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IN REPLY REFER TO: MP-3

April 25, 1973

MES-200

Dr. T. W. Armstrong
Neutron Physics Division
ORNL
Oak Ridge, Tennessee 37830

Dear Tony:

I've outlined below three additional cases of pions incident on tissue for geometries in which M. Kligerman is interested.

The first, shown in Fig. 1, is the case of an infinite slab of bone 4-g/cm^2-thick imbedded in soft tissue such that the top surface of the bone is 1 cm below the soft tissue surface. A cylindrical hole of radius r is placed through the bone and is centered on the axis of the cylindrical geometry as defined for the problem. The pion energy is 53 MeV (Range in tissue = 10 g/cm^2) and the beam is cylindrical with some radius R such that R > r. Two questions would be answered by this calculation. For those pions incident well outside the edge of the hole, we can compare the characteristics of the energy deposition with the same characteristics as shown in your recent progress report for the case of only 2 g/cm^2 of bone. Secondly, this calculation would illustrate the dose distribution in the vicinity of a bone edge. It can be argued that one can interpolate between the two previous 53-MeV cases that you did and gain a feeling for what happens near the bone edge. I am concerned that we cannot accurately estimate the effects of scattering into and out of the bone edge and that a detailed calculation is in order. You expressed concern about the computing time necessary to do this case with good statistics. The computing time might in fact be prohibitive but for our purposes we feel that this case ranks at the top. For this reason we hope that you will give it serious thought.

A few more words about the geometry of the problem. Since the rms deflection at the end of the range due to multiple scattering is approximately 0.6 cm for the case of all soft tissue, I think that the hole radius should be two or three times this if we are to expect the dose distribution near the center of the hole to be essentially the same as for the case of soft tissue alone. By a similar argument the beam radius R should be two or three times 0.6 cm larger than the hole radius r. For ease in interpreting the data it might be advisable to make the total beam flux the same for each increment of radius, i.e., the beam intensity should be inversely proportional to the radius.

The second case concerns the simulation of irradiation through lung. This would involve positioning the stopping region just beyond the volume of lung tissue. Figure 2 illustrates the geometry. Again 53 MeV would be an appropriate energy.

Finally, we are interested in what effect an air cavity would have on the depth dose characteristics of a monoenergetic beam. A suggested geometry for this case is shown in Fig. 3. This configuration is similar to that for the lung geometry.

It would be surprising to find anything unusual for the last two cases. I would guess that, as was illustrated by your original bone calculation, the distribution of energy deposition would depend only on the depth in g/cm^2. Since you pointed out that there might be some change in survival probability distributions when a bone slab is present it would be interesting to see if such effects appear when lung or air cavities are present.

Radial distributions away from the beam axis are also of interest so that we can see if there are significant changes when bone, lung, or air is introduced into the geometry.

I think our desires for additional calculations are fairly completely described in this letter. If you have any questions give me a call.

I'm still trying to arrange a time when Kligerman could talk with you. I will keep you informed of any developments.

Sincerely,

Dick

RICHARD HUTSON

RH:pat
Attachments: Figures 1-3
cc: Mail and Records, w/o
MP-DO, w/o
R. Hutson, MP-3, w/
File, w/