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MANUAL

Governing the Control and Use

of

Radioactive Materials

Location 514

Carbide and Carbon Chemicals Company

South Charleston, West Virginia

January 21, 1957

E-11

Item 4

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Location 514

Issued by: The Radioactive Materials Committee

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South Charleston, West Virginia

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ABSTRACT

There is an increasing availability of radioisotopes at moderate cost derived as by-products of the many nuclear reactors now in operation. This new source has enabled industry and others to investigate the use of the radioisotope as a new laboratory and measuring tool. The technical personnel of the South Charleston plant have been active in the study of the application of these materials to the many problems that exist in a chemical plant. As a result, there is beginning to be an increase in the quantity and variety of these chemicals within the company, and, along with this condition, an increase in responsibility for the education of personnel in the safe handling, storage and emergency procedures to be used.

It has been well established that radioisotopes in moderate quantities can be handled and used with complete safety by the average trained technician. An analogy might be drawn to plant experience with some acids. Intrinsically, many are damaging and even lethal liquids, but, in trained hands, they are merely chemicals useful in the laboratory and production unit.

The following statement will, therefore, define the object of this manual. There is established an orderly procedure designed to protect the user and all other persons in the plant from radioactive hazards, but which, at the same time, does not inhibit the user from conducting useful scientific investigations or measurements.

While there are no applications in the biological or medical fields in the company at this time, the following categories of activity are either contemplated or in existence:

(a) Tracer work ("tagged" chemicals).
(b) Fixed sources for instrumentation.
(c) Fixed sources for chemical irradiation.
(d) Radiography.

In order to encompass all predictable events for the varied activities listed above, this manual will cover procedures to be followed in connection with these topics:

(a) Procurement: 1. Requisitioning.
2. Receiving.
3. Transportation.
(b) Storage.
(c) Disposal.

(d) Procedures for:
1. Area monitoring.
2. Personnel monitoring.
3. Area identification.
4. Inventory.

(e) Usage.

Finally, it must be added that the ultimate responsibility for the proper handling of radioisotopes rests with the user. It will be correct for him to communicate with the Radioactive Materials Committee to obtain assistance which might be needed during the course of any activity to which this manual relates.

RESPONSIBILITY OF COMMITTEE

A. The Radioactive Materials Committee has been established to be primarily responsible for formulating the objectives contained in this manual and assuring that they are carried out in the proper manner. Inherent with this responsibility are the following:

1. To insure that the contents of the manual are correct and represent safe, practical procedures.
2. To keep the contents of the manual as up-to-date as the various authoritative sources of information permit.
3. To act in an advisory capacity and assist users or prospective users with any problems that are within the scope of this manual.

B. The Committee shall inspect all purchase requisitions pertaining to radioactive materials to determine, as outlined in Section A of the chapter on "Procurement," the following:

1. Usage.
2. Monitoring equipment.
3. Personnel qualifications.

C. The Committee is to serve as the liaison group for all problems dealing with radioactive materials which may arise with or between:

1. User.
2. Personnel Safety Division.
3. Fire Department.
4. Medical Department.
5. Works Purchasing Department.
6. State Board of Health.
7. Atomic Energy Commission (A. E. C.).

Section I

PROCEDURES

PROCUREMENT

In order to stabilize the procurement and handling routine for this company, the following procedure is recommended:

A. Purchase requisitions for any radioactive materials shall be routed, after appropriate departmental approvals, to the Radioactive Materials Committee for further approval. These requisitions shall be plainly marked "Radioactive Materials." There shall be sent a brief statement with each requisition concerning the following:

1. Usage: In what manner are the materials to be used (i.e., tracer for a closed loop process, unrecovered isotope discharged into river, etc.)?
2. Monitoring equipment: What equipment is on hand for the experiments and for personnel protection?
3. Qualifications: What experience has the person principally in charge had with such materials?

