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Metallurgical Laboratory

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A. H. Compton, Project Director

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PROJECT COUNCIL - INFORMATION MEETING (HEALTH)

2/20/45

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Present: Stone, Watson, Hamilton, White, Sinclair, Nickson, Cole, Boyd, Dempster, Franck, Watson, Jesse, Shonka, Abersold, Greninger, Moon, Curtis, Morgan, Warren, Stearns, Hempleman, Whitaker, T. Jones, Mc Kinley, Foote, Brugmann, Simmons, Chapin, Seitz.

Stone: calls on K.S. Cole: (Biology section, Chicago)

Tracer studies on rats have been done with ruthenium tetroxide as vapor and with yttrium chloride as dried spray to furnish a basis for inhalation hazard of fission products. Ruthenium is more slowly absorbed than is iodine. Fifty per cent is absorbed in one day, seventy five per cent in ten days. At fifteen days the amount in the liver is 3% of the activity deposited in the lung. Yttrium is fifty per cent absorbed in 12 hours and 99% in 60 days. The one per cent which remains is still present after 100 days. The skeletal amounts remain constant from 20 to 100 days. Twenty per cent is found there.

Yttrium chloride has been given to rats by stomach tube to determine the hazard of fission product beta emitters which are not absorbed. The radiation intensity in the wall of the small intestine was calculated as five roentgens per hour. Four hours after the administration of 0.4 microcuries per gram, a rat was quick-frozen and was cut into one centimeter slices. Radio autographs were made. The radiation intensity was found to be from 3 to 5 roentgens per hour. The effective transit through the small intestine was 1 to 2 hours. Hence, the total dose to the small intestine was five to ten roentgens. The fifty per cent lethal dose for thirty days is 20 microcuries per gram. This corresponds to 250 to 500 roentgens delivered to the small intestine. Animals given one microcurie per gram per day with a dose to the small intestine of 12 to 25 roentgens per day have shown no weight response or evidence of gastro-intestinal bleeding after 28 days.

Peripheral blood data on the rat have been obtained up to 116 days after the injection of strontium 89 as the chloride. The levels used were 0.25, 0.62, 2.5 microcuries per gram. The data are corrected for variability introduced by uncontrolled factors common to experimental and control groups. No effect was found on the red cells or hemoglobin. At all levels, the lymphocytes and neutrophils showed a minimum value 4 days after injection. Recovery was only partial at 116 days. The lymphocytes had recovered less than had the neutrophils.

Lung damage has not as yet been produced by inhaled alpha activity. Before using large amounts of product in such studies it is desirable to determine

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the level which will produce damage by the introduction of solutions into the lungs as used in the tracer experiment by Hamilton. Plus 4 and plus 6 product citrates are rapidly absorbed. Twenty per cent is deposited in the skeleton and liver in 50 hours. The plus 6 nitrate is absorbed more slowly and the plus 4 nitrate absorbed still more slowly. Only one per cent is in the skeleton and liver after 5 days.

Injection studies with plus 6 product nitrate in rats and mice show a fifty per cent lethal dose at 30 days on intravenous injection with 0.5 to 1.0 micrograms per gram body weight. The mouse livers show a gross effect. Erythropoiesis is eliminated temporarily in the spleen after subcutaneous administration. The 50% thirty day lethal dose is approximately 4.5 micrograms per gram of body weight in the mouse. For injection into the muscle a similar lethal dose is above 4.5 micrograms per gram. With this latter injection the material follows the fascial planes. The inflammatory reaction is very unusual in that it never gets beyond the normal 24 hour stage. This is true even after 44 days. The thigh becomes fixed, hair is lost near the injection site, and ulcerations appear which may extend to the bone.

Animal studies with radium are continuing to provide a link between the animal product studies and human radium cases. Rats are about two times as sensitive to radium as to product on a weight basis for thiry days survival. Mice are about the same at thirty days but are two to five times more sensitive to radium at 100 days depending upon the mouse strain used.

Dempster: Does the strontium act as a chemical poison?

Cole: No. Controls are given weight for weight the same amount of strontium with no effect noted.

W.W. Watson: Beta dust inhalation hazard: is it possible to state a tolerance in air?

Cole: It is easier to state that the tolerance for beta activity in the lungs is 100 mr/day. On this basis it is possible to calculate back knowing the specific fission product and the energy of the beta particle involved. It should be noted that the tolerance in roentgens differs for alpha particles, beta particles, x-rays and neutrons.

Abersold: Dose in roentgens to get alpha damage?

Stone: Depends on the criteria one used. Long term damage most interesting. It has been tentatively assumed that 0.01 r per day will produce damage.

Abersold: Necessity for doing experiments producing acute damage?

Stone: Produce damage in short period of time. Can perhaps extrapolate levels used to give an indication of the amount necessary to produce chronic damage.

