Baystate Medical Center

EMPLOYEE MANUAL

Facts, Figures, Policies, Risks and Benefits

RADIATION SAFETY

October 1984

RADIATION SAFETY: EMPLOYEE MANUAL

Facts, Figures, Policies, Risks and Benefits

by

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The following topics are covered in this information booklet specially designed for employees of Baystate Medical Center.

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Note: The information given in this booklet is only for the radiation safety instruction of the employees and radiation workers at Baystate Medical Center. Copying of this information or its use in other matters is prohibited.

Acknowledgements: Our sincere thanks to Mrs. Peggy Rishel for cover design and to Miss Martha Hess for illustrations included in this booklet. My special thanks to Medical Physics Staff for numerous measurements and data included in the employee manual. Our special thanks to the Department of Radiology, Radiation Safety Committee and Administration for the continued support.

PREFACE

The medical use of radiation involves the offsetting of a risk against a benefit that a patient will derive in early diagnosis or treatment of his or her ailment. Similarly, the individual choice of working in institutions using radiation also carries the offsetting of a small risk against financial benefits of employment. The information in these pages is given so that an individual can make intelligent judgments about the risks or benefits of use of radiations at Baystate Medical Center, Inc.

The risk-benefit equation is particularly hard to balance in the case of future genetic risks because those who receive the benefits and those who run the risks are not the same people.

However, it is incumbent upon users of radiation to minimize the risks of radiation exposure and obtain maximum benefits to the patient, the public and employees. Therefore, the radiation safety program at Baystate Medical Center is designed to assure radiation safety for patients, the public and employees with an ultimate goal of maintaining radiation exposures "as low as reasonably achievable" (ALARA). The ALARA concept is strongly supported by Management, the Radiation Safety Committee, the Department of Radiology, the Medical Staff and other Professionals at Baystate Medical Center, Inc.

Radiation Safety Committee, BMC

INTRODUCTION

Medic: Physics and Radiation Safety Services

At Baystate Medical Center the Medical Physics service and Radiation Safety Program are centralized under the Division of Medical Physics and Radiation Safety in the Department of Radiology.

The Medical Physics Services relate to instrumentation, education, quality assurance and computer operations in diagnostic x-rays, radiation therapy, nuclear medicine, ultrasound, CT scanning and use of other radiations and radioactive isotopes at Baystate Medical Center, Inc.

The Medical Physics Services are designed to be in compliance with guidelines of the American College of Radiology (ACR), American Association of Physicists in Medicine (AAPM), American College of Nuclear Physicians (ACNP), College of American Pathologists (CAP), Nuclear Regulatory Commission (NRC), Centers for Radiological Physics (CRP), and the Department of Radiology.

The Radiation Safety Program relates to safe use of radiations at Baystate Medical Center. The Radiation Safety Program is designed to be in compliance with rules, regulations and conditions of our Nuclear Regulatory Commission (NRC) Broad License, two teletherapy licenses, special nuclear material license and diagnostic x-rays registration. The Radiation Safety Program is also in compliance with requirements of the Department of Public Health (DPH), Joint Commission on Accreditation of Hospitals (JCAH), Bureau of Radiation Health (BRH), Food and Drug Administration (FDA), Occupational Safety and Health Act (OSHA), Environmental Protection Agency (EPA), National Council on Radiation and Measurements (NCRP), recommendations of Radiation Safety Committee (RSC) and guidelines of the Department of Radiology.

A comprehensive Radiation Safety Manual has been written which includes procedures for handling and safe use of radiations by physicians, nursing staff, technologists, paramedical staff, students and other employees at Baystate Medical Center. The written procedures for specific areas are distributed to area supervisors for use. The Operational Radiation Safety Update Series are designed to meet the need of each area supervisor and these are scheduled by appointment at any time during the year. In addition, a radiation safety instruction program is given once a year for all employees.

The professional staff of Medical Physics and Radiation Safety is available for consultations and guidance in the safe us of all radiations at Baystate Medical Center, Inc.

The present information booklet is an updated version of previous booklet "Radiation Safety - Questions and Answers" published in 1980. The resource materials used are listed in the reference section.

What is radiation?

There are two main types of radiation:

Ionizing radiation produced by x-ray machines, nuclear reactors, and radioactive materials. It gets its name from its ability to knock electrons out of atoms, creating electrically-charged ions. In the human body, these ionized atoms can affect normal biological functions.

