# RADIATION SAFETY DATA - $^{32}$P

Phosphorous-32 is used extensively in life sciences research. It is easily detected and measured, available in a wide variety of radiochemicals, and relatively inexpensive.

## Physical Data

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| Decay mode | beta emission to $^{32}$S (stable) |
| Physical half-life | 14.3 days |
| Major emissions | beta minus, 1.71 MeV max, 0.695 MeV avg, 1/dis |
| Range in air | about 12 m |
| Range in tissue | 0.8 cm |

## Biological Data

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| Dose to live skin | 8.8 rem/hr per μCi/cm$^2$ on skin |
| Other doses | 200 rem/hr at 1 cm per mCi |
| | 800 rem/hr at contact with 1 mCi in 1 ml |
| | 1-10 rem/hr at top of vial containing |
| | 1 mCi in 1 ml |
| | 7.8 mrem/μCi ingested |
| | 3.7 mrem/μCi inhaled |
| Annual Limit on Intake | Ingestion - 600 μCi |
| | Inhalation - 900 μCi |

ICRP 30 shows that for most phosphorous intake into the body, about 15% is excreted with half-life of about 1/2 day; 15% goes to intracellular fluids with half-life of about two days, 40% goes to soft tissue with half-life of about 19 days, and 30% is retained in the bone permanently. Intake of 1 μCi, resulting in 0.33 μCi to bone, will produce a dose equivalent of ~9 mrem.

## Common Hazards - Precautions

Researchers accustomed to handling $^{3}$H, $^{14}$C and $^{35}$S often receive high body doses and higher hand doses when working with $^{32}$P. In contrast to the first three isotopes, which produce no external doses, $^{32}$P produces high radiation doses through walls of shipping vials, at distances from open containers, etc., and can cause appreciable x-ray secondary radiation (bremsstrahlung) from glass or metal**.** For instance, dose rates to hands holding a shipping vial or a syringe containing 1 mCi $^{32}$P in 1 ml liquid is several rem per hour if the container is plastic, and could be several tens of rem per hour if the container is glass or thin metal**.** Doses to body, eyes, etc., when working a batch of $^{32}$P on a bench or in a hood can easily be tens to hundreds of mrem/hr if shielding is not used.

Shielding is often misunderstood. Bremsstrahlung production increases rapidly as the atomic number (z number) of the target material increases. Hence, shielding for beta radiation should be lucite, paper or other low-z material. In contrast, shielding for x-rays and gamma rays should be of high-z material for most efficient absorption. For $^{32}P$ work body shields are often needed. Shields of 1/2" thick lucite will stop the $^{32}P$ betas, can be seen through, and are reasonably easy to move. Shielding containers for $^{32}P$ are best made of metal, since the radiation emitted is bremsstrahlung x-ray secondaries.

Distance is important, particularly when dealing with small volumes of high activity material. Generally, gloved hands should be kept at least four inches from the container. Pliers, forceps, tongs, or similar devices must be used for removing vial tops, etc. "Moving fast" is simply not adequate.

An operable survey meter must be present whenever working with more than a few μCi of $^{32}P$. Simple geiger counter-type survey instruments can easily detect quite small amounts of $^{32}P$. Typical efficiency for a pancake GM probe at ½" is ~25%. LSC efficiency is ~95%. Routine instrument surveys must be made to locate contamination so that it can be cleaned, and to locate unexpected radiation levels so that they can be shielded or marked to prevent unneeded personnel doses.

The Oregon State limit for $^{32}P$ release in a fume hood is $1 \times 10^{-9}$ μCi/ml ($2.83 \times 10^{-5}$ μCi/ft$^3$). A 3 foot fume hood drawing 100 linear feet/minute with the sash at 15'' draws 375 ft$^3$/minute. Use these figures to estimate volatile release when preparing Radiation Use Authorization applications.