B. If approved, the requisition will then be sent to the person expressly designated by the Works Purchasing Department to be the purchasing agent for radioactive materials. His responsibilities are twofold:

1. He must handle all purchase requisitions pertaining to radioactive materials both for original purchase and for return.
2. He must remain familiar with the latest requirements of the A.E.C., State Board of Health, and the I.C.C. relating to procurement and shipment of these materials.

C. When any shipments of radioactive materials are received, the Receiving Department will set the package aside with minimum handling and notify the requisitioner of its arrival. Under no circumstances are Receiving Department personnel to open the packages or crates for inspection unless they are directed to do so by the requisitioner, or a person designated by him, who will then use the appropriate safety monitoring equipment.

D. Since the burden of safe handling of radioactive materials rests with the user, he must take preliminary steps in preparation for his future activities to perform the following functions:

1. To go himself, or direct a qualified person to substitute for him, and examine the material at the Receiving Department. Breakages, spillage, or any damage must

be acertained at this time.

2. To advise the Personnel Safety Division that the material has been received and submit the following information:
   (a) Type of material (CS-137, Sr-90, etc.).
   (b) Amount (in curies).
   (c) Location (site of use or storage).
   (d) Name of responsible person and department.
3. To submit the same information listed under D-2 above to the Plant Medical Department and Fire Department so as to keep them informed of the various types and disposition of these materials within the plant boundaries.
4. To take additional steps with respect to the working area listed elsewhere in this manual under "Responsibilities of the User."

STORAGE

A. After receipt of radioactive materials, the availability of suitable storage facilities becomes vital. For those sources that are in frequent or constant use, storage or containment at the site is, of course, normal. Recommendations to the user are listed in Sections B and C below. For those sources not in frequent or constant use, there is a recommended centralized storage area located as follows:

Base of the Power House stack.
Building 47, Location 514 (Mainland).

Several advantages accrue from the use of this facility:

(a) It is remote from large concentrations of plant personnel.

(b) It minimizes the unnecessary dispersal of radioactive materials within the plant boundaries.

(c) It simplifies inventories and record-keeping.

Admission to the storage room may be gained by calling the Personnel Safety Division which maintains custody thereof.

B. Since the user will, for the most part, store the radioactive materials himself, it will be incumbent upon him to ascertain or provide for the following:

1. Area Identification:

(a) Any area containing more than one microcurie of radioactivity shall be marked in a standard manner:

CAUTION
RADIATION AREA

(b) Any area in which there exists a radiation level in excess of 100 millirem in any one hour shall be marked:

CAUTION
HIGH RADIATION AREA
PERSONNEL MONITORING REQUIRED

2. Protection Against Spillage:

(a) When not in active use, sources must be stored in unbreakable containers with securely closed lids or access ports.

(b) Storage containers should be capable of withstanding a five-foot free fall to a hard surface without spillage.

(c) When these conditions cannot be met, the user, with the advice of the Committee, shall ascertain the probability of hazard to emergency personnel based upon a 25R "once-in-a-lifetime" exposure[1] for surface born materials, or upon the limits established[2] for possible ingested or inhaled (air-borne) concentrations. If the safety factor is marginal, then this Committee shall be contacted for additional consideration of emergency procedures.

C. 1. Complete inventory shall be kept of all stored radioactive materials in the direct custody of the user. This information shall include:

(a) Location.
(b) Material.
(c) Amount.
(d) Radiation level at 10 inches (mrem per hour).
(e) Instrument used for monitoring.
(f) Name of inspector and date.

2. The inventory shall be maintained and reviewed at least once every month (except for cases where changes are made; these are to be kept current).

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1 N. B. S. Handbook 59, page 69, "Rule V-A."

2. N. B. S. Handbook 52, pages 18-29, "Table 4."

DISPOSAL

A. Radioactive materials are normally disposed of by returning them to the original vendor or to AEC facilities. Under no circumstances may these materials be disposed of indiscriminately by flushing through sewer system piping, burial, insertion into waste heaps, or by incineration.

There are exceptions to the return procedure in the case of short half-life materials or materials of very low activity. When it is felt that such an exception exists, the Committee's approval may be obtained for the specific case and proposed manner of disposal.

