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College of Physicians and Surgeons

RADIATION SAFETY OFFICE

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STANDARD OPERATING PROCEDURES: PHOSPHORUS-32

INTRODUCTION:

Phosphorus-32 is a commonly used radionuclide with a half-life of 14.3 days, emitting beta particles with a maximum energy of 1.71 MeV (Million Electron Volts). The beta particles travel a maximum of 20 feet in air. See Appendix A for information on the rate at which P-32 decays.

CONCERNS:

The major concerns with using P-32 are:

- Surface radiation exposure to the skin of the hands. A drop of contamination containing 1 microcurie of P-32 on 1 cm^2 area of the skin produces a radiation dose of **6,000 millirems / hour.**

  This means that the quarterly NRC limit of 12,500 millirems to the skin would be reached in 2 hours and 5 minutes and the annual NRC limit of 50,000 millirems would be reached in just 8 hours and 20 minutes.

- One microcurie = 2.22 x 10E6 dpm (disintegrations per minute).

- Radiation exposure in air over an open vial. The dose rate at the opening of a vial containing 1 millicurie of P-32 can be as high as 26,000 millirems per hour.

  This means that the quarterly NRC limit of 12,500 millirems for the hands would be reached in 28 minutes.

Our experience at CUMC has shown that laboratories using pre-labeled P-32 (dATP, dCTP, ATP, etc.) in activities of 0.25 and 0.5 millicuries have had little or no safety problems. Using lower concentrations is very desirable. Most companies will provide lower concentrations if requested. The cost of using pre-labeled materials or lower concentrations is higher but the return in safety more than offsets the additional cost.

SHIELDING:

Plexiglass (lucite) is the best shield for beta particles from P-32. When more than 1 millicurie of P-32 is handled, a sufficient number of x-rays (bremmstrahlung) may be formed to require Lead foil to be added to the exterior of the shield. The beta particles travel a maximum of 3.1 mm. in glass, 6.7 mm. in lucite, and 8 mm. in tissue.

DETECTION:

A tiny drop of contamination of P-32 can be easily detected with a Geiger Counter.

EQUIPMENT / SUPPLIES:

The following equipment and supplies must be available:

- A Geiger Counter sensitive to beta particles.

  We recommend the Ludlum Model 3 or an equivalent with a pancake style G-M detector. Also, another excellent survey meter is Ludlum Model 3-98 which will not only detect the beta particles from P-32 but also the bremmstrahlung (secondary x-ray) radiation.

- 3/8" or 1/2" plexiglass benchtop shield.

  These are available from many lab equipment vendors such as RPI, VWR, Fisher, etc. and cost $150 -$250. If you are going to handle more than 1 millicurie, we recommend the 1/2" thickness.

- Disposable latex or plastic gloves.

- Film badge and ring badge.

- Full-length lab coat.

- Plexiglass containers for radioactive waste.
  These are available from many lab equipment vendors such as RPI, VWR, Fisher, etc.

- Pipettes dedicated to the use of P-32.

- Plastic safety glasses.

- Commercial decontaminate, i.e., DuPont's "Count Off."

SAFETY RULES:

If the following safety rules are followed, personnel radiation exposure will be as low as reasonably achievable.

1. Designate a specific area of the lab for P-32 handling.

2. Place the plexiglass shield near a wall (not toward another work area on the other side of the bench) away from the main flow of traffic in the lab.

3. All persons in the laboratory must wear a whole body film badge when in the lab, even those who are not handling P-32.

4. All persons handling P-32 must wear a ring badge on the hand which is most frequently used to handle vials, samples, pipettes, etc. containing P-32.

5. Full-length lab coats must be worn by all persons who handle P-32.

6. Protect the skin of your hands from becoming contaminated by wearing two pairs of disposable gloves.

7. A Geiger counter must be in operation during the experiment, and preferably at all other times. To avoid contaminating the detector, place a thin sheet of plastic (i.e., Saran Wrap) around the detector

8. Place all vials and test tubes containing P-32 behind a 3/8" or 1/2" thick plexiglass shield. Check the radiation level in front of the shield to determine if Lead foil should be added to block out the x-rays (called bremstrahlung) formed by the beta particles interacting with the plexiglass.

9. Do not work directly over an open container of P-32.

10. Never pipette 32P by mouth.

11. Only use pipettes which have been dedicated to your specific use of P-32.

12. Pipettes will easily become contaminated and therefore, should not be shared with others.

13. Use the Geiger Counter to check your gloves frequently for contamination. If contamination is found, immediately dispose of the gloves in the radioactive waste container.

POST-USE PROCEDURES:

After handling P-32:

- Use the Geiger Counter to check your hands, shoes, clothing, work bench, floor, centrifuges, and water baths for contamination.

- If any contamination is found on your shoes and/or clothing, contact the RSO. You will likely have to remove it temporarily until the radiation decays to background. The RSO has some disposable clothing that you can wear home, but we do not have any shoes.

- If any contamination is found on your hands, wash thoroughly with soap and water. This will usually be sufficient to remove the surface contamination. If it does not, contact the RSO for assistance.

- If any contamination is found on the work bench, floor, or lab equipment, use a commercial radiation contamination remover (i.e., Count Off) with paper towels to clean up the equipment. Place the towels in the radioactive waste receptacle.

- If contamination cannot be removed, place a "radiation" label on the equipment indicating that it is P-32, maximum cpm found, and the date you measured the level.

- If contamination cannot be removed from the floor, contact the RSO to obtain shielding materials.

- Inform your fellow lab workers if any unremovable contamination is found.

- Check the normal trash container to make sure no radioactive waste has been accidentally placed there.

- Store the waste temporarily in plexiglass containers or other containers which are sufficient to absorb P-32's beta particles.

- Send a Radiation Contamination Survey Report to the RSO.

- Call the RSO if you have any questions about where to survey, or how to fill out the form.

- Wash your hands thoroughly after using P-32.

- Bring the waste to the RSO frequently. Do not let it pile up. The RSO accepts waste every Tuesday and Thursday from 10:00 AM-12:00 PM. Call 212-305-0303 or X70303 for an appointment.

ANY QUESTIONS ABOUT THESE PROCEDURES?

Call the Radiation Safety Office, 212-305-0303 or X5-0303, or email rsocumc@columbia.edu

APPENDIX A

DECAY RATE OF P-32

Days Elapsed	% of Activity Remaining	Decay Factor
0	100.0	1.00
1	95.3	0.953
2	90.8	0.908
3	86.5	0.865
4	82.4	0.824
5	78.5	0.785
6	74.8	0.748
7	71.2	0.712
8	67.8	0.678
9	64.6	0.646
10	61.6	0.616
11	58.7	0.587
12	55.9	0.559
13	53.2	0.532
14	50.7	0.507
15	48.3	0.483
16	46.0	0.460
17	43.8	0.438
18	41.8	0.418
19	39.8	0.398
20	37.9	0.379
21	36.1	0.361
22	34.4	0.344
23	32.2	0.328
24	31.2	0.312
25	29.7	0.297
26	28.3	0.283
27	27.0	0.270
28	25.7	0.257
29	24.5	0.245
30	23.3	0.233
143 (10 half-lives)	0.1	0.001

For example, if your vial contained 500 microcuries of P-32 on 7/1/2004, the amount of activity remaining on 7/8/2004 (7 elapsed days) would be:

Activity x Decay Factor =
500 microcuries x 0.712 = 356 microcuries