

RADIATION HEALTH SERIES

No. 3

**TECHNIQUES TO REDUCE
THE RADIATION HAZARDS
FROM USING
PHOSPHORUS-32**

RADIATION HEALTH DIVISION
DEPARTMENT OF HEALTH

General

Phosphorus-32 (P-32) is one of the highest energy beta-emitting radionuclides commonly used in biomedical research. Significant external beta radiation dose rates are likely to be encountered whenever small volume high activity sources are manipulated without the use of specific radiation protection techniques. Although in general, P-32 does not pose as severe a threat from ingestion or inhalation as do the volatile compounds which can arise during the use of I-125 or H-3. Most work with P-32 involves wet chemical manipulations with none of the material becoming volatile. The dangers of aerosol production, however, must be recognised. The following sections summarised the techniques that can reduce the radiation hazards from the use of P-32.

A) Shielding

Beta radiation shielding is best achieved with low atomic number materials, *e.g.* aluminium, perspex etc. to minimize bremsstrahlung production. The thickness chosen is usually the range of the most energetic beta particles, which is the thickness required to stop all beta particle transmission. The range is defined as the thickness of any absorbing material (in mg/cm^2) required to bring the beta attenuation curve down to the bremsstrahlung background. This is approximately $800\text{mg}/\text{cm}^2$ in the case of P-32, which is equivalent to about 0.8cm of perspex.

B) Contamination Monitoring

Contamination monitoring by suitable instrument can reveal the presence of high beta radiation dose rates, and thereby indicate where improved shielding or remote handling may be required. Significant radiation doses will be received unless workers undertake careful monitoring of

their skin and clothing during the work activity and before leaving the laboratory.

A splash of $40\text{kBq}/\text{cm}^2$ of P-32 to the skin will result in a skin dose that can exceed the annual dose limit of 500mSv for the skin in 10 hours.

C) Minimising the dose to hands from labelling solution

In the case of membranes being labelled within hybridisation bags, care must be taken to handle the bag as little as possible.

In the case of polycrylamide gel labelling, beta radiation dose can be reduced by confining the gel to a thick-wall perspex box or hybridisation cassette. To reduce handling further, the radioactive labelling solution is later removed from the gel using a filter pump.

For other procedures, workers must be alert to other situations where high dose rates may be present. For example, shielding may be needed when dealing with harvested biological materials from cells or whole organism culture solutions.

D) Opening of containers

Exposure to external beta radiation may come from contamination either associated with opening of faulty containers or arising from vial opening procedures.

In the case of outer containers, there is always the risk that they have been contaminated by leakage from a vial. If a careful package-opening procedure is not followed, involving monitoring and the use of protective screen, an undetected leaking vial could give rise to surface dose rates to the hands which might exceed 100mSv/min from only 74MBq! A suggested safe system of work for opening unsealed source packages including P-32 is:

a) Wear personal body dosimeter.

- b) Put on surgical or PVC gloves.
- c) Place package behind perspex screen and
 - i) open packaging (bag or can),
 - ii) wipe-test interior for leakage,
 - iii) wipe-test lead pot or stock solution container,
 - iv) if clean, open lead pot/container and monitor inside of lid (for most containers samples can be removed by pipette at this stage),
 - v) if necessary using forceps, remove vial and wipe-test
 - vi) if contaminated, clean with damp tissues,
 - vii) if vial is clean, store it ready for use either in lead shielding or within a perspex vial shield.

E) Minimising uptake into the body

As mentioned before, P-32 does not pose a severe threat from ingestion or inhalation as do the volatile compounds such as I-125 or H-3. The potential hazards of aerosol production must, however, be recognized. It is necessary that whenever particular operations might give rise to aerosols or dusts, these operation should be confined to a fume cupboard.

The risk of aerosol formation by centrifuges should be recognized and so capped or sealed centrifuge tubes shall be used. Contamination monitoring of the inside of centrifuges will give an indication of aerosol production due to leakage from centrifuge tubes.

