E+01	2.090770E-01	2.550600E-01	UNKNOW	7
1.02018000E+01	2.072034E-01	2.550600E-01	UNKNOW	7
1.03818000E+01	2.053370E-01	2.550600E-01	UNKNOW	7
1.05618000E+01	2.034747E-01	2.550600E-01	UNKNOW	7
1.07418000E+01	2.016129E-01	2.550600E-01	UNKNOW	7
1.09218000E+01	1.997472E-01	2.550600E-01	UNKNOW	7
1.11018000E+01	1.978720E-01	2.550600E-01	UNKNOW	7
1.12818000E+01	1.959805E-01	2.550600E-01	UNKNOW	7
1.14618000E+01	1.940630E-01	2.550600E-01	UNKNOW	7

```
*********************************************************************
*                                                                   *
*            INPUT TO ADEPT  (AUGUST 1, 1992 )                      *
*                                                                   *
*********************************************************************

TITLE 1
BUILDUP CAP (PHOTON TO DOSE) 18 MEV SPECTRUM PHOTONS INCIDENT
* Material specification.
* Delrin (the buildup cap material).
MATERIAL C 0.4002 H 0.06714 O 0.53284
 DENSITY 1.417
* Carbon (coating on the inside of the buildup cap).
MATERIAL C
 DENSITY 1.76
* Something else (ask randy).
MATERIAL C 0.37514 H 0.03148 F 0.59338
 DENSITY 1.76
* Air within detector.
MATERIAL N 0.7542 O 0.2330 AR 0.0128
 DENSITY 0.001293
 GAS
* Geometry specification.
GEOMETRY 7
 1 20 5.4
 2 10 0.0305
 3 10 0.0508
 4 10 0.5892
 3 10 0.0508
 2 10 0.0305
 1 20 5.4
* Source.
PHOTON-SOURCE
CUTOFF 0.01
SPECTRUM 26
1.0      0.99981  0.999076 0.997455 0.99434  0.989477 0.982515 0.97286
0.960147 0.943797 0.923642 0.898836 0.868814 0.833437 0.791999 0.743796
0.688123 0.624134 0.551407 0.468531 0.373534 0.266698 0.146049 0.00933329
2.597e-7 0.0
ENERGIES
19.107 18.721 18.335 17.949 17.563 17.177 16.791 16.405
16.019 15.633 15.247 14.861 14.475 14.089 13.703 13.317
12.931 12.545 12.159 11.773 11.387 11.001 10.615 10.229
10.018 10.0
PLANE-WAVE
RELAX-DEFAULT
* Output options.
OUTPUT
 DOSE


*********************************************************************
*                                                                   *
*                 PROBLEM DEFINITION                                *
*                                                                   *
*********************************************************************
```

LAYER	THICKNESS	MATERIAL	DENSITY	XMESH
1	5.4000E+00	1 UNKNOW	1.4170E+00	20
2	3.0500E-02	2 C	1.7600E+00	10
3	5.0800E-02	3 UNKNOW	1.7600E+00	10
4	5.8920E-01	4 UNKNOW	1.2930E-03	10
5	5.0800E-02	3 UNKNOW	1.7600E+00	10
6	3.0500E-02	2 C	1.7600E+00	10
7	5.4000E+00	1 UNKNOW	1.4170E+00	20

```
Plane-Wave at Angle of Incidence =   8.3494E+00 Degrees
Default Electron Groups =  60
Default Photon Groups =  60
Default SN Order = 16


ENERGY CONSERVATION RATIO =    1.0018E+00
```

LAYER	CHARGED-PARTICLE CONSERVATION RATIO
1	1.0000E+00
2	1.0002E+00
3	9.9554E-01
4	1.0012E+00

```
       5           1.0011E+00
       6           1.0296E+00
 ERROR: charge not conserved!
       7           9.9999E-01

1*********************************************************************
*                                                                    *
*                         OUTPUT (CRAY)                              *
*                                                                    *
*             AVERAGE SOURCE ENERGY =  1.2342E+01 MeV                *
*                                                                    *
*          ALL QUANTITIES NORMALIZED TO A SINGLE SOURCE PARTICLE     *
*                                                                    *
*            FOR A SLAB, THIS IS THE SAME AS NORMALIZING TO A        *
*            UNIT NUMBER FLUX (SOURCE PARTICLES/CM2)                 *
*                                                                    *
*      PAIR SECONDARIES PRODUCED, AND POSITRONS AND                  *
*      ELECTRONS ARE THE SAME CHARGED-PARTICLE                       *
*                                                                    *
*      WARNING: POSITRON TREATMENT APPROPRIATE ONLY                  *
*               FOR NON-CHARGED-PARTICLE OUTPUT                      *
*                                                                    *
**********************************************************************
```

