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ARMY SERVICE FORCES
UNITED STATES ENGINEER OFFICE
MANHATTAN DISTRICT
OAK RIDGE, TENNESSEE

IN REPLY REFER TO

EIDMM-e
MD 729.3 (radiation)

1 September 1944

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Subject: Radiation Hazards.

MEMORANDUM to: Colonel K. D. Nichols.

1. Reference is made to a memorandum on radioactive hazards at Hanford, from Roger Williams, dated 26 June 1944.

2. "Product" may be considered to be a potential hazard, but it is doubtful whether the term "superpoisonous" accurately reflects the noxious character of the product. It should be pointed out that five micrograms of the product should not be considered as a lethal dose. Rather, the figures which are available from calculations by Allison, Friedell, and Hamilton indicate that this is the tolerance dose. Parker has calculated the dose to be 0.6 microgram on the basis that 0.01 r per 8 hours is considered to be tolerance. If we modify this to 0.1 r, the standard tolerance unit, in order to make it comparable with the other calculations, Parker's tolerance estimate becomes 6 micrograms.

3. "Product's" radioactive energy is almost entirely restricted to alpha radiation. In addition, the product emanates no radioactive gas as in the case of radium, and gives off no gamma rays to be a hazard as an external source of radiation. By comparing the rates of disintegration and the available energy of product and radium, it can be demonstrated that for equal masses, radium is potentially fifty times more dangerous than the product. Thus, it is reasonable to expect that the product is 1/50 as effective biologically as radium in direct contact with vital tissues inside the body. Furthermore, product is very poorly absorbed from the gastro-intestinal tract (less than 1%). Absorption from the lungs, however, is known to be higher and may reach 25%. It is true that we do not know exactly the amounts of product which will be lethal, but by these calculations alone, it is certainly in the range of several thousands of micrograms stored in the body of the individual (lethal dose for radium 10 - 100 micrograms).

4. In considering the tolerances which have been previously established for other radioactive substances, certain data which have been accumulated recently seem pertinent for orientation. On the 14th and 15th of June, a survey was made of the personnel and the operating conditions of a radium refinery. Excerpts of this report follow:

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Survey of Gamma Ray Intensities

		r per 8 hrs.	Times Tolerance
	Roasting Room		
1.	At bench, 20 ft. from ore	0.03	
2.	Near girl shoveling wet ore	0.09	
3.	Passage at end of roaster, 2-1/2 ft. from ore	0.4	4
4.	3-1/2 ft. from above ore	0.32	3.2
5.	At screening table	0.12	
	Radium Plant		
1.	Chloride section, chloride thickener 3-1/2 ft. above level of liquid	0.01	
2.	Chloride section, in midst of 7 cooking tanks	0.05	
3.	Caustic leaching section, passageway among drums of caustic precipitate	0.4	4
4.	Passageway between drums of carbonate leach	0.28	
5.	2 ft. from surface of carbonate leach	0.34	3.4
6.	Radium, barium sulfate concentration. Center of aisle near two filter tanks, 3 ft. from material	0.13	
7.	1 ft. above concentration tank	0.6	6
8.	Radium, barium carbonate platform, operator's position 2-1/2 ft. from tank	0.23	
9.	1-1/2 ft. from above tank	0.45	4.5
10.	2nd floor, filtration carbonate leaching, center of passageway 10 ft. wide, drums and wooden boxes on one side	0.1	
11.	Between wooden boxes and drums in above location	0.12	
12.	Area of 2nd sodium carbonation, passageway, middle of floor, drums and vats 2 ft. distant on each side	0.32	
13.	Radium, barium sulfate precipitators, passageway 3 ft. from liquid	0.23	
14.	Ground floor, radium, barium sulfate collector, passageway 4 ft. from collecting tanks	0.32	3.2
15.	2-1/2 ft. from above tank, shoulder-height in passageway	0.4	4
16.	Waste liquor tanks from radium plant, ground floor	0.17	
	Radium Laboratory		
1.	Waste level, 4 ft. from vats, dissolving radium barium carbonate in hydrobromic acid	0.64	6.4
2.	Center of passage, 6 or 8 ft. from vat and 4 ft. from 1st evaporator (head liquor)	0.8	8
3.	1 ft. from HBr vat	0.64	6.4
4.	On fractionating table, 2 ft. from liquid	0.66	6.6
5.	Between 2 sets of evaporators	0.16	
6.	1-1/2 ft. from #3 second set evaporator	0.12	
7.	1-1/2 ft. from #6 second set evaporator	0.14	

