less, according to the adjustment of the levers. By using other sizes of syringes in a similar way other orders of volume changes may be recorded.

Radiation From a Flask Containing Various Amounts of Radioactive Phosphorus[1]

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The handling of radioactive phosphorus becomes a radiation hazard if not properly executed.

One must consider beta particles from radioactive phosphorus as a potential hazard. These beta particles produce ionization directly and thus directly injure tissues. The most energetic of these particles penetrate tissue to a depth of 8 mm (*2, 5*), and during this passage each expends 2.7×10^{-6} ergs of energy (*3*). If one were to receive as whole-body radiation the permissible daily dose of 0.1 r for an 8-hr day (*1, 4*), the dosage rate per hour would be 12.5 mr (0.0125 r/hr). The dose of radiation for multiple exposures that can be tolerated by the fingers has not definitely been determined; therefore, it is being assumed that a dosage rate of 12.5 mr/hr is a permissible amount. Under these conditions, if one were to receive this permissible dose on his hands, each square centimeter of area will have been struck by 4×10^5 beta particles. This fact must be taken into consideration when handling an ordinary Erlenmeyer flask containing a solution of radioactive phosphorus.

To substantiate the existence of this radiation hazard, measurements were taken of the radiation emitted from a 125-cc Erlenmeyer flask containing 100 cc of distilled water to which various amounts of P^{32} were added.

Readings were taken in mr/hr by means of a glass beta-gamma counter tube having a wall of 30 mg/cm^2 approximately 0.12 mm thick. The counter was placed at an angle of 45° with the liquid level and at a distance of 15.0 cm from the angle formed by the meniscus and the side of the flask.

It was found during this investigation that the wall thickness of several flasks was not the same and that variations in the amount of emerging radiation were as great as 30%. Also, as any one flask was rotated, the amount of emergent radiation varied, indicating uneven thickness of the glass in various areas.

Table 1 shows the amounts of P^{32} in millicuries that were added to the 100 cc of distilled water and the average mr/hr as measured at a distance of 15 cm. The values listed in the column headed "1.5 cm" were calculated by the inverse square law. Those given in the column headed "On flask" were obtained by extrapolation from a graph of mr/hr vs. distance.

[1] The radioactive phosphorus used in this investigation was supplied by Clinton Laboratory and obtained on allocation from the U. S. Atomic Energy Commission.

The work was supported in part by Office of Naval Research.

[2] The authors gratefully acknowledge the assistance of Kathryn H. Haley and Charles K. Spalding.

From Table 1 it is readily seen that a solution containing 1 mc (1,000 μc) of P^{32} is emitting 56 times the permissible amount per hour through the flask at zero

TABLE 1

RELATION BETWEEN VARIOUS CONCENTRATIONS OF P^{32} AND THE AVERAGE MR/HR AT SEVERAL DISTANCES

P^{32} (mc)	Average mr/hr at		
	15 cm	1.5 cm	On flask
0.5	2.2	284	450
1.0	3.6	475	700
1.5	5.3	703	1,100
2.0	7.0	925	1,500
2.5	9.2	1,210	1,900
3.0	11.0	1,450	2,300
3.5	12.8	1,690	2,700
4.0	14.3	1,880	2,920

distance. The allowable handling time for a flask under these conditions would be 8.5 min, since in this length of time one's hands would have received a daily dose.

Fig. 1 has been drawn from the data shown in Table 1 and may be used as a guide for determining the length

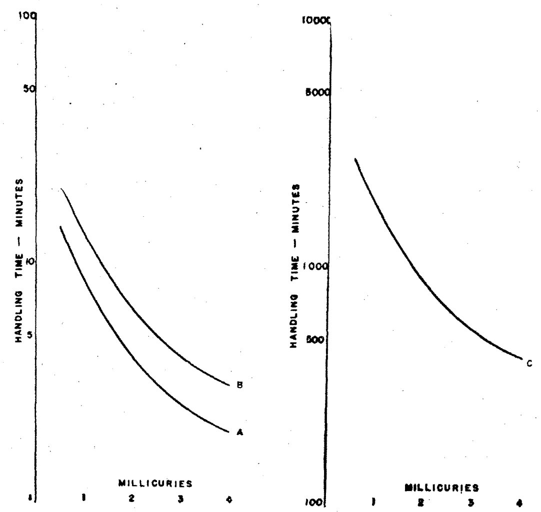

FIG. 1. Handling time for various concentrations of radioactive phosphorus. Curve A indicates the handling time when one grasps the flask barehanded. Curve B is to be used when the distance from hand to flask is only 1.5 cm. Curve C shows the handling time at a distance of 15 cm from hand to flask.

of time a flask of this type can be safely handled when it contains various concentrations of radioactive phosphorus.

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