Curtis: (Clinton biology)

Beta skin damage work continues. Histology has recently been studied. The damage was produced by a $P^{32}$ placque to white skin of the rabbit



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was exposed. Normal rabbit skin is approximately 75 to 175 micra thick. Dose of $P^{32}$ beta particles has a half thickness value of 0.78 millimeters. After the treatment, epilation appears in 20 to 30 days followed by ulceration, secondarily by healing. The healing occurs from the edges of the wound. The bed of the ulcer is not capable of nourishing normal skin at first. For this reason the healing time is prolonged. Many of the hair follicles are killed. Some of the deeper hair follicles are not killed, but the cells which used to form hair lose that power. This leaves islands of epithelial tissue which may play a role in the healing.

Animals have been exposed to total body beta radiation, 500 r per day for 90 days. This is a total of 35,000 roentgens. Animals are living and well. The hair is largely gone. There is a marked difference in the beta ray response and x-ray response to divided doses over long periods of time. This suggests a good recovery rate from beta ray damage.

Abersold: 500 r inplies depth dose measurement; does the hair influence this measurement

Curtis: A 4% difference is noted which is attributed to the hair. The above animals have shown no change whatsoever in the blood constituents. This is true even in the animals which have died from the chronic experiments.

J.G. Hamilton for Berkeley:

Radioautographs of bone taken from animals 256 days after intramuscular injection of product show that the majority of the material is next the endostium and within the bone marrow itself. Similar radioautographs have been obtained following intravenous injection of this material.

Smoke studies have continued. More recently the soluble forms of product have been investigated. It is felt that this problem may be analyagous to the exposures which some chemists may receive. Mr. Scott has developed a machine for exposing rats to fine spray. Its overall efficiency is approximately 5%. The instrument works on the principle of a seltzer bottle.

$PuO_2(NO_3)_2$ Spray

| | 0 d | 1 d | 4 d |
|---|---|---|---|
| Lungs | 53% | 43% | 29% |
| Liver | 0.34% | 1.1% | 0.91% |
| Head | 39% | <5% | < 2% |
| Skeleton | 1.5% | 9.6% | 12% |
| Urine | ---- | 1.1% | 1.7% |
| Feces | ---- | 30% | 53% |

It has been found that the fixing capacity of the soils for fission product is a function of the amount of clay present.

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J.J. Nickson: (Medical hazards, Chicago)

4215 pocket meter readings were taken during the month. 1.1% of these were above 100 mr for one day. 0.9% were valid readings .1521 pocket badge surveys were made. 0.4 of these were above 0.6 r for one week. In four instances the darkening beneath the shield was greater than the darkening beneath the window. All of these were from Argonne personnel. The evidence points to exposure of the film to slow neutrons. In two of the four instances a history of working in a beam of slow neutrons was obtained.

Routine surveys for alpha, beta and gamma activity in the various buildings of the laboratory continue. Of interest is the finding of a towel, freshly laundered, in the Ryerson shop. This towel gave a reading of 5 mr/hr. As a result of this finding steps are being taken to establish a separate laundry service for this shop to avoid the question of the contamination of instruments being built. On February 14th a fire occurred in Site B caused by spontaneous combustion of tuballoy shavings. The individuals who put out the fire are being followed by Dr. Schwartz to determine the existence of possible biochemical change due to the exposure to tuballoy fumes. Surveys of the Armory reveal that waste paper or other materials contaminated with active material may be sent to waste paper dealers. A cork with 2 r per hour was found in such rubbish.

Urine analysis for product continues. 197 analyses were done on 97 specimens. In no instance was a count of greater than 2 per minute obtained. This indicates less than $3 \times 10^{-13}$ grams of product per c.c. of urine.

The monthly report includes a detailed discussion of a technique for analyzing mouse tissue for product content.

J.E. Rose for Health-Physics, Chicago

Recent studies on wave length dependence of the Landsverk-Wollan aluminum pocket meter indicate that the readings are too high by a factor of 4 when exposed to 50 to 70 kilovolt x-rays. If a bakelite shell and a bakelite holder for the quartz system is substituted for some of the aluminum, the readings are too high by a factor of 2 for similar x-rays. If the wire support for the quartz system is coated by graphite the chamber becomes almost linear in its response, only a ten per cent effect being noted.

So it would appear that the best solution at the present time for a portable pocket electroscope would be to make it with a thin aluminum barrel lined with bakelite or conducting plastic, the quartz fiber system to be supported by a graphitized wire. It is felt that such a system would give readings which are linear to within 25%.

Abersold: Graphite sufficient to stop beta rays?

Rose: Yes, the contribution from the gold is negligible.

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Jesse: Anything one can do to avoid the use of aquadag? Is it possible to use an aluminum wire?