Nonionizing radiation, such as microwaves, sound waves and light, damages living tissue by other means.

How do we protect ourselves from these radiations?

a. *External Exposure Protection*

The means of protection from external radiation exposure are a combination of three things: *Time, distance, shielding.* That is to say, protection is provided by:

1. Controlling the length of time of exposure to radiation.
2. Controlling the distance between the individual and the source of radiation.
3. Placing an absorbing material (e.g. lead aprons and shields, etc.) between the individual and the source of the radiation.

b. *Internal Exposure Protection*

Keep your hands out of "HOT" material.
Wash up before you eat and before you go home.
Do not eat, drink or smoke in an area where radioactive materials are processed.
Cover containers of "HOT" material when being handled or moved.

What is ALARA?

In addition to providing an upper limit on an individual's permissible radiation exposure, the NRC also requires that its licensees maintain exposures "as far below the limit as is reasonably achievable" (ALARA). This means that every activity at a nuclear facility involving exposure to radiation should be planned so as to minimize unnecessary exposure to individual workers and also to the worker population. A job that involves exposure to radiation should be done only when it is clear that the benefit justifies the risks assumed. All design, construction, and operating procedures should be reviewed with the objective of reducing unnecessary exposures.

Paragraph 20.1 (c) of 10 CFR Part 20, "Standards for Protection Against Radiation," states that licensees should make every reasonable effort to keep radiation exposures, as well as releases of radioactive material to unrestricted areas, as far below the limits specified in that part as reasonably achievable. Regulatory Guides 8.10, 8.18 and NUREG-0267 set forth the philosophy and general management policies and programs that licensees should follow to achieve this objective of maintaining radiation exposures to employees "as low as is reasonably achievable" (ALARA).

What is RAD? **What is Rem?**

The amount of radiation or, as it is usually called, the dose, is measured in terms of the energy absorbed in the tissues. All ionizing radiations are measured in rads. This unit, the rad, is adequate as a unit for x-rays, gamma rays, electrons, neutrons, protons and heavier ions.

In some instances, a dose is very much less than one rad, and then the term millirad is used. There are 1000 millirads in one rad. To give an idea of the way these units are used, two examples will be quoted. A dose of 400 rads to a human being would most probably be fatal; the natural background radiation to which we are exposed amounts to about 100 millirads/year.

Rem is an abbreviation of "rad equivalent, man". The object of using rems is to reduce all types of radiations to a common scale of measurement. The dose in rems is equal to the dose in rads, multiplied by a factor to allow for the relative effectiveness of the particular type of radiation involved. X-rays and gamma rays are regarded as the standard, and for these, rads and rems are interchangeable. A dose of 100 rads of x-rays is, by definition, 100 rems.

How are radiation dose limits established?

The Nuclear Regulatory Commission (NRC) established occupational radiation dose limits based on guidance to Federal agencies from the Environmental Protection Agency (EPA) and on NCRP and ICRP recommendations. Scientific reviews of research data on biological effects such as the BEIR report are also considered.

How is a radiation worker's radiation dose determined?

A radiation worker may wear two types of radiation-measuring devices. A self-reading pocket dosimeter records the exposure to incident radiation and can be read out immediately upon finishing a job involving external exposure to radiation. A film badge or TLD badge records radiation dose, either by the amount of darkening of the film or by storing energy in the TLD crystal. Both these devices require processing to determine the dose and are considered more reliable than the pocket dosimeter. A radiation worker's official report of dose received is normally based on film or TLD badge readings.

What is meant by prompt effects, delayed effects, and genetic effects?

Prompt effects are observable shortly after receiving a very large dose in a short period of time. For example, a whole body dose of 450 rems to an average adult will cause vomiting and diarrhea within a few hours; loss of hair, fever, and weight loss within a few weeks; and about a 50 percent chance of death within 1 month without medical treatment.

Delayed effects such as cancer and cataracts may occur years after exposure to radiation.

Genetic effects occur when there is radiation damage to the genetic material. These effects may show up as birth defects or other conditions in the offspring of the exposed individual and succeeding generations, as demonstrated in animal experiments, although this effect has not been observed in human populations.

As radiation workers, which effects should concern us?

