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### HEALTH PHYSICS AND SAFETY GUIDELINES FOR THE DOSAR FACILITY

G. D. Kerr, J. W. Poston and E. M. Robinson

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PREFACE

This report was developed several years ago to provide a document which enumerates guidelines for activities somewhat unique with our Facility. It was not intended to be all inclusive, but simply to provide a handy reference to the more important guidelines in effect at the Laboratory and, in particular, at the DOSAR Facility. This manual has been revised to reflect changes in these guidelines which have evolved over the past several years. T. G. Clark and D. R. Ward assisted with this revision, and their help is gratefully acknowledged.

J. W. Poston



## CONTENTS

	Page
Preface.....	iii
Introduction.....	1
I. General.....	1
II. Personnel Control at the DOSAR Facility.....	3
A. Health Physics Research Reactor.....	3
B. The DOSAR Low-Energy Accelerator.....	6
III. Handling of Radioactive Materials.....	7
A. Encapsulated Radioactive Sources.....	7
B. Unencapsulated Radioactive Materials.....	9
IV. Transfer of Radioactive Materials and Equipment.....	10
A. Interarea Transfer.....	10
B. Interlaboratory Transfer.....	11
C. Off-Site Transfer.....	12
V. Other Safety Guidelines.....	13
References.....	15



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INTRODUCTION

It is the health physics and safety policies of the DOSAR Facility to conduct all activities with the lowest reasonable risk of personal injury or property loss and perform all work and maintain the working environment in accordance with Laboratory health physics and safety regulations.

Staff members and visitors are required to follow the guidelines of this report. They are urged also to give due consideration to safety at all times. The Facility Supervisor, Reactor Supervisor, Accelerator Supervisor, and Facility Health Physicist are always available for discussions of the more detailed problems concerning experiments including safety aspects. More detail on specific problems in radiation protection and safety procedures is given in the Oak Ridge National Laboratory's *Health Physics Manual* and *Safety Manual*.

I. GENERAL

Each person must have a security pass containing dosimetric devices in order to gain admittance to the DOSAR Facility. Visitors must obtain security passes at the East Portal of the main Oak Ridge National Laboratory complex. It is required that security passes issued to visitors be signed by a responsible supervisor on the reverse side if the visitor enters a radiation zone. Passes issued to visitors for more than one day must be left at the Guard Station to the DOSAR area

overnight. Visitors may obtain their security passes each morning from the guard at the Facility by presenting him with suitable identification.

In addition, each person entering the area is given a numbered "DOSAR-MUSTER" badge, which should be worn on the clip of the security badge at all times. These badges are used to account for personnel in the area during reactor operations and emergencies. "Muster" badges must be returned to the guard each time a person leaves the DOSAR area.

All persons are required to wear a pair of pocket ionization chamber meters when working with radioactive sources or working in the reactor or accelerator buildings. These meters are located in a tray near the front entrance of Building 7710, the laboratory and reactor control building. Envelopes are provided in the tray for used meters. The envelopes should be signed (name, affiliation, and date), pocket meters placed in the envelopes, and the envelopes containing the pocket meters placed in the tray. A rack located above the tray is for the use of staff members only, and pocket meters should not be removed from it or deposited in it by other persons.

Personnel radiation monitors (audible) and pocket electrosopes are provided in the HPRR and DLEA control rooms for the convenience of persons who wish to monitor their own dose rates or doses, respectively. It is suggested that each person entering Building 7709 (the HPRR building) or Building 7712 (the DLEA building) wear a personnel radiation monitor to indicate unexpected changes in a radiation field.

In addition, radiation survey meters to measure fast neutron, thermal neutron, and gamma-ray dose rates are available in Room 111. The

gamma-ray survey instruments can be used also to estimate the dose rate from small beta-particle sources.<sup>1</sup> Monitoring services will be provided by the Facility Health Physicist (Room 106) on request of persons who lack familiarity with the proper usage of these instruments.

## II. PERSONNEL CONTROL AT THE DOSAR FACILITY

### A. Health Physics Research Reactor

The radiation field produced by the reactor makes it necessary to control access to the DOSAR area during reactor operation. Two areas of control are provided at the Facility: An Exclusion Area, surrounded by a fence of a 1000-ft radius around the reactor building, and a Controlled Area, surrounded by a fence with a minimum radius of 3000 ft. No one is allowed inside the Exclusion Area during any type of operation. Before any reactor operation, a "muster badge" check is requested by the reactor operator, and horns in the area sound for three minutes. Low power operation (< 100 watts) is indicated by a continuous sounding of the horn. High power or burst operation is indicated by an intermittent horn. Reactor scram switches, which prevent reactor operation, are located inside and outside the reactor building and on the main gate to the area. The badge check, operation announcements, waning horns, lights, and the use of these switches insure the safety of all personnel before reactor start-up.

