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In reply refer to:
CG16/HS/pr

17 January 1947

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NAVY DEPARTMENT
JOINT CROSSROADS COMMITTEE
WASHINGTON 25, D. C.

404471

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Classification changed to ~~[illegible]~~ by Authority of the U.S. Atomic Energy Commission, by Tec Classification Officer [illegible] Belcher

CK Uncl

Doctor Wright Langham
P.O. Box 1663
Sante Fe, New Mexico

Dear Wright:

Joe Nolan has gotten together a group of CROSSROADS photographs which have been released for public views, and these were forwarded on to you today. Therefore, you should probably receive them even before this letter since no problems of delivery are involved.

In going through the safe in the main CROSSROADS office they discovered a copy of the section of our report dealing with the neutron flux. This copy was supposed to have been delivered to you by courier in September and I must apologize for such a bad foul-up. However, I am now enclosing it along with a copy of a graph showing the variation with distances for slow neutrons. The points used on this graph were carefully selected to make sure no shielding of any sort existed and their accurate locations on the ships were used in computing the distances. As you will see, they agree quite closely with the predicted equation of Hirschfelder and Magee.

In analyzing these neutron results, we have raised a few questions. We have put them to Doctor Dessauer and he is checking them, but I wondered if perhaps you or some one at Los Alamos could also help us out. The first point involves the question whether the Sulphur pills are measuring all the fast neutrons which are of physiological importance. Since the minimum energy of the neutrons captured by the Sulphur is between two and three Mev and since it is our impression that a number of the fast neutrons of physiological significance are in the energy range between 1/10 and 2 Mev, we thought our values might be considerably in error. Would it be possible to obtain the energy distribution of the fast neutrons which actually get out of the bomb? Another point involves the question of whether we are using the proper cross-section for the phosphorous pills, since they may in practice be capturing only neutrons with energies greater than the nitrogen band

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by Authority of the U.S. Atomic Energy Commission,
Per R D Frahm 1-4-62
(Person authorizing change in classification) (date)
By Delores Ann Band 3-6-62
(Signature of person making the change, and date)

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Letter to Doctor Wright Langham (Cont'd)

We are also trying to calculate the absorption of slow neutrons by steel. Do you know of any data at Los Alamos which would help us out in this respect? Unfortunately, our experimental data from the pills placed around the various ships is not too satisfactory because of the tremendous scattering of the slow neutrons and the consequent difficulty in measuring the thickness of the steel shielding.

Some time ago we wrote to Doctor Holloway to see if any of the data obtained by Linenberger and Ogle could be used to obtain neutron flux, but as yet have had no reply. I also wondered if you had succeeded in getting Dessauer's neutron films calibrated. The more data we can collect the better chance we will have of coming out with at least a reasonably accurate answer.

I hope this sudden onslaught won't completely snow you under, but we are desperately trying to tie up some of our loose ends before the powers that be make their decisions.

Sincerely yours,

Pete.

Herbert Scoville, jr

Encls:
1 graph, Top Secret, 1 page
App XIII, 8 pages, Neutron Dosage from Sulphur and Phosphate Pills.

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Crossroads Corresp.

INTER-OFFICE MEMORANDUM

~~SECRET~~

TO: G. A. Linenberger

DATE: January 28th, 1947

FROM: Wright Langham

Page #2 of 2 copies

SUBJECT: Request for information on sulphur and phosphorus neutron capture cross-section.

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Enclosed is a classified letter from Dr. Herbert Scoville of the Navy Department, Joint Crossroads Committee. In this letter, he requests information regarding the energy distribution of fast fission neutrons. He also asks for information regarding the neutron capture cross-sections of sulphur and phosphorus.

This information is of considerable importance to the crossroads committee in order that they may interpret data taken at crossroads in terms of the physiological significance of the neutrons emitted from the bomb. They also request information regarding your measurements of fast neutron flux from the Bikini tests.

I can see no reason why the committee whould not be given this information. If you will write me a letter regarding the questions Dr. Scoville asks, I will clear it through the proper channels and send it to the Crossroads Committee.

I think it would be appropriate also for you to refer them to your report LAMS-447 and to LA report #616. These documents should be available to the Crossroads Committee as I understand they have access to the Manhattan District files.