LAYER	MATERIAL	MASS-THICKNESS (g/cm2)	DOSE DEPOSITION (MeV-cm2/g)
1	UNKNOW	7.6518E+00	1.2797E-01
2	C	5.3680E-02	1.5919E-01
3	UNKNOW	8.9408E-02	1.5994E-01
4	UNKNOW	7.6184E-04	1.6881E-01
5	UNKNOW	8.9408E-02	1.5928E-01
6	C	5.3680E-02	1.5818E-01
7	UNKNOW	7.6518E+00	1.6088E-01

TOTAL ENERGY DEPOSITED =   2.2559E+00 MeV/source

****

RESIDENT KERMA (DERIVED FROM PHOTON-FIELD ONLY)

LAYER	MATERIAL	DOSE (MeV-cm2/g)
1	UNKNOW	1.7258E-01
2	C	1.5173E-01
3	UNKNOW	1.6115E-01
4	UNKNOW	1.6169E-01
5	UNKNOW	1.6096E-01
6	C	1.5128E-01
7	UNKNOW	1.5551E-01

****

DIFFERENTIAL DOSE PROFILE

x (cm)	dose(MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.35000000E-01	1.203119E-02	3.825900E-01	UNKNOW	1
4.05000000E-01	3.114675E-02	3.825900E-01	UNKNOW	1
6.75000000E-01	4.979843E-02	3.825900E-01	UNKNOW	1
9.45000000E-01	6.762269E-02	3.825900E-01	UNKNOW	1
1.21500000E+00	8.443124E-02	3.825900E-01	UNKNOW	1
1.48500000E+00	1.000884E-01	3.825900E-01	UNKNOW	1
1.75500000E+00	1.144669E-01	3.825900E-01	UNKNOW	1
2.02500000E+00	1.274310E-01	3.825900E-01	UNKNOW	1
2.29500000E+00	1.388360E-01	3.825900E-01	UNKNOW	1
2.56500000E+00	1.485417E-01	3.825900E-01	UNKNOW	1
2.83500000E+00	1.564365E-01	3.825900E-01	UNKNOW	1
3.10500000E+00	1.624851E-01	3.825900E-01	UNKNOW	1
3.37500000E+00	1.667864E-01	3.825900E-01	UNKNOW	1
3.64500000E+00	1.695834E-01	3.825900E-01	UNKNOW	1
3.91500000E+00	1.711990E-01	3.825900E-01	UNKNOW	1
4.18500000E+00	1.719533E-01	3.825900E-01	UNKNOW	1
4.45500000E+00	1.721130E-01	3.825900E-01	UNKNOW	1
4.72500000E+00	1.718826E-01	3.825900E-01	UNKNOW	1
4.99500000E+00	1.714217E-01	3.825900E-01	UNKNOW	1
5.26500000E+00	1.710670E-01	3.825900E-01	UNKNOW	1
5.40152500E+00	1.587016E-01	5.368000E-03	C	2
5.40457500E+00	1.588466E-01	5.368000E-03	C	2
5.40762500E+00	1.589344E-01	5.368000E-03	C	2
5.41067500E+00	1.590177E-01	5.368000E-03	C	2
5.41372500E+00	1.591018E-01	5.368000E-03	C	2
5.41677500E+00	1.591914E-01	5.368000E-03	C	2
5.41982500E+00	1.592909E-01	5.368000E-03	C	2

