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NAVAL RADIOLOGICAL DEFENSE LABORATORY

SAN FRANCISCO NAVAL SHIPYARD
SAN FRANCISCO, 24, CALIFORNIA

1 March 1949.

NR-RBS-2

MEMORANDUM

From: Health Physics
To: Scientific Director

Subj: Evaluation of Possible Radioactive Hazard from Control Knobs and Phone Caps on Type CCT 46217-A Radio Receiver and Power Amplifier.

INTRODUCTION

The comparatively high beta-gamma activity from subject receiver and power amplifier were brought to the attention of the laboratory by Mr. C. J. Camp. One unit each of the receiver and power amplifier were furnished for evaluation. The receiver control knobs contained grooved designator letters inlaid with self-luminous radium compound. The power amplifier has two phone jack caps with surface painted radium compound. Neither the control knobs nor caps have any apparent form of protective covering over the radium paint. Since these controls are manipulated with bare hands, it seemed desirable to determine the alpha, beta and gamma radiation intensity at contact distances, and in addition, the amount of activity that might be picked up by the fingers when the exposed surface of the radium paint is touched or rubbed.

DESCRIPTION OF EQUIPMENT TESTED.

The radio receiver was a type CCT 46217-A, a unit of model RBS-2 equipment.

Four control knobs on this receiver contained radium painted position markers and letter designators as follows: 1) Frequency Band Control, "B". 2) Tuning Control, "T". 3) Gain Control, "G", 4) Output Level Control, "L".

The rectifier power amplifier was also a unit of RBS-2 equipment. It contained two phone jack cover caps, each with a designation of "HP" in radium paint. This unit also contained one toggle switch with a small radium paint pill imbedded in the handle and sealed over with a plastic cap. This switch showed only 0.4 mr/hr gamma, 20 mr/hr beta plus gamma and no alpha activity when tested at contact distance. There appears to be no possible hazard from a single unit of this type.

BETA AND GAMMA RADIATION

A standard model 263 survey meter was considered satisfactory for an approximate indication of the beta and gamma radiation and the total amount of radium salts present in the radium paint compound on these control knobs.

The tolerance value for total or limited body exposure is 100 mr per day gamma and 100 mrep. per day beta. It was immediately shown that no flux of gamma or beta radiation of sufficient extent to produce total body exposure of this magnitude could be obtained from the radium paint present on either the receiver or amplifier.

In view of the above finding, attention was next turned to the limited exposure that would be received by direct hand contact with these knobs. This data is shown in Table I. A recently calibrated type 263 survey meter was used for these measurements. Columns 1 and 3 show the gamma readings at contact and at a distance of one inch. Button B, showing the highest gamma activity, would require about 45 hours of continuous contact to result in 100 mr of limited exposure.

Columns 2 and 4 show beta plus gamma reading at contact and at one inch. Button "B" would give limited exposure tolerance for beta plus gamma in about 4 hours and the rest in 6 or 7 hours. Column 5 shows the calculated contact beta activity including all energies and is based on the measured gamma activity.

Using the data of column 5, the situation is more severe. Limited localized beta tolerance would be obtained with button "B" in less than 20 minutes of contact, for "T" in about 40 minutes and for the other controls in slightly over an hour.

Column 6 shows the calculated total radium salts on each control in μ gms of radium.

It should be noted that the beta rays for radium salts form a complex continuous spectrum with the most energetic beta from radium C having an energy 3.13 Mev and a range 1.54 gms/cm^2, or 12.8 meters of air.

SURFACE ALPHA ACTIVITY

The surface alpha activity was determined by direct measurement with an argon CO_2 multiple wire chamber.

In the normal disintegration of radium it should be noted that radium, radon, radium A and radium C each emit alpha rays. The alpha radioactivity of radium in equilibrium with its decay products is, therefore, four times as great as the alpha activity of radium alone which is 2.22 X 10^6 alpha disintegrations per minute per microgram of radium.

In view of the customary hand contact with these controls, it seemed of value to determine the total exposed surface alpha activity. This was accomplished by direct reading of the knobs and caps with the argon CO_2 multiple wire chamber. In Table II the surface alpha activity of all radium components and of radium alone is tabulated. The last column in this table shows the amount of exposed radium in μ gms calculated from the measured surface alpha activity.

In BuMed circular letter #48-10 covering radiological safety, it is implied that safety regulations for the alpha emitter Plutonium apply to all long lived materials presenting a similar hazard. Radium with its 1600 year half life would fall into this category. If this assumption is correct, then an exposed surface, subject to handling should not contain alpha activity exceeding 2,000 d/m per 150 sq. cm. of area. This would amount to about 13 d/m for 1 sq. cm. of exposed surface. From Table II it can be seen that this value is exceeded by 100 times in the lowest case and 6,000 times in the highest case. The surface area of the exposed radium is approximately 1 sq. cm.

SMEAR TESTS.

In order to determine whether or not active material would actually be recovered by direct contact or rubbing of the surface, smear tests were made. Filter papers were wiped over the surface of the knobs and then read for alpha activity. Again, if we can apply the radiological safety hand book standard of zero d/m for filter paper smears Table III shows the tolerance to be exceeded by 100 to 9000 disintegrations.

Finally, actual finger wipes were made and the activity remaining on the finger read with the alpha counter chamber. The alpha count for all radium components of the finger wipe is shown in Table III.

The radiological safety manual indicates alpha hand tolerance as zero disintegrations per minute. This tolerance is exceeded by 60 to 7000 disintegrations.

The comparative large activities that are removed by hand contact would present a more serious condition in the event of abrasions or open wounds of the hand or finger.

R. K. SKOW.

TABLE I

BETA AND GAMMA RADIATION

KNOB OR CAP	CONTACT READING		1.0 INCH DISTANCE		CONTACT	Calc. Total Radium on Knob or Cap (μgs)
	GAMMA mr/hr	BETA-GAMMA mr/hr	GAMMA mr/hr	BETA-GAMMA mr/hr	CALC. BETA mrep/hr.	
B	2.8	56	1.0	20	280	2.3
T	1.4	28	0.55	11	140	1.2
G	0.9	18	0.6	12	90	0.7
L	0.75	15	0.45	9	75	0,6
PH(1)	0.75	17	0.5	10	75	0.6
PH (2)	0.75	18	0.55	11	75	0.6

TABLE II

DIRECT MEASUREMENT OF SURFACE ALPHA ACTIVITY.

KNOB OR CAP	ALL COMPONENTS ALPHA d/m	RADIUM ONLY ALPHA d/m	CALC. SURFACE RADIUM μgms
B	163,000	41,000	.018
T	26,600	6,660	0.003
G	20,500	5,100	.002
L	11,000	2,700	0.001
PH(1)	242,000	60,500	.027
PH(2)	218,000	80,000	0.036

TABLE III

SMEAR TESTS

KNOB OR CAPT	NO. OF TEST	FILTER PAPER WIPE ALL COMPONETS ALPHA d/m	FINGER WIPE ALL COMPONETS ALPHA d/m	REMARKS
B	1	1700	1500	
	1	2100	1300	
T	1	400	800	
	2	2000	560	
	3	3076	---	
G	1	300	110	
	2	400	200	
G *	1	9200	7000	* Well worn used knob from same type receiver.
L	1	100	63	
$HP_{(1)}$	1	1400	1190	
	2	2100	762	
$HP_{(2)}$	1	970	970	
	2	2000	840	