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	Radium Laboratory (Contd.)	r per 8 hrs.	Times Tolerance
8.	Cooling room, center of passageway 6 ft. from flasks of material	0.23	
9.	Cooling room, 1-1/2 ft. from 7 flasks heated and presumably de-emanated 6 hrs. ago	1.28	12.8
10.	Cooling room, passageway on far end 6 ft. from 3 grams of radium in 7 small beakers which have just been heated	0.26	
11.	Locker in changing room of radium laboratory	0.12	
	Final Fractionating & Intubation Laboratory		
1.	Table with incubators and funnels for filtration	0.32	
2.	Above lead shield and 3 to 3-1/2 ft. from radium ready for tubing	2.0	20
3.	Behind lead shield at usual working distance	1.6	16
4.	4 ft. in front of radium-containing safe door, lead door closed	3.2	32
5.	Laboratory office	0.2	
6.	At door of safe, source in hood, removed, safe door shut	2.0	20
7.	In front of hood at usual working distance, after removing known radium from hood	1.2	12

Survey of Radon Concentration in Plant Air

	Location	Micromicrocuries per liter air	
1.	Ore grinding room, 8 ft. from hopper leading into crusher, and over ore barrels	184	
2.	Roasting room, at corner of roasting furnace near conveyor	38	
3.	General ore storage room, a large amount of ore present	76	
4.	2nd floor, near filtering of carbonating leach	336	3.3
5.	3rd floor, midway between two filter tanks for radium, barium sulfate concentration and radium, barium carbonate platform	444	4.4
6.	3rd floor, filter platform 3 ft. from filling side, acid leach insoluble filter	413	
7.	4th floor, leaching room, beside one platform where ore and acid are mixed with sodium nitrate	867	8.67
8.	4th floor leaching room, beside 2nd mixing platform, more ore stored at this end of room	918	9.1
9.	Ground floor, center of main work area	100	
10.	Radium laboratory, site of dissolving radium, barium carbonate in hydrobromic acid	1076	10.7
11.	Resting, locker and lunch room of radium laboratory	157	
12.	Center of small fractionating and intubation laboratory	1666	16.6

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Breath Sample Reports

Name	Radon micromicrocuries/liter	Micrograms radium indicated in body	Times Tolerance
M. L. P.	13.0	1.3	13
L. S.	21.0	2.1	21
C. E. W.	32.0	3.2	32
W. C.	29.0	2.9	29
L. F.	4.2	0.42	4

5. A review of these figures indicates that the daily tolerance (established at 0.1 r per 8 hr. day for gamma radiation, 100 micromicrograms of radon per liter of air, and 0.1 micrograms of radium in the body) has been exceeded many times. Concomitant physical examinations of personnel employed in the radium refinery have indicated that only one individual has suffered a minor biological disturbance, and this after 30 years of exposure. This report should be considered preliminary, however, since long periods of time have not elapsed in order to demonstrate minor changes satisfactorily. It is doubtful that any such excessive exposure will occur at Hanford under the present design and arrangements.

6. There are many occupations which involve greater hazard than working with "product", such as the preparation of rabies vaccine, plague cultures and vaccine, etc., where just a few virus bodies or bacteria could cause death. The manufacture of explosives, tetra-ethyl lead and many other manufacturing procedures are fraught with constant dangers which are more certain to cause death in a certain percentage of workers than the procedures involving the manufacture of our product.

7. It is likely that the present investigations for extracting and concentrating the product will result in a procedure for processing the material in a closed system which will practically eliminate most of these dangers to personnel. A properly designed extraction and handling procedure, the technical training of the personnel, proper masks, constant instrument-monitoring and supervision by the contractor's health group, and regular inspection by the District's Medical Section are all intended to eliminate the hazard. Periodic health examinations are designed to screen out those who have had excessive exposure before they are damaged.

8. Dr. Stone of the Metallurgical health group has been made aware of the data included above and other similar information. From review of the various data which are constantly being made available to the Medical Section of the Manhattan District, it is evident that the tolerance standards of various radioactive materials should be re-examined. It is not unlikely that the tolerance values could be modified upward in certain respects. A series of discussions will take place shortly in order to re-survey the situation in light of the urgency of the problems set forth in Mr. Williams' memorandum.

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Stafford L. Warren

STAFFORD L. WARREN,
Colonel, Medical Corps,
Chief, Medical Section.

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