Phosphorus-32 handling precautions

This document contains general information designed to provide a basic understanding of radiation safety. While we believe the information to be accurate, regulatory requirements may change and information contained herein is not tailored to individual needs. A radiation protection specialist should be consulted for specific applications.

Physical data

Maximum beta energy: 1.71 MeV (100%)[1]
Maximum range of beta in air: 6 m (20 ft)[2]
Maximum range of beta in water: 8 mm (0.3 in)[2]

Occupational limits[3]

Annual limit on intake: 600 µCi (22 MBq) for oral ingestion and 400 µCi (15 MBq) for inhalation
Derived air concentration: 2 x 10^{-7} µCi/ml (7.4 kBq/m^3)

Dosimetry

The high-energy beta emissions from ^{32}P can present a substantial skin and eye dose hazard. Multi 100-millicurie (multi 3.7 GBq) quantities of ^{32}P can produce significant secondary radiation, presenting a more penetrating external exposure hazard. Uptakes of phosphorus are assumed to be retained with a biological half-life of 0.5 days[4]. Of this phosphorus, 15% is rapidly excreted, 15% is retained in intracellular fluids with a biological half-life of 2 days; 40% is retained in soft tissue with a biological half-life of 19 days; and 30% retained permanently in mineral bone where ^{32}P is reduced by radioactive decay[4].

^{32}P

14.29 d

β^- 1.71

No γ

E 1.71

Decay table

Physical half-life: 14.29 days[1].

To use the decay table, find the number of days in the top and left hand columns of the chart, then find the corresponding decay factor. To obtain a precalibration number, divide by the decay factor. For a postcalibration number, multiply by the decay factor. Visit www.revvity.com to use our online Radioactive Decay Calculator.

Days	Days									
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
0	1.000	0.976	0.953	0.930	0.908	0.886	0.865	0.844	0.824	0.804
5	0.785	0.766	0.748	0.730	0.712	0.695	0.678	0.662	0.646	0.631
10	0.616	0.601	0.587	0.573	0.559	0.545	0.532	0.520	0.507	0.495
15	0.483	0.472	0.460	0.449	0.438	0.428	0.418	0.408	0.398	0.388
20	0.379	0.370	0.361	0.353	0.344	0.336	0.328	0.320	0.312	0.305
25	0.297	0.290	0.283	0.277	0.270	0.264	0.257	0.251	0.245	0.239
30	0.233	0.228	0.222	0.217	0.212	0.207	0.202	0.197	0.192	0.188
35	0.183	0.179	0.174	0.170	0.166	0.162	0.158	0.155	0.151	0.147
40	0.144	0.140	0.137	0.134	0.130	0.127	0.124	0.121	0.118	0.116
45	0.113	0.110	0.107	0.105	0.102	0.100	0.098	0.095	0.093	0.091
50	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.071
55	0.069	0.068	0.066	0.065	0.063	0.062	0.060	0.059	0.057	0.056
60	0.054	0.053	0.052	0.051	0.049	0.048	0.047	0.046	0.045	0.044

Revvity has developed the following suggestions for handling Phosphorus-32 after years of experience working with this high-energy beta emitter.

General handling precautions for Phosphorus-32

1. Designate area for handling ^{32}P and clearly label all containers.
2. Store ^{32}P behind lead shielding.
3. Wear extremity and whole body dosimeters while handling mCi (37 MBq) quantities.
4. Handle millicurie (37 MBq) quantities of ^{32}P behind 1-cm (0.375-in) thick Lucite® shielding. Where necessary, increase shielding by attaching 3-mm to 6-mm (0.125-in to 0.25-in) thick lead sheets to the outside of the Lucite® to reduce secondary radiation.
5. Do not work over open containers.
6. Practice routine operations to improve dexterity and speed before using ^{32}P.
7. Avoid skin exposure by using tools to indirectly handle unshielded sources and potentially contaminated vessels.
8. Prohibit eating, drinking, smoking and mouth pipetting in room where ^{32}P is handled.
9. Use transfer pipets, spill trays and absorbent coverings to confine contamination.
10. Handle potentially volatile chemical forms in ventilated enclosures.
11. If airborne activity is suspected, sample exhausted effluent and room air by continuously drawing a known volume through membrane filters.
12. Use lab coat, wrist guards and disposable gloves for secondary protection.
13. Regularly monitor and promptly decontaminate gloves and surfaces to maintain contamination and exposure control.
14. Use pancake or end-window Geiger-Mueller detectors, NaI(Tl) detector or liquid scintillation counter to detect ^{32}P.
15. Submit urine samples for bioassay from two hours to seven days after handling ^{32}P to indicate uptake by personnel.
16. Isolate waste in clearly labeled shielded containers and hold for decay.
17. Establish surface contamination, air concentration and urinalysis action levels below regulatory limits. Investigate and correct conditions that may cause these levels to be exceeded.

18. On completing an operation, secure all ^{32}P; remove protective clothing; dispose of protective coverings; monitor and decontaminate self and surfaces; wash hands and monitor them again.

The dose rate at the mouth of an open combi-vial containing 1 mCi (37 MBq) of ^{32}P in 1 ml of liquid is roughly 26 rem/hour (260 mSv/hour[5]. Since this dose rate will not be attenuated significantly by air, shielding materials should be placed between the source and personnel to absorb most of the radiation. The best shield for a ^{32}P source is a material like Lucite® 1-cm (0.375-in) thick, or other plastic that will absorb the beta particles while generating little secondary radiation. For millicurie (37 MBq) amounts of ^{32}P, thin, high-density shielding, such as lead 3-mm to 6-mm (0.125-in to 0.25-in) thick, should be added to the exterior of the Lucite® shield to absorb the more penetrating secondary radiation.

A high local dose can be received if the radioactive material is touched and allowed to remain on the skin or gloves. Both the hands and face can receive a considerable dose of radiation near an open container of ^{32}P, particularly if the radioactivity is in a concentrated form. Therefore, never work over an open container of ^{32}P.

References

1. Kocher, David C., Radioactive Decay Data Tables, Springfield: National Technical Information Service, 1981 DOE/TIC-11026.
2. Kaplan, Irving, Nuclear Physics, New York: Addison-Wesley, 1964.
3. U.S. Nuclear Regulatory Commission. 10 CFR 20 Appendix B – Standards for Protection Against Radiation, 1994.
4. ICRP Publication 30, Part 2, Limits for Intakes of Radionuclides by Workers. Pergamon Press, Oxford, 1979.
5. Measurements made using Landauer TLD 100 chips extremity badges.

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