Immediate or prompt effects are very unlikely since large exposures would normally occur only if there were a serious radiation accident. Accident rates in the nuclear medicine laboratory have been very low, and only a few accidents in nuclear industry have resulted in overexposures. The probability of serious genetic effects in the children of workers is estimated at about one-third that of other delayed effects. The main concern to radiation workers should be the delayed incidence of cancer. The chance of delayed cancer is believed to depend on how much radiation exposure a person gets; therefore, every reasonable effort should be made to keep exposures low.

What is the difference between acute and chronic exposure?

Acute radiation exposure, which causes prompt effects and may cause delayed effects, refers to a large dose of radiation received in a short period of time; for example, 450 rems received within a few hours or less. The effects of acute exposures are well known from studies of radiotherapy patients, atomic bomb victims, and accidents that have occurred in nuclear fuel processing. There have been few occupational incidents that have resulted in large acute exposures.

Chronic exposure, which may cause delayed effects but not prompt effects, refers to small doses received repeatedly over long time periods; for example, 20-100 mrems (mrem is one-thousandth of a rem) per week every week for several years. Concern with occupational radiation risk is primarily focused on chronic exposure to low levels of radiation over long time periods.

What are basic facts about radiation?

— Everyone is exposed to background radiation.

— The degree of risk associated with low doses of radiation is thought to be *very low* although there is unavoidable uncertainty in providing precise risk estimates.

— Despite some disagreement about risks at low levels, experts agree that any exposure is potentially harmful and *unnecessary* exposure should be avoided.

— Risk should always be measured against the benefit (medical x-rays, nuclear energy, waste disposal).

— Risks of exposure to radiation need to be placed in proper perspective alongside other health hazards.

How does radiation cause cancer?

How radiation causes cancer is not well understood. It is impossible to tell whether a given cancer was caused by radiation or by some other of the many apparent causes. There are nearly 500 different carcinogens in our environment. However, most diseases are caused by the interaction of several factors. General physical condition, inherited traits, age, sex, and exposure to other cancer-causing agents such as cigarette smoke are a few possible interaction factors. One theory is that radiation activates an existing virus in the body which then attacks normal cells causing them to grow rapidly. Another is that radiation reduces the body's normal resistance to existing viruses which can then multiply and damage cells. Radiation can also damage chomosomes in a cell, and the cell is then directed along abnormal growth patterns. What is known is that, in groups of people exposed to high levels of radiation, a higher than normal incidence of cancer is observed. An increased incidence of cancer has not yet been observed at low radiation levels, although human studies are still incomplete. Higher incidence rates of cancer can be produced in laboratory animals by high levels of radiation.

What is a "Low Level" exposure?

— Single exposure below 10 Rads

— Slightly larger exposures if delivered over many days

Why are low level radiation effects so difficult to demonstrate?

— Low doses of radiation will cause few, if any, induced cases.

— There are many spontaneous cases in any group of people:

a. Cancer — 33% incidence, 16% fatal lifetime risk

b. Embryo — 4% of liveborn have congenital defects

c. Genetic — 10% of liveborn have inherited disorders

— Induced effects are indistinguishable from those occurring spontaneously.

What populations are exposed to unusually high levels of background radiation?

1. Residents of Kerala plains of India (1300 mrem/year).
2. Residents on monzanite sands of Brazil (500 - 1000 mrem/year).
3. Residents of high background regions of China (175 - 344 mrem/year).

Note: No increased incidence of cancer in these populations exposed to 5 to 13 times the background radiation in USA.

What are the Low-Dose (10 rads) results in A-Bomb survivors?

— 20,000 people in the 1-9 rad dose range (mean of 3.5 rads)

— 30 year followup

— Total absence of demonstrable leukemia incidence.

Why is it so difficult to quantify the risk of radiation induced cancer?

— At low radiation levels the projected number of radiation induced cancers is very small compared to the number occurring naturally.

— Radiation induced cancers are *not* unique. They cannot be distinguished from naturally occurring cancer.

— Long latent period.

— The observed number of cancers in the control population is so large with respect to the number of cancers possibly induced by radiation that any radiation effects are undetectable.

The present status of radiation exposure and cancer induction.