By the use of normal laboratory precautions, *e.g.* wearing laboratory coats and either PVC or, preferably, rubber surgical gloves, the risk of uptake through the skin can be minimised. The most likely possibility of uptake is through a puncture wound which may be due to either self-injection when using a hypodermic needle or cuts caused by contaminated glassware.

Uptake of P-32 might also occur if careless working and lack of monitoring allow contamination to accumulate on fingers which may subsequently be sucked. There will be a similar risk of ingestion of P-32 if pens and pencils are left on contaminated surfaces. Clear laboratory rules, enforced by careful supervision, should minimised the risk of internal irradiation.

F) Decontamination of work surfaces

If liquid spillages are tackled quickly the bulk of the contamination can usually be removed with water and damp paper towels or tissues. If the radioactivity is associated with lipid material, *e.g.* P-32 phospholipids, the cleaning may be achieved with an organic solvent, *e.g.* 1,1,1-trichloroethane, or by using EDTA.

Where contamination is more persistent, water and a detergent should be tried first. If this is not successful, particularly on stainless steel, a commercially available abrasive powder cleaner should be used. An alternative abrasive cleaner can be made up with water, EDTA and titanium oxide. If polished floors are contaminated, removal of the polish with a solvent, *e.g.* 1,1,1-trichloro-ethane may be necessary. Contaminated wood can be covered with hardboard which attenuates the beta radiation until the P-32 has decayed. Contaminated laboratory coats should be stored to allow for decay of the P-32 before cleaning.

G) Good Radiochemical Practice

- (a) on entering the laboratory, put on laboratory coat and, if required overshoes;
- (b) check that body dosimeter is being worn;
- (c) check that contamination/radiation monitor is working;
- (d) never handle stock solution directly;

- (e) put on protective rubber or PVC gloves;
- (f) use handfuls of paper tissues to limit the spread of liquid spillages;
- (g) monitor hands and work areas frequently and after concluding each specific work period;
- (h) work with liquid over trays; with gases, vapour, aerosols in a fume cupboard;
- (i) avoid ingestion of contaminations; pencils, pens, fingers must not be sucked. Never eat, drink or smoke in the radioactive laboratory. Mouth pipetting is NOT permitted;
- (j) clean up contamination immediately;
- (k) monitor all items before removing them from the laboratory;
- (l) keep radionuclide stocks in a locked cupboard or locked refrigerator;
- (m) always assume that the contents of radioactive packages arriving from suppliers are contaminated and follow the proper opening procedures;
- (n) use forceps to pick up vials containing radioactive sources. Place unshielded vial in vial shield for dispensing operations;
- (o) use Perspex screens to stop beta radiation;
- (p) use lead shield to shield gamma radiation;
- (q) when leaving the laboratory:
 - (i) monitor work surfaces (record in log book);
 - (ii) monitor gloves, remove gloves;
 - (iii) monitor hands and wrists in case gloves have been punctured;
 - (iv) monitor laboratory coat fronts, cuffs, and sleeves, and overshoes if worn;
 - (v) remove laboratory coat (and overshoes);
 - (vi) wash and dry hands;
 - (vii) monitor hands and leave laboratory.

Procedures in Case of Minor Injuries

Cuts from glassware may inject activity into the wound. In this case it is important to wash the wound and to monitor the wound for residual activity. Although stimulation of bleeding may help to remove injected contamination, if, from a first aid point of view, the bleeding is serious then all efforts must be devoted to stopping the bleeding rather than to worrying about the radioactivity.

As well as monitoring the wound, First Aiders should ask a radiation protection supervisor to monitor the object which caused the wound. If the object is not contaminated, it is likely that there will not be radioactive material in the wound. This information should reassure the injured person.

Where bleeding has been stimulated to remove contamination, First Aiders might be encouraged to collect the blood obtained so that the amount of radioactive material removed from the wound may be determined.

H) Information on radiation protection can be obtained from:

Radiation Health Division,
 3/F., Sai Wan Ho Health Centre,
 28 Tai Hong Street,
 Sai Wan Ho,
 Hong Kong
 Tel: 2886 1551
 Fax: 2834 1224
 E-mail: rhd@dh.gov.hk
 Domain: <https://www.rhd.gov.hk/>

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