

TO BE CONSIDERED

In preparation

of

SAFETY PLAN

for

Radioisotope Unit

This is probably one of the most valuable and most important guides available (Isotope Branch Circular B-2).

It is more applicable to Veterans Administration Radioisotope Units because it covers the "microcurie" and the "millicurie" levels so much better than does Isotope Branch Circular B-1.

Attention is invited particularly to implications of the following items in regard to local plan

1 (e), 2 (a), 2 (b), 3, 4, 5, 6 and 7

footnote bottom page 2 (r.e.p.)

note bottom page 3 (Morgan)

footnotes page 4 (Appendix I)

appendix II

appendix by Isotopes Branch

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UNITED STATES
ATOMIC ENERGY COMMISSION

Isotopes Branch, Research Division

Oak Ridge, Tennessee
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Isotopes Branch Circular No. B-2

HEALTH-PROTECTION IN HANDLING RADIOISOTOPES*

by

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Harvard Medical School
December 31, 1946

With no accumulated experience on the amounts of radioactivity which are likely to be in use, it will be necessary at first to take more stringent measures than may be required later.

In each laboratory one responsible member should be delegated to supervise all local protection measures.

(1) Definition of Hazardous Materials

- (a) Any material emitting gamma rays in amounts equivalent to that from 10 micrograms of radium, or greater, regardless of half life.
- (b) Any material emitting beta radiation of energy greater than 150,000 electron volts, in amounts larger than 1 millicurie (1 curie = 3.7×10^{10} disintegrations per second), regardless of half life. (Radiation as soft as this will not penetrate the skin, and hence precautions are only required to avoid inhalation of gaseous compounds or dusts.)
- (c) Amounts smaller than those given above of elements with long (1 month or longer) half lives should be carefully observed with regard to the disposal of waste and the cumulative absorption in human bodies.
- (d) Alpha radioactive elements are not considered here since they will not be used normally in connection with radioisotope research here. If they are used, special precautions should be taken.
- (e) No material in amounts greater than 10 microcuries should be used without taking the full precautions given below.

*See Note by Isotopes Branch as footnote on page 3

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(2) Immediate Hazard to Health

(a) X-ray film

All workers engaged in radioactive research should be required to wear at all times on the outside of their laboratory coats, badges containing small pieces of x-ray film. These badges should be collected at weekly intervals and brought to the Biophysical Laboratory for routine development and recording. At that time, a new badge containing unexposed film will be issued. Distribution of x-ray film badges should also be made to various strategic places in the laboratory where exposure may be expected. They should also be collected routinely, say monthly, for development and recording.

(b) Ionization Chambers

Those people engaged in immediate research with appreciable quantities (say amounts of 1 millicurie or more of radioactivity) should carry a fountain-pen size ionization chamber clipped in their pockets while engaged in this research. Appendix I gives details of the ionization chambers now available for sale.

The laboratory supervisor should arrange for daily records to be kept in a book of the ionization thus measured. A copy of this record should be forwarded at monthly intervals to the Biophysical Laboratory. The level of tolerable radiation is 0.1 r per eight-hour day.*

(3) Long-range Protection of Human Health

Blood counts should be taken of all people who are likely to be engaged in radioactive research. The first count should begin before the start of such research, and thereafter, counts should be taken at monthly intervals for analysis either by Dr. Shields Warren or a local pathologist. If the blood counts are taken locally, copies of the results should be forwarded to the Biophysical Laboratory for deposit.

If there is reason to expect that anyone has received an unusually heavy exposure, a special blood count should be taken.

(4) Local Contamination in Laboratories

Weekly checks should be made in laboratories where amounts of radiation in excess of 1 millicurie are handled, and the results should be entered in the health protection center records and also forwarded to the Biophysical Laboratory. Details of the instruments recommended are given in Appendix I. No deposit greater than 0.0002 r per eight-hour day in any one place is tolerable.

*In the Manhattan Project the r for radiation other than x or gamma is replaced by the rep (roentgen equivalent physical) defined as "the amount of radiation which may be absorbed in tissue at the rate of 83 ergs per gram."

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(5) Storage of Material

Radioactive materials in amounts greater than 0.1 millicuries should be stored at all times in a safe with a minimum of two inches of lead protection in all directions. Care must be taken that the safe is constructed to be light-tight, and, hence, radiation tight.

The safe should be monitored to be sure that the radiation at normal working distance remains below the tolerable level of 0.01 r per eight hour day. Since, in general, distance is the best protection of all, material should be stored as far as possible from personnel.

(6) Disposal of Waste

People engaged in research using radioactivity which may be volatile at any time should do so only in a room equipped with adequate ventilation and preferably under a hood with suction discharging at the top of the building. It is important that there be no back draft between the radioactive hood and any other hoods on the system.

Flushable waste should be disposed of down the sink as long as the amount of radioactivity is less than 0.1 millicuries per flush, and a total of 5 millicuries per week. The trap should be monitored weekly to make sure that the background radioactivity remains below the tolerable level of 0.01 r per eight-hour day.

Contaminated glass can be disposed of in ordinary waste as long as the level of radioactivity in the waste disposed of by the city will remain below 0.01 r per eight-hour day per load.

Complete waste disposal systems should be monitored monthly by routine measurements for radioactivity both of above-surface waste lines and the exits of hood discharge lines. The allowable level of radiation in this case is 0.01 r per eight-hour day. These duties should be carried out under the supervision of the designated laboratory supervisor and the results should be recorded locally and also forwarded to the Biophysical Laboratory monthly.

- (7) Amounts greater than 10 millicuries of unused radioactivity, contaminated glass with levels higher than 0.1 r per eight-hour day, and ashes of animals which are more active than 0.1 r per eight-hour day should all be disposed of by sinking at sea.