B. Return of radioactive materials will be handled by the purchasing agent who is designated by the Works Purchasing Department to be the person qualified for the purchase and return of these materials.

Requisition sheets covering returns should be plainly marked "Radioactive Materials" and routed through the Committee. The user must notify the proper departments as outlined in Section D of the chapter on "Procurement."

Section II

DEPARTMENTAL RESPONSIBILITIES

THE USING DEPARTMENT

A. Technical Skills:

The term "user" denotes the person principally in charge of any project or series of experiments involving the use of radioactive materials. While persons under his direction may perform the actual handling of materials, he will be, nevertheless, responsible for the proper and safe procedures in force. Therefore, it is necessary that the user be familiar with the technical aspects of radioactivity in general, either by previous experience and training, or by a study of the various suggested publications listed in the bibliography. This knowledge is in addition to that needed for the problems of chemistry or measurements involved in the project itself.

B. Proper Facilities:

There are several minimal requirements (in terms of physical facilities) involved in the use of radioactive materials. These are listed below, not necessarily in the order of their importance, but rather to point out the various ramifications one encounters when using these materials.

1. Instrumentation:

There are three forms of instrumentation which must be considered with each individual application. No one set of recommendations can be made to apply to every laboratory or installation. However, the general classifications listed below may be used in the consideration of each problem.

(a) Personnel Monitoring: Any reliable personnel monitoring device may be used. This includes either pocket chamber or film badge types.

Any person who in any week receives or is likely to receive a radiation dose, which is more than 25 percent of the limits established in appendix A, must use a monitoring device.

In any case, it shall be considered advisable to use a monitor when handling gamma emitting sources in amounts over 10 microcuries.

(b) Area Monitoring: Any reliable beta-gamma counter with at least one range of sensitivity in the order of 0-10 mr/hour (and others preferably lower) may be used to monitor the areas adjacent to an installation or storage site. These instruments find particular application when using medium or low level gamma emittors or in checking areas for spillages of beta or gamma sources.

(c) Project Instrumentation: The actual project itself, whether chemical or instrumental in character, necessarily involves the use of some measuring device. The choice and quality remains a consideration for the department undertaking the work. Many times, however, these instruments may perform a dual function and serve not only for the measurement itself but also for checking spillages, etc. The ingenuity of the user will govern to what extent this versatility may be exploited.

2. Shielding:

(a) When not in use, all sources shall be stored in adequate, shielded, spill-proof containers as prescribed in Section B-2 of the chapter on "Storage." Shielding should be sufficient to reduce the dose rate to less than 6.25 mrem/hr. at a distance of 10 inches from the nearest access point to the stored material.

(b) The maximum practical shielding shall be used to isolate radioactive materials from personnel during normal use. At no time is the exposure of any person to be allowed to approach the amounts indicated in Appendix A.

(c) There will never be allowed to exist any condition where ingestion or inhalation of radioactive materials may occur in any amount whatsoever.

(d) No conditions of airborne concentrations will be permitted (with particular reference to Radon gas) without a complete review of facilities, instrumentation and purpose by this Committee.

3. Area and Source Identification:

(a) Radiation areas shall be appropriately marked in conformity with the requirements set forth in Section B-1 of the chapter on "Storage."

(b) Source holders, which contain the radioactive materials, shall be individually marked with the standard AEC symbol, illustrated in Appendix B, and the amount and type of material located therein.

C. Record-Keeping:

1. There will be kept a running account, in ink, of all incidents relating to routine or other exposure of personnel to radioactivity. These records shall include:

(a) Name of person.

(b) Degree of exposure (mrem).

(c) Type and amount of material to which exposed (if known).

(d) Date of exposure.

(e) Instrument used for data.

(f) Date and name of person entering record.