5.42287500E+00	1.594068E-01	5.368000E-03	C	2
5.42592500E+00	1.595496E-01	5.368000E-03	C	2
5.42897500E+00	1.598146E-01	5.368000E-03	C	2
5.43304000E+00	1.600730E-01	8.940800E-03	UNKNOW	3
5.43812000E+00	1.600330E-01	8.940800E-03	UNKNOW	3
5.44320000E+00	1.600109E-01	8.940800E-03	UNKNOW	3
5.44828000E+00	1.599901E-01	8.940800E-03	UNKNOW	3
5.45336000E+00	1.599672E-01	8.940800E-03	UNKNOW	3
5.45844000E+00	1.599407E-01	8.940800E-03	UNKNOW	3
5.46352000E+00	1.599098E-01	8.940800E-03	UNKNOW	3
5.46860000E+00	1.598741E-01	8.940800E-03	UNKNOW	3
5.47368000E+00	1.598330E-01	8.940800E-03	UNKNOW	3
5.47876000E+00	1.597974E-01	8.940800E-03	UNKNOW	3
5.51076000E+00	1.687767E-01	7.618356E-05	UNKNOW	4
5.56968000E+00	1.688083E-01	7.618356E-05	UNKNOW	4
5.62860000E+00	1.688230E-01	7.618356E-05	UNKNOW	4
5.68752000E+00	1.688306E-01	7.618356E-05	UNKNOW	4
5.74644000E+00	1.688333E-01	7.618356E-05	UNKNOW	4
5.80536000E+00	1.688321E-01	7.618356E-05	UNKNOW	4
5.86428000E+00	1.688270E-01	7.618356E-05	UNKNOW	4
5.92320000E+00	1.688170E-01	7.618356E-05	UNKNOW	4
5.98212000E+00	1.687993E-01	7.618356E-05	UNKNOW	4
6.04104000E+00	1.687630E-01	7.618356E-05	UNKNOW	4
6.07304000E+00	1.597373E-01	8.940800E-03	UNKNOW	5
6.07812000E+00	1.596646E-01	8.940800E-03	UNKNOW	5
6.08320000E+00	1.595935E-01	8.940800E-03	UNKNOW	5
6.08828000E+00	1.595123E-01	8.940800E-03	UNKNOW	5
6.09336000E+00	1.594194E-01	8.940800E-03	UNKNOW	5
6.09844000E+00	1.593118E-01	8.940800E-03	UNKNOW	5
6.10352000E+00	1.591851E-01	8.940800E-03	UNKNOW	5
6.10860000E+00	1.590315E-01	8.940800E-03	UNKNOW	5
6.11368000E+00	1.588379E-01	8.940800E-03	UNKNOW	5
6.11876000E+00	1.584931E-01	8.940800E-03	UNKNOW	5
6.12282500E+00	1.581232E-01	5.368000E-03	C	6
6.12587500E+00	1.581586E-01	5.368000E-03	C	6
6.12892500E+00	1.581740E-01	5.368000E-03	C	6
6.13197500E+00	1.581831E-01	5.368000E-03	C	6
6.13502500E+00	1.581888E-01	5.368000E-03	C	6
6.13807500E+00	1.581928E-01	5.368000E-03	C	6
6.14112500E+00	1.581960E-01	5.368000E-03	C	6
6.14417500E+00	1.581985E-01	5.368000E-03	C	6
6.14722500E+00	1.582007E-01	5.368000E-03	C	6
6.15027500E+00	1.581783E-01	5.368000E-03	C	6
6.28680000E+00	1.699446E-01	3.825900E-01	UNKNOW	7
6.55680000E+00	1.689646E-01	3.825900E-01	UNKNOW	7
6.82680000E+00	1.680582E-01	3.825900E-01	UNKNOW	7
7.09680000E+00	1.671496E-01	3.825900E-01	UNKNOW	7
7.36680000E+00	1.662378E-01	3.825900E-01	UNKNOW	7
7.63680000E+00	1.653227E-01	3.825900E-01	UNKNOW	7
7.90680000E+00	1.644050E-01	3.825900E-01	UNKNOW	7
8.17680000E+00	1.634856E-01	3.825900E-01	UNKNOW	7
8.44680000E+00	1.625653E-01	3.825900E-01	UNKNOW	7
8.71680000E+00	1.616447E-01	3.825900E-01	UNKNOW	7
8.98680000E+00	1.607238E-01	3.825900E-01	UNKNOW	7
9.25680000E+00	1.598014E-01	3.825900E-01	UNKNOW	7
9.52680000E+00	1.588756E-01	3.825900E-01	UNKNOW	7
9.79680000E+00	1.579436E-01	3.825900E-01	UNKNOW	7
1.00668000E+01	1.570015E-01	3.825900E-01	UNKNOW	7
1.03368000E+01	1.560438E-01	3.825900E-01	UNKNOW	7
1.06068000E+01	1.550598E-01	3.825900E-01	UNKNOW	7
1.08768000E+01	1.539986E-01	3.825900E-01	UNKNOW	7
1.11468000E+01	1.528423E-01	3.825900E-01	UNKNOW	7
1.14168000E+01	1.475723E-01	3.825900E-01	UNKNOW	7