A "muster badge" check is conducted as follows: All personnel are asked, by a public address announcement, to report for a badge check. This is done through an intercommunication system located in each room of the Facility or by contact with the operator in the control room. If there is any difficulty, a staff member can assist you. Briefly, the "call-in"

button on the speaker is pushed to alert the operator. In a short while, the operator responds, "Go ahead". Place the switch in the "normal" position and call the muster badge numbers, three at a time. The operator acknowledges each time three numbers are called. Proceed in this manner until all badges are reported and acknowledged by the reactor operator.

The dose rate in the area between the 1000-ft fence and the 3000-ft fence will vary several orders of magnitude, depending upon the type of reactor operation. Therefore, at the time that the operator calls for the badge check, the type of reactor operation and any restrictions will be announced, viz, one of the following:

1. Low power operation, no entry or exit restrictions (outside the 1000-ft fence), or
2. High power operation, remain in the building until further notice, or
3. Burst operation, remain in the building until further notice.

Immediately after the announcement of condition (2) or (3), a red sign over every outside door will be illuminated which states, "DO NOT EXIT WITHOUT APPROVAL OF REACTOR OPERATOR", and air horns sound in short blasts for three minutes. These horns, located in the reactor equipment room and on the intervening hill can only be heard outside the building. Thus, the horns serve as a warning to anyone who may be outside the shielded control building. In addition, a rope barrier is placed across the main exits of the control building. Each door is equipped with a switch which actuates an annunciator in the Control Room should the door be opened. Any accidental opening of the doors during high power or burst operation should be reported immediately to the Control Room.

Upon reactor shutdown, the warning lights will be turned off, and an announcement will be made that "the reactor is shut down until further notice". Reactor shutdown from a low power condition is not normally announced except to experimenters directly interested in the operation.

For safety reasons, access to the reactor building is restricted, and visitors will be permitted access to the building only when escorted by a DOSAR staff member. Private vehicles are not permitted inside the inner area fence. Only government vehicles will be allowed in this area. Transportation will be provided by members of the staff. Removal of equipment from this area should conform to the guidelines presented in the section on "Transfer of Radioactive Materials and Equipment".

Rotating colored lights at the reactor building indicate possible radiation hazards. Rotating magenta lights located inside and outside the reactor building indicate the presence of neutrons while the reactor is not operating. In addition, an evacuation warning horn will also sound inside the reactor building. The area should be evacuated immediately and the applied health physicist notified.

Other warning lights are: A rotating amber light which indicates that the neutron warning system is out of service. A rotating red light indicates that the gamma radiation level is above 20 mrad/hr at the reactor building. A health physics survey should be made before working at the building.

In the event a nuclear accident should occur, there will be a general announcement over the public-address system. Instructions will be given as to the proper procedures to follow at this time. No control building evacuation alarm will be given for a nuclear emergency.

In the event of fire in the control building, the fire alarm will sound. This is the only audible alarm located in the control building. The staff members have assigned duties and will carry them out immediately. All unassigned staff members and visitors will assemble outside the front door of the control building. This may be accomplished through the nearest available exit. Please note the nearest exit should its use be necessary. At this time, a badge check will held to assure that all personnel are present.

More details concerning the HPRR are contained in the HPRR Procedures Manual (ORNL-3519 Rev.).

B. The DOSAR Low-Energy Accelerator

The DOSAR Low-Energy Accelerator (DLEA) is located across the street from the laboratory building in Building 7712. Control of the accelerator is accomplished in a shielded trailer located a short distance from the building. The unit is a Texas Nuclear Model 9999, which has been modified to make it capable of delivering a 1-ma beam at 200-kV accelerating potential.

Access to the accelerator building is restricted by the DOSAR staff, and visitors are not permitted in the building unless accompanied by a staff member.

Several personnel safety warning devices are located in and around the accelerator building. The area is surrounded by a chain and rope barrier posted with radiation warning signs. During operation, a yellow rope barrier is used to close the entrance to this area. A rotating red light located on top of the building and red lights over the doors indicate that the accelerator is on. Inside the building,

lights and signs are provided to indicate "High Voltage On" and "Beam On". An automatic-resetting neutron monitor equipped with a rotating magenta warning light is also installed in the building (alarm point set at < 10 mrem/hr).

Before the accelerator is operated, a PA announcement is made stating the restrictions which apply to the area. All accelerator shutdowns are similarly announced. At this time, a green light over the entrance door is turned on.

Equipment which has been connected into the accelerator vacuum must be placed inside two layers of plastic bags and left in the accelerator building until it has been checked and cleared by the Facility health physicist. Removal of other equipment from the building should conform to the guidelines laid down in the section on "Transfer of Radioactive Materials and Equipment".