2. At least once every month there will be a check of all radioactive areas with the following information recorded:
   (a) Location.
   (b) Dose rate at 10 inches from source (mrem/hr.).
   (c) Type and amount of source.
   (d) Date and name of person entering record.
   (e) Instrument used for monitoring.
3. At least once every month, there will be an inventory of all radioactive materials. There will be recorded the information outlined in Section C-1 of the chapter on "Storage."
4. In addition, there will be entered in the record all new incoming materials, outgoing materials (including returns), or transfers as they occur. The information shall contain:
   (a) Type and amount of source.
   (b) Disposition.
   (c) Date and name of responsible person.
5. There will be entered in the record all unusual occurrences (such as spills, overexposures, etc.) detailing to the greatest degree the incident, amounts and type of materials involved, and personnel.

D. Disposal:

The uniqueness of radioactivity precludes the utilization of ordinary disposal methods. The proper procedure is covered in the chapter on "Disposal."

E. Emergency Procedures:

1. It is the responsibility of the user to advise the following departments of the receipt, disposition, amount and type of radioactive materials under his immediate jurisdiction:
   (a) Personnel Safety Division.
   (b) Plant Fire Department.
   (c) Medical Department.
2. The user must maintain all of the precautions itemized under Section B of the chapter on "Storage" pertaining to marking and rugged containment of radioactive materials.
3. If, because of the quantity and method of containment of radioactive materials in his possession, the user feels

that Fire Department personnel would be unsafe in performing their duties during a fire and/or explosion in the storage area, he shall contact the Committee for advice as to methods of marking areas and detailing the hazards to the Fire Department.

4. In cases where a hazard exists to emergency personnel in the performance of their duties, the department involved shall designate a responsible person from whom emergency personnel may request assistance during a time of need. This person must be aware of the following:

   (a) Disposition of materials.

   (b) Type and amount.

   (c) Degree of hazard.

   (d) Detection and recovery methods.

PERSONNEL SAFETY DIVISION

The specific functional responsibilities and services of this division are to include the following:

A. To keep a permanent record of every radioactive source in the plant and include this information:
   (1) Location of source.
   (2) Type and amount of source.
   (3) Responsible department and individual.

B. To periodically verify the presence of each source at the specified location; to make measurements to determine the radiation levels and to record these data as follows:
   (1) Date and name of inspector.
   (2) Location of source.
   (3) Type and amount of source.
   (4) Radiation level at 10 inches (mrem/hour).
   (5) Instrument used for monitoring.

C. To assure the proper posting of the areas adjacent to the material as outlined in Section B-1 in the chapter on "Storage."

D. To notify the responsible supervisors of the using department concerning the results obtained from routine examinations and particularly of any potential or actual unsafe conditions which are found to exist.

E. To maintain close contact with this committee and to assist its members in the determination of safe practices in conformity with general plant procedures.

FIRE DEPARTMENT

When advised by the using department of the presence of radioactive materials in any plant location, the Fire Department will take the following action to protect their personnel in the performance of duties during fires and/or explosions in these locations:

A. They will instruct the proper fire fighting and emergency squad personnel concerning precautions to be taken while executing their duties in the areas.

B. They will ascertain the availability during day or night of the person designated as being responsible by the using department.

C. They will cause to be carried in their vehicles, or make available, the proper personnel and area radiation monitoring equipment.

D. They will, through liaison with this committee, determine the degree of hazard represented by the particular radiation sources under consideration and formulate emergency plans accordingly.

E. When the degree of dispersal and activity warrants, they may with the advice of this committee, cause area designations to be made and posted, such designations to conform to A. E. C. recommendations.

During conditions of an emergency, the following rule* will be in effect: "Accidental or emergency exposure of the whole body of adults or parts thereof to X-rays with photon energy less than 3 Mev, from external sources, occurring only once in the lifetime of the person, under the conditions and in the respective dosages stated below, shall be assumed to have no effect on the radiation tolerance status of that person.

(a) Exposure of the whole body--any adult. Total dose measured in air: up to 25 r.

(b) Local exposure--any adult. Dose measured in air and additional to whole-body dose: (1) hands and forearms, up to 100 r; (2) feet and ankles, up to 100 r."