RESIDENT DIFFERENTIAL KERMA PROFILE
DOSE DERIVED FROM PHOTON-FIELD ONLY

x (cm)	dose (MeV-cm2/g)	Mesh(g/cm2)	Material	Layer
1.35000000E-01	1.797107E-01	3.825900E-01	UNKNOW	1
4.05000000E-01	1.790338E-01	3.825900E-01	UNKNOW	1
6.75000000E-01	1.783273E-01	3.825900E-01	UNKNOW	1
9.45000000E-01	1.776013E-01	3.825900E-01	UNKNOW	1
1.21500000E+00	1.768620E-01	3.825900E-01	UNKNOW	1
1.48500000E+00	1.761135E-01	3.825900E-01	UNKNOW	1
1.75500000E+00	1.753584E-01	3.825900E-01	UNKNOW	1
2.02500000E+00	1.745978E-01	3.825900E-01	UNKNOW	1
2.29500000E+00	1.738324E-01	3.825900E-01	UNKNOW	1
2.56500000E+00	1.730623E-01	3.825900E-01	UNKNOW	1
2.83500000E+00	1.722875E-01	3.825900E-01	UNKNOW	1
3.10500000E+00	1.715077E-01	3.825900E-01	UNKNOW	1
3.37500000E+00	1.707227E-01	3.825900E-01	UNKNOW	1
3.64500000E+00	1.699326E-01	3.825900E-01	UNKNOW	1
3.91500000E+00	1.691375E-01	3.825900E-01	UNKNOW	1

4.18500000E+00	1.683374E-01	3.825900E-01	UNKNOW	1
4.45500000E+00	1.675327E-01	3.825900E-01	UNKNOW	1
4.72500000E+00	1.667235E-01	3.825900E-01	UNKNOW	1
4.99500000E+00	1.659100E-01	3.825900E-01	UNKNOW	1
5.26500000E+00	1.650925E-01	3.825900E-01	UNKNOW	1
5.40152500E+00	1.517700E-01	5.368000E-03	C	2
5.40457500E+00	1.517603E-01	5.368000E-03	C	2
5.40762500E+00	1.517506E-01	5.368000E-03	C	2
5.41067500E+00	1.517408E-01	5.368000E-03	C	2
5.41372500E+00	1.517311E-01	5.368000E-03	C	2
5.41677500E+00	1.517214E-01	5.368000E-03	C	2
5.41982500E+00	1.517116E-01	5.368000E-03	C	2
5.42287500E+00	1.517019E-01	5.368000E-03	C	2
5.42592500E+00	1.516922E-01	5.368000E-03	C	2
5.42897500E+00	1.516824E-01	5.368000E-03	C	2
5.43304000E+00	1.612357E-01	8.940800E-03	UNKNOW	3
5.43812000E+00	1.612165E-01	8.940800E-03	UNKNOW	3
5.44320000E+00	1.611973E-01	8.940800E-03	UNKNOW	3
5.44828000E+00	1.611781E-01	8.940800E-03	UNKNOW	3
5.45336000E+00	1.611591E-01	8.940800E-03	UNKNOW	3
5.45844000E+00	1.611400E-01	8.940800E-03	UNKNOW	3
5.46352000E+00	1.611210E-01	8.940800E-03	UNKNOW	3
5.46860000E+00	1.611020E-01	8.940800E-03	UNKNOW	3
5.47368000E+00	1.610831E-01	8.940800E-03	UNKNOW	3
5.47876000E+00	1.610641E-01	8.940800E-03	UNKNOW	3
5.51076000E+00	1.616919E-01	7.618356E-05	UNKNOW	4
5.56968000E+00	1.616917E-01	7.618356E-05	UNKNOW	4
5.62860000E+00	1.616916E-01	7.618356E-05	UNKNOW	4
5.68752000E+00	1.616914E-01	7.618356E-05	UNKNOW	4
5.74644000E+00	1.616912E-01	7.618356E-05	UNKNOW	4
5.80536000E+00	1.616911E-01	7.618356E-05	UNKNOW	4
5.86428000E+00	1.616909E-01	7.618356E-05	UNKNOW	4
5.92320000E+00	1.616908E-01	7.618356E-05	UNKNOW	4
5.98212000E+00	1.616906E-01	7.618356E-05	UNKNOW	4
6.04104000E+00	1.616904E-01	7.618356E-05	UNKNOW	4
6.07304000E+00	1.610436E-01	8.940800E-03	UNKNOW	5
6.07812000E+00	1.610247E-01	8.940800E-03	UNKNOW	5
6.08320000E+00	1.610059E-01	8.940800E-03	UNKNOW	5
6.08828000E+00	1.609870E-01	8.940800E-03	UNKNOW	5
6.09336000E+00	1.609682E-01	8.940800E-03	UNKNOW	5
6.09844000E+00	1.609495E-01	8.940800E-03	UNKNOW	5
6.10352000E+00	1.609307E-01	8.940800E-03	UNKNOW	5
6.10860000E+00	1.609120E-01	8.940800E-03	UNKNOW	5
6.11368000E+00	1.608934E-01	8.940800E-03	UNKNOW	5
6.11876000E+00	1.608748E-01	8.940800E-03	UNKNOW	5
6.12282500E+00	1.513222E-01	5.368000E-03	C	6
6.12587500E+00	1.513125E-01	5.368000E-03	C	6
6.12892500E+00	1.513028E-01	5.368000E-03	C	6
6.13197500E+00	1.512931E-01	5.368000E-03	C	6
6.13502500E+00	1.512833E-01	5.368000E-03	C	6
6.13807500E+00	1.512736E-01	5.368000E-03	C	6
6.14112500E+00	1.512639E-01	5.368000E-03	C	6
6.14417500E+00	1.512541E-01	5.368000E-03	C	6
6.14722500E+00	1.512444E-01	5.368000E-03	C	6
6.15027500E+00	1.512346E-01	5.368000E-03	C	6
6.28680000E+00	1.636757E-01	3.825900E-01	UNKNOW	7
6.55680000E+00	1.628468E-01	3.825900E-01	UNKNOW	7
6.82680000E+00	1.620139E-01	3.825900E-01	UNKNOW	7
7.09680000E+00	1.611770E-01	3.825900E-01	UNKNOW	7
7.36680000E+00	1.603363E-01	3.825900E-01	UNKNOW	7
7.63680000E+00	1.594916E-01	3.825900E-01	UNKNOW	7
7.90680000E+00	1.586428E-01	3.825900E-01	UNKNOW	7
8.17680000E+00	1.577896E-01	3.825900E-01	UNKNOW	7
8.44680000E+00	1.569318E-01	3.825900E-01	UNKNOW	7
8.71680000E+00	1.560688E-01	3.825900E-01	UNKNOW	7
8.98680000E+00	1.552001E-01	3.825900E-01	UNKNOW	7
9.25680000E+00	1.543249E-01	3.825900E-01	UNKNOW	7
9.52680000E+00	1.534420E-01	3.825900E-01	UNKNOW	7
9.79680000E+00	1.525501E-01	3.825900E-01	UNKNOW	7
1.00668000E+01	1.516469E-01	3.825900E-01	UNKNOW	7
1.03368000E+01	1.507296E-01	3.825900E-01	UNKNOW	7
1.06068000E+01	1.497940E-01	3.825900E-01	UNKNOW	7
1.08768000E+01	1.488342E-01	3.825900E-01	UNKNOW	7
1.11468000E+01	1.478411E-01	3.825900E-01	UNKNOW	7
1.14168000E+01	1.468000E-01	3.825900E-01	UNKNOW	7