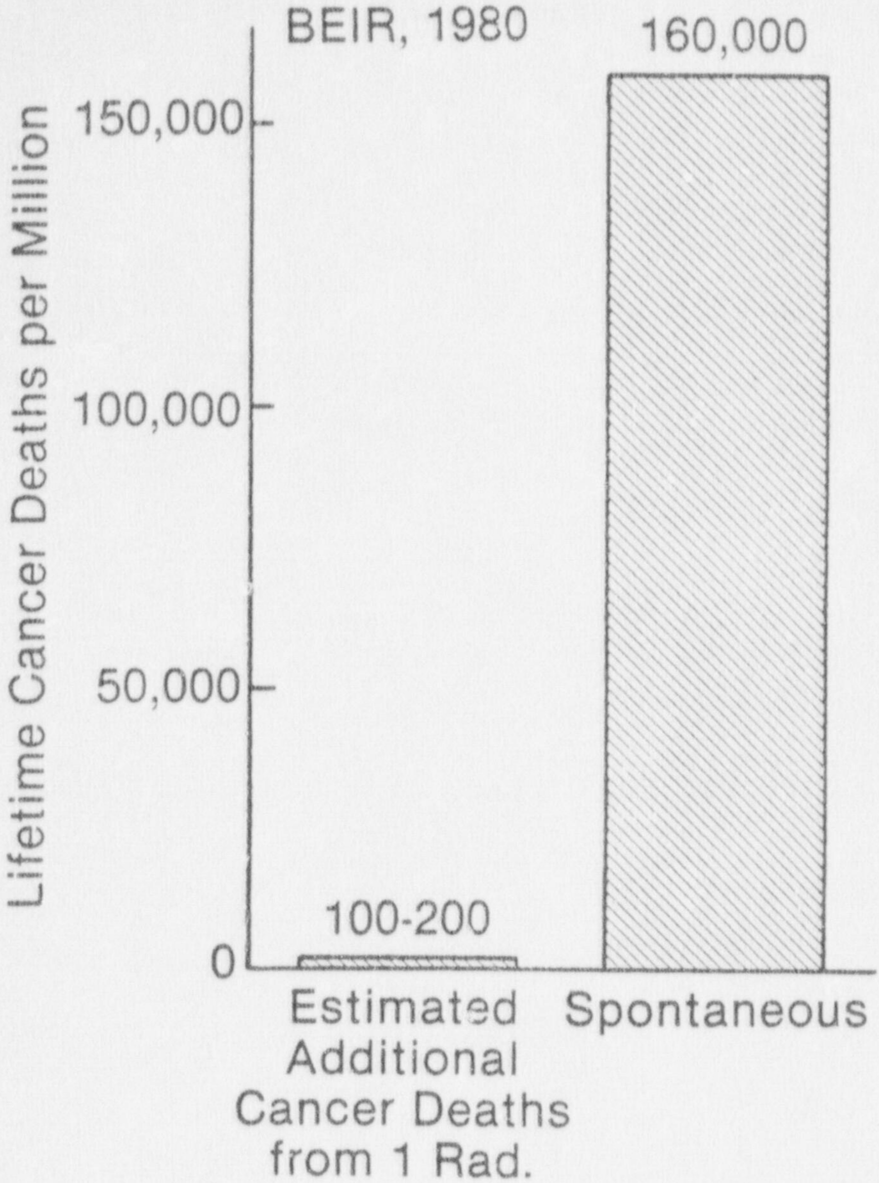
— In a million persons 160,000 will die of cancer

— Background radiation (100 mrem/yr over lifetime) may account for 1 - 2% of these deaths

— Each rem of radiation received above background by a million persons may contribute 100 - 200 additional cancer deaths

— The American Cancer Society's *Cancer Facts and Figures - 1979* notes that about 25% of the population will eventually die of it. So the risk rate for radiogenic cancer death, 1 in 10 million per millirem, is about 6 ten-millionths of the "natural" cancer risk.

— Ionizing radiation is a carcinogen. Excessive radiation exposures may impose large and unacceptable burdens on individuals who receive many times the average dose. From the point of view of protecting the population from cancer, however, reduction of exposure holds little promise of substantial progress because (1) the existing burden is so small a portion of the total, and (2) much of the exposure is beyond control.


