

Occupational Safety & Environmental Health

Radiation Safety Service

1239 Kipke Drive 1010

[764-4420]

PHOSPHOROUS - 33

[P-33]

PHYSICAL DATA

Beta Energy: 249 keV (maximum)
85 keV (average)

Physical Half-Life: 25.4 days
Biological Half-Life: 1155.0 days
Effective Half-Life: 24.9 days

Maximum Beta Range in Air: 51.00 cm = 20 inches
Maximum Beta Range in Water / Tissue: 0.06 cm = 0.025 inches
Maximum Range in Plexiglas / Lucite / Plastic: 0.05 cm = 0.020 inches
Half-Value Layer (HVL): 0.008 cm (water / tissue)

NOTE: (1) A beta with an energy of 795 keV can penetrate to the lens of the eye (0.3 cm) depth.
(2) A beta particle with an energy of ≥ 70 keV is required to penetrate the dead layer of skin.
(3) Rule of Thumb:
• 250 keV betas can penetrate about 0.6 mm of tissue/water
• 250 keV betas can penetrate about 1.7 feet in air

• [Fraction of P-33 beta particles transmitted through the dead layer of skin (0.007 cm) ~35%]

RADIOLOGICAL DATA

- Critical Organ (soluble form): Bone marrow
- Critical Organs (insoluble forms or non-transportable P-33 compounds): Lung (inhalation) and G.I. Tract/Lower Large Intestine (ingestion)
- Routes of Intake: Ingestion, Inhalation, Puncture, Wound, Skin Contamination (Absorption)
 - Internal exposure & contamination are primary radiological concerns

Committed Dose Equivalent (CDE): 0.5 millirem / uCi (inhalation)

Annual Limit on Intake (ALI): 6 millicuries (oral ingestion)
8 millicuries (inhalation / Class "D")
3 millicuries (inhalation / Class "W")

• [1.0 ALI = 6 millicurie (ingested) = 5,000 millirem CEDE (Whole Body)]

Skin Contamination Dose Rate: 2,659 mrem/hour per 1.0 uCi/cm²
(Dose Rate to Basal Cells) (7 mg/cm² or 0.007 cm depth in tissue without air reflection)

Skin Contamination Dose Rate (Extremity Skin): P-33 betas cannot penetrate 0.3 cm or 30 mg/cm² of tissue

- Tissues with rapid cellular turnover rates show higher retention due to concentration of phosphorous in the nucleoproteins.
- P-33 is eliminated from body primarily via urine.
- Phosphorous Metabolism:
 - 30% is rapidly eliminated from body
 - 40% has a 19-day biological half-life
 - 60% of P-33 (ingested) is excreted from body in first 24-hours;
 - only about 1% per day is excreted after the 2nd or 3rd day.

SHIELDING: Not Required; however, low-density (low atomic number) material is recommended ($\geq 3/8$ " of plexiglas, acrylic, plastic, or plywood).

SURVEY INSTRUMENTATION:

- Use G-M survey meter and pancake / frisker probe (15.5 cm² area). Counting efficiency is approx. 6% for P-33 beta energy (249 keV)].
- Liquid scintillation counter (indirect counting) should be used to detect removable P-33 contamination on smears or swabs.

PERSONNEL RADIATION MONITORING DOSIMETERS: Not Required (beta particle is too weak)

REGULATORY COMPLIANCE LIMITS (10 CFR 20 / Appendix B)

- Derived Air Concentration (DAC):
 - (Occupational) 4.0E-6 uCi/cc (Class "D")
 - 1.0E-6 uCi/cc (Class "W")
- Airborne Effluent Release Limit:*
 - (Annual Average) 1.0E-8 uCi/cc (Class "D")
 - 4.0E-9 uCi/cc (Class "W")

* Applicable to the assessment & control of dose to the public (10 CFR 20.1302). If this concentration was inhaled or ingested continuously over one year it would produce a TEDE of 50 millirem.

- Urinalysis: Not Required; however, may be requested by RSS personnel after a radioactive spill of P-33 or a suspected intake.
- Unrestricted Area removable Contamination Limit: 1,000 dpm / 100 cm²
- Posting Areas or Rooms [10 CFR 20.1902(e)]: > 1000 uCi
- Container Labeling Requirement [10 CFR 20.1905]: \geq 100 uCi
- Limited Quantity [DOT Limits / 49 CFR 173.425]: \leq 2.43 mCi

- Type A Quantity [DOT Limits / 49 CFR 173.425]:* > 2.43 mCi
* [Requires Certified Type A Transport Container]
- Reportable Quantity ["RQ" DOT Limits]: 1.00 Ci

GENERAL RADIOLOGICAL SAFETY INFORMATION

- Inherent Volatility (STP): Insignificant
- Skin dose, internal contamination, and area contamination are the primary radiological concerns.
- Drying can form airborne P-33 contamination.
- **Always** wear a lab coat and disposable gloves when handling P-33.
- Monitor work areas for removable surface contamination by smearing, swabbing, or wipe testing where P-33 is used. Count smears or swabs in a liquid scintillation counter (LSC).