Appendix D, Weekly Beam Calibration Check Sheets and Mini-Phantom Dose Calculations.

St.Joseph Med Cen : Radiation Oncology Physics Routine Checks (HVC:1-Dec-92)

Date/Time: 5/6/94 TG-21 Calibration Check, SJMC CL4/80 #003R, Init DEL

1. Emergency Off Chk: (2)Table_____ (2)Walls________ (2)Gantry_____
(every 3 months) (1)Console____

2. Indicators:

	LED Indicator	DIAL	Mechanical
Gantry (w) (± 1°)	90	________	270, 180, 90, 0
collimator(m) (± 1°)	180	________	________
field size(upper,w)	10	(± 2 mm)	________
field size(lower,w)	10	(± 2 mm)	________
TSD (w)	100	(± 2 mm)	________

3. Laser Alignment (w) south wall______ north wall_____ sagittal_____
(± 2 mm) back Pointer______

4. Door interlock(w) _____ Time Check(w) ______ Beam off reset(w) ________
Mech Counter(w)____ MU set(w) ____ Light field vs radiation(w) ______(± 2 mm)

5. Chamber measurement using yellow plastic phantom at 80cm TSD and 10x10 fs.
Chamber: PTW 172 Leakage: 0.5E-4 P 635 T 23 C Ctp 1.2009 Celec 0.998
Electrometer:______ "Doserate":__________(MU/min) Bias: -307 DVM: PRM
Gty Angle: 180 Coll Angle: 90

5 cm Readings (NC) 5 x 40 MU	200 MU		16 cm Readings 200 MU	
24.88	-24.55	{ }	11.491	{ }
	-24.55	{ }	11.481	{ }
	-24.55	{ }	11.461	{ }
average	Q5(200) -24.55	{ }	Q16(200) 11.48	{ }

Calibration Chk: $\left[\frac{Q5(200) * Ctp * Celec * 200.5}{Rc * (200 \div 5 \text{ MU})} \right]$ = 0.988 cGy/MU { 1.2% low }

% Dev from 1.0: 1.2% OK yes Adjustment done none use "{}"
(Adjustment needed if %dev is > ± 1.5% or three times > ± 1 %)

Depth Dose Check

$\frac{Q16(200)}{Q5(200)} = \frac{11.48}{24.55} = 0.468$ % Dev from 0.463 = 1.0%

Protea Check (20x20 fs at 79.5 cm TSD to plastic plates, 100 MU)