* * * * *

NOTE by Isotopes Branch: These regulations have been set up as a guide for the use of radioisotopes at Harvard University. By permission of Dr. Solomon they are reproduced and furnished as an indication of regulations that may be suitable for adoption by other small-scale users of radioisotopes. A preliminary

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draft (Nov. 27, 1946) was reviewed by Dr. K. Z. Morgan, Director, Health-Physics Dept., Clinton Laboratories. On the basis of Dr. Morgan's suggestions this revision (Dec. 31, 1946) was issued. Dr. Morgan's comments on the revision are included as an appendix.

APPENDIX I

Instruments Recommended*

(1) Ionization Chambers

- (a) Victoreen Minometer - reading instrument and one pocket meter ionization chamber - \$77. For each additional pocket ionization chamber - \$22.50. These ionization chambers are considered unsatisfactory by the Manhattan District**
- (b) Hinspater Tool Company - Ryerson Pocket Electrometer chambers (can be read in minometer) - approximately \$10 each.

(2) Electrometers

- (a) Henson Model 3 Electrometers - \$35 each. Charging box - \$40.
- (b) Landsverk Electrometer - \$40 each. (Price reduced to \$32 in lots of ten). Charging box - \$25.

(3) Survey Meters

- (a) Instrument Development Company - (Model 2610 portable beta-gamma ray meter) - \$200 (less Geiger-Mueller tube).
- (b) Victoreen Radiation Meter - \$185.
- (c) Zeus (not yet commercially available - expected to sell for \$200).

*Note by Isotopes Branch: These are Dr. Solomon's personal recommendations. The situation in regard to models, prices, and performance is subject to rapid change due to increased interest by many manufacturers in radiation instruments. Reference is made to the list of instruments manufacturers prepared by the Isotopes Branch (Memorandum IB-66). Inquiry to these manufacturers will keep you current on models and prices. A program of testing commercially available instruments has been undertaken by Dr. L. F. Curtiss, Radioactivity Section, National Bureau of Standards, Washington 25, D. C.

**Dr. Solomon refers to experience of some groups which required the carrying of two pocket meters to obtain a reliable reading. Improved models are being developed.

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APPENDIX II

Recommendations for Health-Protection Badges

Badges as used by the Manhattan Project can be purchased from the Newman Metal Products manufacturing Company, 126 South Clinton Street, Chicago 6, Illinois. In order for the film to register density linearly proportional to exposure, it is necessary that half the badge be covered with a sheet of 1 millimeter thick cadmium. The badges are designed with special clasps to hold the cadmium. The other half of the badge is left open to register soft radiation. The cadmium can be obtained from the Belmont Smelting and Refining Works, 320 Belmont Avenue, Brooklyn, New York. The film to be used is DuPont 552-2 which should be developed in a standard DuPont developer; a new batch for each batch of film.

In order to make sure that the calibration is accurate, it is wise to examine the films on a densitometer is the Ansco Sweet device obtainable from the Ansco Company, Binghamton, New York, at a cost of \$300. At present, delivery is from stock. For calibration purposes it is wise to develop each batch of film with a set of calibration films obtained by exposing a set of films at known distances from a 1 millicurie radium seed. A calibration table on which these calibration films may be exposed has been drawn up by Dr. Julius Tabin of the Laboratory of Nuclear Science and Engineering, Massachusetts Institute of Technology. Radium seeds still cost \$1000 per millicurie, but arrangements can usually be made with a local hospital for exposure of the calibration films.

APPENDIX BY ISOTOPES BRANCH

Excerpts from letter dated January 16, 1947 from Dr. K. Z. Morgan to Dr. A. K. Solomon concerning the latter's health-protection regulations.

I am quite pleased with the revised radiation rules which you have set up, and in general agree with most of the provisions. I am glad to note under your regulations 5 and 6 that you have set 0.01 r per 8-hour day as your general maximum operating tolerable level. The level you have set under regulation 4 of 0.0002 r per 8 hours is about twice cosmic ray and general radon-thoron background and better than we have been able to maintain at Clinton Laboratories. Under regulation 1-b, I think one should be cautious about the ingestion or absorption through the skin of certain compounds of low energy beta emitters.

Please let me state again, as I did in my letter to you of December 17, 1946, that I think you are to be commended for your efforts in setting up these radiation rules for your institution. I am sure that they have been a great help

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in preventing or minimizing radiation damage to your personnel. My comments were at the request of Dr. P. C. Aebersold from whom you requested criticisms, and were intended to indicate the directions in which this set of rules could perhaps be improved from our point of view on the Project.

I am not able at the present writing to tell you how or from whom you can obtain pocket meters superior to those furnished by the Victoreen Company. We have our own design and Dr. J. E. Rose at the University of Chicago has a design of his own. Both of these are superior to the old type Victoreen pocket meter. Victoreen has very recently produced a new type pocket meter, and we have about 100 of these on test here at the laboratory. They seem to be much superior to any of the older Victoreen pocket meters, and it may be that these will prove more suitable for our work.

A copy of my paper on "Tolerance Concentrations of Radioactive Substances" is scheduled to be published in Industrial Engineering Chemistry in the near future. Perhaps this may be of some value.

Statement of Dr. Shields Warren to Dr. Lyon (29 October 1947)

The Harvard group has added to item (2) (b) above the following

"Maximum permissible exposure not to exceed 0.1 rem per day or in instances of special need or emergency not over 0.5 rem at any one time providing the individual is immediately thereafter removed from all possible contact with radiation or radioactive materials for a period of one week".

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