Rose: It would be difficult to attach the fiber to aluminum.

Jesse: Yes.

Morgan: (Clinton, Health-Physics)

Have recently used $P^{32}$ impregnated bakelite placque to calibrate the pocket badge films. It was found that the film is three times as sensitive to beta rays of the energy of the $P^{32}$ as they are to radium gammas.

The laundry has recently been using citrate as a decontaminating agent. It has been found to be more satisfactory than acetic acid. A 90% alpha, beta and gamma decontamination can be obtained with the former acid which is much higher than any decontamination obtained with the latter acid.

It was recently discovered that unclad bismuth bricks have been placed in the Clinton pile. Recently some of these were removed. Readings of 65 mr/hr could be obtained from the surface. This was largely beta activity. Air sampling indicated alpha activities of 10 times tolerance in air. It is felt that the alphas are from polonium. A cursory review of the literature does not indicate that one is justified in assuming the biological half-life is of a different order of magnitude than is the biological half-life of product. Consequently it would appear that polonium has approximately the same order of toxicity as product.

Epithermal neutrons cannot be satisfactorily measured at the present time. Investigation is under way to determine a satisfactory means of measuring the energy levels of these neutrons. Borst has recently suggested that means of energy exchange other than ionization may exist in the body. Among the possibilities are hydrogen recoils and molecular disturbances. An attempt will shortly be made to measure such phenomena. Heavy and light mesotrons have, it is felt, been detected from the Clinton pile with the use of triple coincidence counters shielded by one foot of lead. No geotropism has been noted. It is felt that the mesotrons have energies greater than 10 MEV.

The neutrino hazard does not seem to be great in the Clinton pile. It is noted that 10% of the pile energy is dissipated as neutrinos.

The sky shine was recently measured with an approximately 500 curie source. The Borst-Wheeler theory was not approximated. There is some evidence that multiple scattering is present.

The 200 area clean up has progressed very satisfactorily. Activities

of greater than a thousand roentgens per hour have been decontaminated to approximately 12.5 mr/hr.

Whitaker: 12.5 mr/hr predominantly beta or gamma?

Morgan: The ratio varies. It is usually approximately 50-50.

Shonka: What means was used to detect neutrinos?

Morgan: If the cross section for hydrogen is approximately 1 x $10^{-29}$ centimeters squared, the neutrinos may be a biological hazard. Double ionization chambers at high pressures should detect ionization due to neutrinos even if the hydrogen cross section were a factor of 100 less than the above figure. No readings with the above instruments have been obtained.

Hamilton: Possible excelleration effect without ionization?

Morgan: Yes.

Stone: Clinical program at Clinton will not be reported this month. Dr. Wirth was not able to come to the meeting this time.

C.J. Watson (Clinical section, Chicago):

From Jan. 1 to Feb. 16, 1945, 1379 persons were examined by the blood laboratory. For the first time what may be a significant difference in the numbers of abnormalities in the work hazard and non-exposed groups is noted.

| | No. of persons | No. abnormal | Percentage |
|---|---|---|---|
| Control | 483 | 126 | 26 |
| Hazard | 896 | 354 | 39 |

The abnormalities are of four types:

a) WBC 5000
b) Reversal of Lymphocyte: Neutrophil ratio
c) Presence of immature WBC
d) Total of 1500 lymphocytes

Future studies should help in the determination of the significance of the above difference.

The urine analysis for tuballoy content on Ames personnel has recently been done. The following table summarizes the results: The evaluation of the supervisors as to the exposure of the personnel has been accepted.

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Urine T excretion in gamma per liter

| Group | No. of persons | Exposure designation | Range | Average |
|---|---|---|---|---|
| I | 10 | controls | <2-7 | <2 |
| II | 6 | light | 5-27 | 14 |
| III | 18 | moderate | 10-130 | 47 |
| IV | 7 | heavy | 40-200 | 90 |
| V | 10 | variable (Chemists) | 7-55 | 29 |

It would seem that there is some correlation between exposure to tuballoy and tuballoy excretion. At the present time a correlation between excretion and the existence of damage cannot be made. The rate of excretion of tuballoy after cessation of exposure will be studied in the near future.

W.W. Watson: Is inhalation or absorption the source of contamination in the above studies?

C.J. Watson: Probably inhalation. Absorption in animal experimentation has been shown to be an unlikely route by which tuballoy will get into the body.

Whitaker: 896 persons in work hazard might possibly be regrouped so as to include only individuals with high exposure.

C.J. Watson: Yes, Dr. Jacobson is at present so regrouping.

R.S. Stone: The blood examinations may prove to be of group value but of little value as an individual test. That is to say, the test may show when given type of work is producing damage, but may yet not indicate in any given instance the probability with which damage has occurred.

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