Channel	1	2	3	4	5	
Readings	______	______	______	______	______	REVIEW:________
Typical	1.093	1.082	1.088	1.091	(0.95 to 1.02)	(as of 1/12/92)

4 MeV Buildup cap / Mini-phantom Dose Calculations

Dose to the water mini-phantom at the 4 MV Medical Linear Accelerator. The values used are from the Weekly Beam Calibration Check Sheets, as determined by the facility's Medical Physicists.

$$D_{mini} = \left[\frac{D_{Full}}{PSF}\right] \left[\frac{\left(\frac{\mu_{en}}{\rho}\right)_{water}}{\left(\frac{\mu_{en}}{\rho}\right)_{tissue}}\right] = \left[\frac{0.988}{1.027}\right] \left[\frac{0.0206}{0.0204}\right] = 0.971 \frac{cGy}{mu}$$

Dose to the mini-phantom of delrin or the 6 MeV Buildup Cap. The result is converted to a dose to a water phantom for comparison to the Weekly Beam Calibration Check.

$$D_{mini} = MN_{gas} \left(\frac{\overline{L}}{\rho}\right)_{air}^{delrin} P_{repl}\, P_{wall}\, P_{ion} \left(\frac{\overline{\mu_{en}}}{\rho}\right)_{delrin}^{water}$$

$$D_{mini}^{delrin} = \left(199.7 \frac{R}{200mu}\right) \left(0.845 \frac{cGy}{sd}\right) \left(1.126\right)_{air}^{delrin} 0.991 \;\; 1.0 \;\; 1.0 \;\; 1.035 = 0.974 \frac{cGy}{sd}$$

NOTE: **"sd"** indicates the scale division of the instrument making the measurement, which in this case was set on the Roentgen (R) scale. Therefore, the unit of (R) is substituted for the unit "sd".

Comparison between Weekly Beam Calibration Check and Dose to the Buildup Cap.

$$\frac{0.974 \frac{cGy}{mu}}{0.971 \frac{cGy}{mu}} = 1.003 \quad OR \quad 0.3\%$$

CLINAC 6/100 B: Weekly Physics Checks
UNM Medical Physics

Output check: 30 cm x 30 cm x 40 cm or 20cm cubic water phantom, 10 cm x 10 cm field (cone), 100 mu set. Depth given is to the center of the ion chamber.

Ion chamber: PTW # 799 N_{gas} = 45.4 cGy/10^{-8}C

Electrometer: Kiethly 602 # 69 N_{elec} = 1.019 10^{-8}C/V

DMM: --------- # --- N_{dmm} = 1.000 V/rdg

Gantry: 90 ° Collimator: 180 °

Water Temperature: 22.6 °C Pressure: 633* mm Hg K_{tp} = 1.203

Ion chamber bias: ~~-XXXXX~~ -299.2 V Elect. scale: 10^{-8}C, ffb Leakage: 0.000 x10^{-11}A

X-ray Energy	Depth (cm)	F	Readings (-V)	Dose Rate (cGy/mu)
6 MV	5.0	01213	1.458, 1.463, 1.464; $\overline{1.462}$	0.987

$$\text{Dose rate} = M*K_{tp}*N_{gas}*N_{elec}*N_{dmm}*F$$

$$F = L/\rho*P_{wall}*P_{repl}*P_{cep}*P_{ion}*(1/TMR_{5cm})*(1/mu)*\mu/\rho$$

$$K_{tp} = [(760 \text{ mm Hg})/P]\ [(T + 273.0\ °C)/295.0\ °C]$$

Dose specification: Absorbed dose at d_{max} in muscle, 10cm x 10cm field, 100cm TAD.

Prepared: T. Kirby, Ph.D. May 17, 1994 <qa\machines\wkly6B.frm>

6 MeV Buildup cap / Mini-phantom Dose Calculations

Dose to the water mini-phantom at the 6 MV Medical Linear Accelerator. The values used are from the Weekly Beam Calibration Check Sheets, as determined by the facility's Medical Physicists.

$$D_{mini} = \left[\frac{D_{Full}}{PSF}\right] \left[\frac{\left(\frac{\mu_{en}}{\rho}\right)_{water}}{\left(\frac{\mu_{en}}{\rho}\right)_{tissue}}\right] = \left[\frac{0.987}{1.026}\right] \left[\frac{0.0180}{0.0178}\right] = 0.973 \frac{cGy}{mu}$$

Dose to the mini-phantom of delrin or the 6 MeV Buildup Cap. The result is converted to a dose to a water phantom for comparison to the Weekly Beam Calibration Check.