Further information concerning the DLEA can be found in the Texas Nuclear Neutron Generator Instruction Manual and the DOSAR Low Energy Accelerator (DLEA) Operations Manual.

### III. HANDLING OF RADIOACTIVE MATERIALS

#### A. Encapsulated Radioactive Sources

Sources available for routine use at the DOSAR Facility are shown in Table 1.

Laboratory policies require that areas be posted with warning signs where the dose-equivalent rate exceeds 3 mrem/hr.<sup>2</sup> Radiation signs on yellow stanchions are provided for this purpose in Room 111. The dose-equivalent rate and source description should be written on these signs with a grease pencil in the manner of the following example:

Table 1. Calibration Sources at the DOSAR Facility

Source Material	Source Designation	Source Output	Dose-Equivalent Rate at 1 Meter
$^{60}\text{Co}$	"Little Blue"	8.11 mr/hr $\pm 3\%$ @ 1 meter by NBS on 5/6/60	7 mrem/hr (5/6/60)
$^{60}\text{Co}$	"Big Blue"	104 mr/hr $\pm 3\%$ @ 1 meter by NBS on 4/20/65	90 mrem/hr (4/20/65)
$^{239}\text{Pu-Be}$	M698	$1.86 \times 10^6$ n/sec $\pm 2\%$ by NBS on 12/12/63	3 mrem/hr
$^{239}\text{Pu-Be}$	MRC-274	$6.82 \times 10^6$ n/sec from long-counter comparison with NBS- certified sources	12 mrem/hr
$^{241}\text{Am-Be}$	MRC-110	$1.27 \times 10^7$ n/sec $\pm 2\%$ by NBS on 5/16/66	22 mrem/hr
$^{241}\text{Am-B}$	3000-AM- 114	$5.55 \times 10^6$ n/sec from long-counter comparison with NBS- certified sources	9 mrem/hr

3 mrem/hr @ 2 meters  
 $^{241}\text{Am}$ -B Neutron Source

If the source is not under direct supervision of a person at all times during its use, the area around the source where dose-equivalent rates are greater than 3 mrem/hr should be enclosed with a yellow rope barrier and the Facility health physicist advised. Rope can be obtained for this purpose in Room 111.

If a rope barrier to control exposure to a source is not practical, areas can be used where access is controlled by other methods, such as the HPRR building or DLEA radiation zone. Radiation signs must be posted near the source in all cases.

Sources should be removed from the storage cage in Room 114 only after steps necessary for limiting exposures to other persons have been taken. Visitors must have the approval of the Facility health physicist unless they are working with a staff member. Name of user and place of use should be recorded on source inventory list located on the storage cage.

Any possible damage to the source during its use should be reported immediately to the Facility health physicist.

Name of user should be removed from inventory list when source is returned to the storage cage.

#### B. Unencapsulated Radioactive Materials

Visitors must obtain permission from the Facility health physicist to work with unencapsulated radioactive materials. Both staff members and visitors are required to monitor their work continuously. Portable alpha-particle, beta-particle, and gamma-ray survey meters are provided for this purpose in Room 111.

Counting systems employing a scintillation detector for alpha particles, a G-M end window detector for beta particles, and a  $2\pi$  gas flow detector for evaluating  $^3\text{H}$  smears are available in Room 112. In addition, a 7.5 x 7.5 cm scintillation crystal located in this room is available for identification of gamma-ray activity on smears.

Facility tolerances for unidentified surface contamination are:

<u>Type of Activity</u>	<u>Transferable</u>	<u>Direct Reading</u>
$\alpha$ particle	30 dpm/100 cm <sup>2</sup>	300 dpm/100 cm <sup>2</sup>
$\beta$ particle and $\gamma$ ray	200 dpm/100 cm <sup>2</sup>	0.05 mrad/hr
Tritium	2000 dpm/100 cm <sup>2</sup>	----

Work with radioactive material at the Facility is limited to those quantities which can be handled safely in a chemical hood or bench top<sup>3</sup> (Type C or D Laboratory). Appropriate modifying factors,<sup>3</sup> depending on operations to be performed with the material, should be applied. All work should be carried out on blotter paper.

The Facility health physicist should be notified when work with the radioactive material has been completed, so that the area and equipment can be cleared for further use. Contaminated waste should be doubly sealed in plastic bags and deposited in one of the YELLOW waste cans located on the loading dock of the control building.

All radioactive material to be stored at the Facility must be surveyed and properly identified with a RADIATION HAZARD sign, tag, or label.