*Rule V-A, pages 69-70, N. B.S. Handbook 59, "Permissible Dose from External Sources of Ionizing Radiation."

WORKS PURCHASING DEPARTMENT

The Works Purchasing Department has certain responsibilities as outlined in Section B on the chapter on "Procurement." These are reiterated here:

A. A purchasing agent will be designated to be responsible for the purchase of all radioactive materials in the plant.

B. His responsibilities will include:

(a) The handling of all purchase requisitions pertaining to radioactive materials both for original purchase and for return.

(b) Maintaining familiarity with the latest requirements of the A. E. C., State Board of Health, and any other regulating agency cognizant of the procurement of these materials.

(c) Honoring only those requisitions for radioactive materials bearing approval of this committee along with the usual departmental approvals.

RECEIVING AND SHIPPING DEPARTMENTS

Since all incoming and outgoing radioactive materials must pass through the hands of Receiving or Shipping Department personnel, they should exercise special precautions upon receipt of such materials. Safe practice will consist of the following:

A. Incoming Shipments:

When shipments of radioactive materials are received, the packages shall be set aside with minimum handling by Receiving Department personnel and the requisitioner will be notified of the arrival. I. C. C. regulations make mandatory the marking of these packages with a POISON label and a statement thereupon of the type and quantity of materials.

Under no circumstances may these packages be opened without permission of the requisitioner whose duty it is to test for dose rates and spillages with the proper equipment.

B. Outgoing Shipments:

Transshipments or returns of radioactive materials must conform to the latest I. C. C. regulations governing this class of poisons. Instructions will be issued to the Shipping Department by the Traffic Department and supervision during crating will be performed by the requisitioner with the proper area and personnel monitoring equipment.

TRAFFIC DEPARTMENT

The Traffic Department will remain familiar with the latest I. C. C. regulations governing the shipment of radioactive materials. It shall issue instructions to the Shipping Department when shipments are to be made outside the plant boundaries.

INSTRUMENT DIVISION

A. In routine laboratory experimentation, the Instrument Division will follow the procedures outlined in this manual in the regular manner.

B. Since this division may be the organization principally responsible for dispersing radioactive materials to operating units and other areas where daily personal supervision of competent technical caliber is not available, it will be an added responsibility to assure that the initial instrument installations containing these materials be consistent with safe practices.

C. Field instrument installations containing radioactive materials will be considered a transfer of the materials. Therefore, the following persons shall be notified of the disposition:

   (a) Personnel Safety Division.

   (b) Fire Department.

   (c) Head of the department to which the transfer has been made.

D. The Instrument Division will provide its usual services with respect to repairing and maintaining instruments used by the various groups to measure the amount of radiation.