$$D_{mini} = MN_{gas} \left(\frac{\overline{L}}{\rho}\right)_{air}^{delrin} P_{repl}\, P_{wall}\, P_{ion} \left(\frac{\overline{\mu_{en}}}{\rho}\right)_{delrin}^{water}$$

$$D_{mini}^{delrin} = \left(104.4 \frac{R}{100mu}\right) \left(0.845 \frac{cGy}{sd}\right) \left(1.087\right)_{air}^{delrin} 0.992\ 1.0\ 1.0\ 1.029 = 0.979 \frac{cGy}{sd}$$

NOTE: **"sd"** indicates the scale division of the instrument making the measurement, which in this case was set on the Roentgen (R) scale. Therefore, the unit of (R) is substituted for the unit "sd".

Comparison between Weekly Beam Calibration Check and Dose to the Buildup Cap.

$$\frac{0.979 \frac{cGy}{mu}}{0.973 \frac{cGy}{mu}} = 1.006 \quad OR \quad 0.6\%$$

Appendix E, Certificate of Conformance.

Radcal Corporation 426 west duarte road monrovia, california 91016 (818) 357-7921 fax (818) 357-8

CERTIFICATE OF CONFORMANCE

Issued to

Sandia National Laboratories
1515 Eubank S.E.
Building 957
Albuquerque, NM 87123

Identification

1515 Radiation Monitor S/N 15-1102
1050U Converter S/N 5U-1062
10X5-0.6 Ion Chamber S/N 9173

The equipment identified above has been subjected to standard Radcal acceptance test procedures and has been found to conform in all respects. All radiation measurements performed during the acceptance testing employ NIST traceable techniques. These test procedures are designed to ensure that the tested equipment meets or exceeds the manufacturer's specifications.

Tested By

[signature]

Date of Test

12/22/93

Radcal Corporation

Report on Calibration

Report Number 2905

INSTRUMENT SUBMITTED BY Sandia National Laboratory
Bldq 957
1515 Eubank S.E.
Albuquerque, NM 87123
On PO Number: AI-2698

As Left Calibration

IDENTIFICATION Model 1515 Radiation Monitor S/N: 15-1102
with Model 1050U Converter S/N: 5U-1062
and Model 10X5-0.6 Ion Chamber S/N: 9173

The test results listed below are believed to have an overall accuracy of ±5%. All measurements have been made to a precision of < ±2%. For unsealed ion chambers, the results have been normalized to one standard atmosphere and 22.0° Celsius. Temperature and pressure corrections were applied to all readings.

The exposure at the calibration position was determined by an NIST-Calibrated three terminal ion chamber which was corrected for ambient temperature and pressure. NIST reports DG 8639/87 and DG 8640/87 identify the chambers used.

Calibrated on December 21, 1993

By [signature]

426 West Duarte Road
Monrovia, California 91016
Phone: (818) 357-7921
FAX: (818) 357-8863

CALIBRATION DATA

Chamber Model	Chamber S/N	Beam Code	Tube Potential (kVp)	First HVL (mm Al)	Homogeneity Coefficient (1)	Correction Factor (2)	Approx Exp Rate (R/min)	Distanc (cm)
10X5-0.6	9173	60 Co	-	-	-	0.98	36.4	17
		137 Cs	-	-	-	1.00	0.674	50

Ambient Temperature 21.1°C
Ambient Pressure 1001 mb

Chamber Polarizing Voltage
At Battery 297 V
At Chamber 291 V

Notes:
(1) - Homogeneity Coefficient = First HVL / Second HVL
(2) - Correction Factor = (True Exposure / Test Instrument Reading) * Chamber Multiplication Factor.
3 - The ion chamber instrument stem was oriented perpendicular to the beam direction.
4 - All measurements, unless otherwise noted, were performed in integrate mode.
5 - The electrometer readout unit has been tested in exposure and exposure rate modes over its entire operating range utilizing standard current sources. It was found to meet or exceed the manufacturer's specifications.
6 - When received at Radcal, the instrument was found to be within the manufacturer's specifications.
7 - For Co^{60} and Cs^{137} measurements the wall thickness of the ion chamber was increased by the addition of the manufacturer's recommended build-up material.

Calibrated on December 21, 1993

By

426 West Duarte Road
Monrovia, California 91016
Phone: (818) 357-7921
FAX: (818) 357-8863

[illegible] Corporation
426 W. Duarte Rd.
Monrovia, CA 91016
FAX: (818) 357-8863

TRAVELER # 16595 PAGE 3

MODEL # 1515 SERIAL # 15-1102

CUSTOMER'S STATEMENT OF REPAIR

SYSTEM AS FOUND CONDITION WAS: (Circle One)
(WITHIN) OUTSIDE PUBLISHED SPECS AT RECEIPT

Comments: ______

CALIBRATION DATA: This data should not be used to correct previous measurements. Out of specification determinations should be followed up with remeasurement. Specification limits are 0.95 to 1.05 Radiation measurements based on a NIST traceable tertiary standard.