WL/ars

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Wright Langham

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Form 25

COPY

This document contains / Page #373 of 373 pages

INTER-OFFICE MEMORANDUM

DATE January 31st, 1947

TO: Wright Langham

FROM: G. A. Linenberger

SUBJECT: Neutron results from Crossroads measurements

~~SECRET~~ UNCLASSIFIED

Uncl

I am returning herein your letter from H. Scoville and will take up in order the questions raised by him. Concerning the neutrons in the physiologically interesting region from between ca. 1/10 and 2 Mev., reference should be made to my Crossroads Technical Instrumentation Report--Project No. VII-2 (Los Alamos reference notation is LAMS-447), in which the number of neutrons having energies greater than 3 Mev. is given for 4π solid angle as a function of distance. If this curve (taking proper account of distance squared factors) is compared with the phosphorous activity curve sent you by Scoville, I think a few qualitative considerations will indicate that the slope of the latter curve may be considered the upper limit for the slope of the number-distance curve for any neutrons of intermediate energies. Also, the number of these neutrons will not be less for a given distance than the number indicated by the phosphorous curve. The reasoning briefly runs as follows. Assume for the moment no capture by nitrogen and oxygen in the air. The scattering mean-free-path of those neutrons for which phosphorous is of any value as a detector (i.e., slow to thermal region) is sufficiently short as to require that they be "born" of higher energy neutrons at or near the point of capture by phosphorous; i.e., they do not emerge from the bomb with these energies. The "parents" of the "phosphorous neutrons" may then in a sense be considered as all those neutrons which the sulphur does not see; and, were it not for capture, they would be equal in number to the parent neutrons. That the slope of the distribution curve for neutrons of any intermediate energy will be less than that of the phosphorous curve, is based on two considerations; (a) the usually reliable assumption that the scattering cross section will decrease with increasing energies; and (b) the fact that the slowing down distance increases with increasing energy. Applying (a) and (b) in reverse will serve to make plausible that at the same time the slope of the sulphur curve will be a lower limit for the slope of the number-distance curve for neutrons of an intermediate energy. Here, however, no comparison can be made concerning the actual numbers of neutrons. In fact, it is reasonable to expect that due to general degradation more neutrons emerge with energies less than 3 Mev. than with energies greater than this.

It is by no means a simple matter to make any sort of quantitative analysis of the energy spectrum of neutrons from the bomb; however, I am appending a memorandum by Holloway which may shed some light on the matter.

The cross section for absorption of slow neutrons by phosphorous used by Scoville agrees with the generally accepted value of that quantity for thermal neutrons, and hence known about the variation of this cross section with energy so that I am at a loss to know what to suggest as a better value. On the other hand, the cross section for the $S^{32}(n,p)P^{32}$ reaction may be regarded as a step function rising very steeply at 3 Mev. to a constant value of about 0.4 barns (See Klema, Los Alamos report LA-515).

As for the absorption of slow neutrons by steel, the thermal absorption cross section of Fe is about 2.5 barns; so that the capture mean-free-path or e-folding distance comes to 2.6 cm.

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CAL;bjd

G. A. LINENBERGER

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Form 25

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SPECTRUM OF NEUTRONS FROM EXPLOSIONS

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SECRET

M.G. Holloway

29 January 1947

Unc

I understand there is some question as to whether the spectrum of neutrons is a smooth function or has peaks and holes in it. I believe some light can be shed on this point, but anything further is a project of some magnitude. The fission neutrons spectrum is a smooth function of energy having a maximum at about 1.8 Mev and extending, with small ordinate, up to 11 Mev. Collisions of the neutrons with matter after the explosion will decrease the average energy of the neutrons.

If there should be a strong resonance scattering or absorption in the air atoms, then the spectrum need not necessarily remain a smooth function. In oxygen there are several resonances in the scattering cross-section; at about 3.8 Mev (3 barns over a background of 1 barn), at 0.9 Mev (5 barns over a background of 2 barns) and a rapidly rising cross-section towards low energies (about 6 barns at 0.4 Mev). The presence of a scattering resonance which has a cross-section say twice that on either side of the resonance leads to the condition that there are fewer neutrons existing at the energy of the resonance, since neutrons are scattered out of that energy region twice as fast as they are scattered into it. Thus, one would expect a "hole" in the spectrum at the energy of the resonance. However, one should not expect any sharp holes, since the resonances are fairly broad and the energy lost per collision is not a definite fraction but depends upon the angle of collision. In nitrogen there are absorption resonances at 1.45 Mev (0.085 barns over background of 0.01 barn), at 0.7 Mev (0.12 barn over 0.01 barn) and at 0.55 Mev (0.06 barn over 0.005 barn. These absorption resonances are not strong enough to appreciably change the spectrum, since only 1/10 of the neutrons see these resonances; the average scattering cross-section is about 10 times greater than the resonance cross-section.

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In conlusion, I see no reason for the spectrum of neutrons to be very irregular. The information on scattering and absorpiton cross-section was obtained from LA-140 and LA-140A.

MGH:MK

M. G. Holloway

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