Section III

APPENDIXES

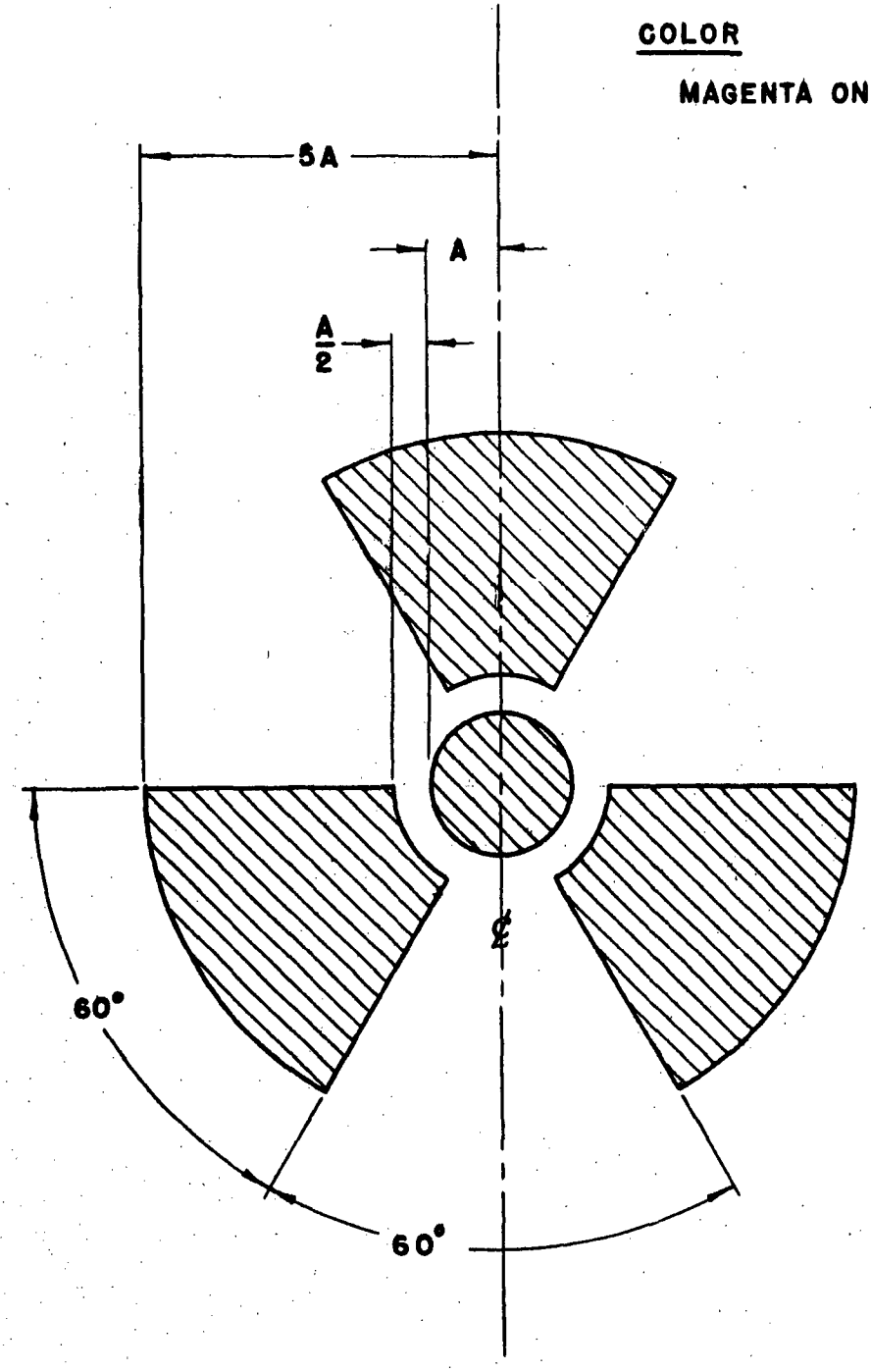
Appendix A - PERMISSIBLE TOTAL WEEKLY DOSES IN SIGNIFICANT VOLUMES OF CRITICAL ORGANS UNDER VARIOUS CONDITIONS OF EXPOSURE (Taken from Page 5104, Federal Register, Saturday, July 16, 1955).

Conditions of Exposure		Dose in Critical Organs (mrem per week)			
Part of body	Radiation	Skin at basal layer of epidermis	Blood forming organs	Gonads	Lens of eye
Whole body	Any radiation with half-value-layer greater than 1 mm of soft tissue.	[1] 600	[1] 300	[1] 300	[1] 300
Whole body	Any radiation with half-value-layer less than 1 mm of soft tissue.	1,500	300	300	300
Hands and forearms or feet and ankles or head and neck.	Any radiation	[2] 1,500			

[1] For exposures of the whole body to X or gamma rays up to 3 Mev, this condition may be assumed to be met if the "air dose" does not exceed 300 mr. provided the dose to the gonads does not exceed 300 rem. "Air dose" means that the dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material.

[2] Exposure of these limited portions of the body under these conditions does not alter the total weekly dose of 300 mrem permitted to the bloodforming organs in the main portion of the body, to the gonads, or to the lens of the eye.