Model Number	Serial Number	Corr. Factor
10X5-0.6	9173	1.01

WORK PERFORMED

- ✓ WE DID NOT FIND ANY PROBLEMS
- __ CHECKED AND MADE NECESSARY ADJUSTMENTS
- __ READJUSTED AND/OR REPAIRED CONTROL UNIT
- __ READJUSTED AND/OR REPAIRED CONVERTER
- __ REPAIRED CHAMBER(S) ______
- __ WE WERE NOT ABLE TO DUPLICATE YOUR PROBLEM
- ✓ RECALIBRATED TO MANUFACTURER'S SPECIFICATION
- ✓ CERTIFIED CALIBRATION OF CONTROL UNIT & CHAMBERS
- __ WARRANTY REPAIR
- __ WARRANTY EXTENSION
- __ USER DAMAGE (NOT WARRANTY REPAIR) ______
- __ ADDITIONAL COMMENTS:

PARTS REPLACED: PART NUMBER	DESCRIPTION	BOARD/ION CHAMBER			

TOTAL MATERIAL $______

If you have an intermittent or elusive problem, please call technical services and discuss the problem with them when it occurs.

In California (818) 357-7921 Outside California (800) 423-7169
(800) 726-7169

REC REP FRM [WINWP51] FORM REV # 1.090

CERTIFICATE OF CONFORMANCE

Radcal charges for labor and material to return your equipment to the original specifications. Upon receipt of your instrument at Radcal, tests are performed prior to repair or adjustment to determine if the instrument is operating within our published specifications as received. These tests include visual inspection for damage, electronic bench tests, and in beam radiation exposures. The Customer Statement of Repair returned with your unit states whether your instrument was within or outside of specification. Our test procedures use NIST traceable instrumentation and a Certificate of Conformance is issued. This level of documentation and calibration will meet the needs of most programs. Repairs (parts and labor) are warranted for one year.

CERTIFIED CALIBRATION

When your measurement program requires specific calibration data, Radcal is equipped to handle these needs. Send us your monitor and the chambers you wish calibrated (Radcal or other manufactured). Indicate the desired calibration points, Beam Codes, from the available beam qualities illustrated on this sheet. All measurements are performed using an NIST calibrated three-terminal ion chamber.

If you have requirements which we have not included, please call and discuss them with our technical staff.

Certified Calibration Charges (Effective September 1, 1993)

First Ion Chamber at one point	$ 235
Additional Ion Chamber(s) at one point	160
Additional point(s) on any chamber(s)	110

Cost for repairs required to return your Radcal monitor and ion chambers to our original specifications will be quoted in addition to the prices shown above.

Moderately-Filtered X ray (Generally for diagnostic applications)

NIST	Energy	Added Filter (mm)		Filtration HVL (mm)			Maximum	
Code	(kVp)	Al	Cu	Al	Cu	h^A	Rate	Dose
M60		.302		1.68	.052	.68	2 R/min	50 R
S60		2.805		2.8	.089	.73	2 R/min	50 R
M100	100	4.572		5.0	.20	.72	2 R/min	50 R
M150	150		.5	10.2	.67	.87	3 R/min	75 R
M200	200	2.040	1.254	14.9	1.69	.95	7 R/min	150 R
M250	250		4.016	18.5	3.2	.98	5 R/min	100 R

Lightly-Filtered X ray (Generally for mammographic applications)

NIST Code	OLD Code	Energy (kVp)	Added Filter $Al(mm)^B$	Filtration HVL(mm	h^A	Maximum Rate	Maximum Dose
L20	LD	20	0	0.065	.74	50	1000 R
LF		20	.500	0.26	.76	10	200 R
M30	LG	30	.500	0.36	.64	15	200 R
M50	LI	50	1.00	0.95	.65	20	200 R

^{A}h is the homogeneity coefficient (1^{st} HVL / 2^{nd} HVL)
^{B}Inherent Filter 1 mm Be

Gamma Ray (For quality assurance applications)

^{60}Co (rates from 1 R/h to 120 R/min)
^{137}Cs (rates from 50 mR/h to 1.5 R/min)

Heavily Filtered X ray calibrations by special arrangement only.

Revised September 1, 1993

DISTRIBUTION

6 University of New Mexico

Attn: Randell L. Salyer (2)

Robert D. Busch

Anil K. Prinja

Thomas Kirby

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Farris Engineering Center, Room 209

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