#### IV. TRANSFER OF RADIOACTIVE MATERIALS AND EQUIPMENT

##### A. Interarea Transfer

All items used in the HPRR or DLEA buildings should be returned to the loading dock of the control building to be surveyed before being

brought into the control building. All items used in both buildings should be surveyed for alpha- and beta-particle contamination, although this has never been a problem at either of the buildings. In addition, equipment used in the DLEA must be surveyed for tritium contamination before removal from the building.

If the activity on the items exceeds Facility tolerances,\* they should be double-sealed inside of two plastic bags and identified with a yellow and magenta RADIATION HAZARD tag.

One problem associated with the use of experimental equipment in both buildings is neutron-induced radioactivity; therefore, a preliminary survey should be made with field instruments to determine the level of neutron activation in irradiated equipment.

Staff members can complete their own radiation and contamination surveys on equipment and can assist visitors in surveying equipment.

Any contamination of equipment or significant neutron-induced radioactivity (external dose rate > 3 mrem/hr) should be reported to the Facility health physicist.

Interarea transfers of radioactive material are required to be conducted in a manner that will prevent the release and spread of radioactive contamination and minimize personnel radiation exposures.

#### B. Interlaboratory Transfer

All materials or equipment that involve a shift in supervisory responsibilities must be identified by a properly executed tag of the following type: Health Physics Material Transfer Clearance, Radiation Hazard, Contamination Hazard, or Health Physics and Property Material Transfer Clearance.

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\* See Section III. B.

Equipment and tools for reissue are given a Health Physics Material Transfer Clearance if the levels of contamination are less than the recommended maximum contamination given in Section III.B.

All transfers of radioactive materials or equipment must be identified by a Radiation Hazard-Material Transfer tag properly executed by the shipper and Facility health physicist. Laboratory regulations require all radioactive materials to be adequately shielded and reliably contained while in transit. Secondary containment is required for transfer of liquids, gases, or finely divided solids. On completion of the transfer, the perforated section of the Radiation Hazard tag marked "Material Transfer" should be removed.

Contaminated equipment being transferred should be contained in a manner which will prevent the release and spread of radioactive contamination. It should be identified by a properly executed Contamination Hazard-Special Handling tag if it is being transferred to the Decontamination Facility. Otherwise, the contaminated equipment should be identified by a Radiation Hazard-Materials Transfer tag.

### C. Off-Site Transfer

In brief, radioactive materials must be packaged, labeled, marked, and certified in accord with Interstate Commerce Commission, Federal Aviation, U.S. Postal, or other applicable regulations.

Before shipment or removal of radioactive or fissile materials in any form (including instrument testing sources, equipment with measurable neutron-induced radioactivity, etc.) from the Laboratory, the Isotopes Division Sales Department should be contacted to determine the proper procedure for handling or transfer of material.<sup>5</sup>

Shipment of radioactive materials can be made from the Oak Ridge National Laboratory only after an appropriate form has been completed (AEC Form-375 if shipment is to a federal agency or AEC Form-391 if shipment is to other organizations). Thus, a visitor should bring the appropriate completed form to avoid delays in shipment of radioactive materials or equipment in which the neutron-induced radioactivity during an experiment may be significant.

#### V. OTHER SAFETY GUIDELINES

Some safety guidelines<sup>6</sup> established for the Oak Ridge National Laboratory with which all staff members and visitors at the Facility should be aware are listed below.

Several laboratories, shops, and the DLEA building of the DOSAR Facility have been designated as areas in which eye protection is necessary. These areas are posted with the standard sign: "SAFETY GLASSES MUST BE WORN IN THIS AREA". Safety glasses are provided for visitors near the entrances to all these areas. In addition, goggles are required for work with machine tools and chemicals.

Electronics equipment having voltages in excess of 50 volts must be protected from accidental human contact by means of an enclosure, and the enclosure must be grounded. In addition, power supplies must be labeled, "DANGER HIGH VOLTAGE", and the main switch to the power supply must be clearly identified. All terminals, cables, or exposed electrical contacts on power supplies must be provided with means to prevent accidental human contact.

Gas cylinders must be used in an upright position and adequately fastened or chained to prevent them from falling. Regulators or automatic

reducing valves must be used only for the gas for which they are intended. If toxic or flammable gases are being used, an appropriate warning should be posted in a conspicuous manner. In the event of a leak or suspected leak of toxic or flammable gases, a fire alarm should be sounded and the building evacuated immediately.

Working alone during off hours is allowed at the Laboratory, but personnel are required to report to the Laboratory Shift Supervisor (Ext. 3-6606) at least every two hours.

All personnel are asked to back in when parking vehicles outside the control building. Such an arrangement allows orderly evacuation of the area should it be necessary. Please observe the speed limits as posted in our area.

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