APPENDIX B
STANDARD A.E.C. SYMBOL



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Appendix C

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Section IV

LARGE FIXED IRRADIATION SOURCES

Large "fixed" irradiation sources offer some additional problems in radiological protection, and operational procedures. The following general procedures are intended to be in addition to and not to abrogate any provision of Sections I to IV, unless here specifically excepted.

Large fixed irradiation sources are defined as permanently-sealed radioactive material in excess of 100 curies of activity, fixed in adequately shielded permanent locations and used primarily for their output of high-energy radiation. Such sources will generally be used for experimental purposes only.

Section I

PROCEDURES

STORAGE

A. Storage or containment of the radioactive material at the site of use is mandatory, except where such rule prohibits the effective use of the radioactive material. An example would be the radiographic examination of large objects that cannot be transported to the radioactive source. In such case, transport of the radioactive material is especially designed and adequate shielding containers will be permissible when under the constant control and authority of personnel trained in its safe use and responsible for the project.

Section II

DEPARTMENTAL RESPONSIBILITIES

THE USING DEPARTMENT

B. 1. Instrumentation

(a) Personnel Monitoring: Since they perform different and complementary functions, both film badges and pocket ionization chambers or dosimeters shall be worn by all personnel while at the radiation site.

(b) Area Monitoring: In addition to the portable monitoring device specified in Section B 1 (b), there shall be permanently installed at the irradiation site, an automatic monitor which will record the radiation levels at points judged likely to give the greatest radiation exposure to personnel. Such records shall become part of the permanent health records of the Company, and shall be kept in the files of the Personnel Safety Department.

The area monitor shall be so arranged as to give a visible or audible warning, if the radiation exceeds a certain prefixed level, which shall not be higher than the maximum permissible exposure levels fixed by the Atomic Energy Commission and/or other competent authority.

Operation of the irradiation facility will not be permitted, if the area monitor shows radiation levels above this permissible exposure.

Personnel entering the shielding chamber of the irradiation site will be required to carry portable monitoring devices sensitive to 0-10 mr./hr. and will be required to leave such premises immediately, if the device indicates a radiation level above 10 mr./hr.

C. Record-Keeping

1. G. Film badge service shall be maintained with a competent outside agency. This agency shall keep the badges on file for the length of time prescribed in the service contract, and shall then return them to the Personnel Safety Department.

3. The monthly inventory provision is annulled.

F. Operational Procedures

1. Transfer of Sealed Radioactive Sources

Transfer of high-activity, sealed radioactive sources from the shipping container to their fixed location will be made only behind shielding adequate to reduce the radiation dose to operating personnel well below the maximum permissible levels. The transfer may be done by remotely-controlled manipulators from personnel locations behind a barrier wall, or alternatively the transfer operation may be done with long-handled tongs, if both shipping container and radioactive

source holder, to which it will be transferred, are submerged below a depth of water adequate to provide necessary shielding at all times during the operation.

2. Experiments using large irradiation facilities.

(a) All experiments will be designed to limit exposure of personnel to a minimum. This may be accomplished by setting up the experimental apparatus in a radiation-free area and, after personnel have left the area, moving the source by remote control to the vicinity of the apparatus. Alternately the apparatus to be exposed may be placed in the vicinity of the source submerged under a depth of water adequate to shield personnel.

(b) Safeguards must be provided to insure absence of all personnel from the exposure area during radiation exposures. These safeguards should include: a visual and/or audible alarm in the exposure area interlocked with the source-moving mechanism; an alternative manual source-moving mechanism with an interlock to prevent activation of the source-moving mechanism inadvertently; a barrier-gate to the exposure area, which can be opened manually at all times from the inside, but is locked from the outside automatically when the source-moving mechanism is activated.

(c) At least two technicians, familiar with the proper use of radiation must be present when radiation exposures are begun or ended.

(d) Personnel working inside the shielded area will be required to carry personnel monitoring and area monitoring devices as stated in Section B 1 (b).