BEIR, 1980
160,000
150,000
100,000
50,000
0
Lifetime Cancer Deaths per Million
100-200
Estimated Additional Cancer Deaths from 1 Rad.
Spontaneous

Radiation Dose Limits

1. Hazardous Dose Limits: **(mR)**

100,000	Nausea, Fatigue
50,000	Slight temporary blood changes
25,000	Detectable physiological effects
550,000	Sterility (Localized dose)
10,000	Fetal dose

2. Personnel Dose Limits: **(mR)**

5,000 per year	Maximum Permissible Dose
15,000 per year	Skin of Whole Body
75,000 per year	Hands
30,000 per year	Forearms
500 (nine month gestation)	Fetus
5 (N-18) rems; N = Age	Maximum accumulated dose
500 per year	General population

3. Average Radiation Exposures Received by Individuals at BMC 1983: (mR)

100 per year	Background radiation
100 per year	Medical Reasons
680 per year	Nuclear Medicine Technologists
1001 per year	Diagnostic X-ray Technologists (Special Procedures)
45 per year	Nursing Staff working with Brachytherapy patients
30 per year	Non-radiology personnel working with radiation
1232 per year	Cine Fluoroscopy (Cardiac Cath Lab)
50 per year	Portable X-rays and C-Arm Fluoroscopy
30 per year	Pediatric ICU and O.R.

4. Average Annual Doses of Radiation Per Person in (mR):

Nuclear reactor (50-mile radius)	
Natural background	
cosmic rays	35.00
air	5.00
building materials	34.00
food	25.00
ground	11.00
Man-made sources	
coast-to-coast jet flight	5.00
color television	1.00
chest X-ray (one)	30-50

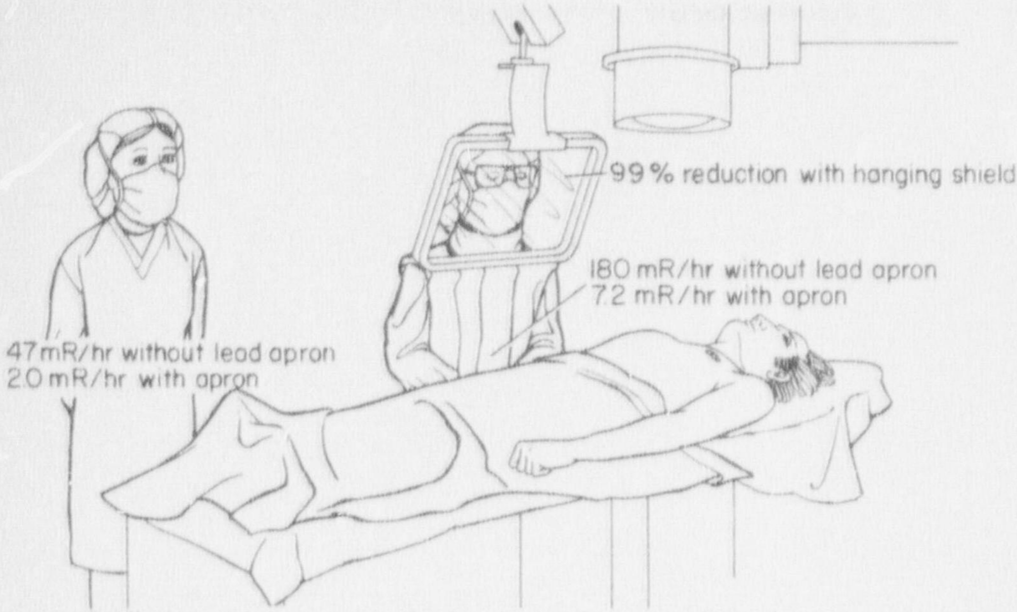
SCATTER RADIATION EXPOSURES: DIAGNOSTIC PROCEDURES

Type of Study	Distance From Center of Patient						Annual
	18 inch		36 inch		72 inch		Personnel Exposures Records 1983
Use of Lead Apron	No	Yes	No	Yes	No	Yes	
Fluoroscopy (special procedures)	180 mR/hr	7.2 mR/hr	47 mR/hr	2.0 mR/hr	9.7 mR/hr	0.4 mR/hr	1001 mR
Cine-Fluoroscopy (Cardiac cath.)	862 mR/hr	26 mR/hr	265 mR/hr	8.0 mR/hr	60.0 mR/hr	2.0 mR/hr	1232 mR
Portable X-ray (including C-Arm Fluoro)	120 mR/hr	4.0 mR/hr	38 mR/hr	1.2 mR/hr	12.0 mR/hr	0.4 mR/hr	50 mR
Pediatric ICU (including O.R.)	1.8 mR/hr	—	—	—	—	—	30 mR
Nuclear Medicine (Brain, bone, etc.)	3.7 mR/hr	—	0.92 mR/hr	—	—	—	680 mR

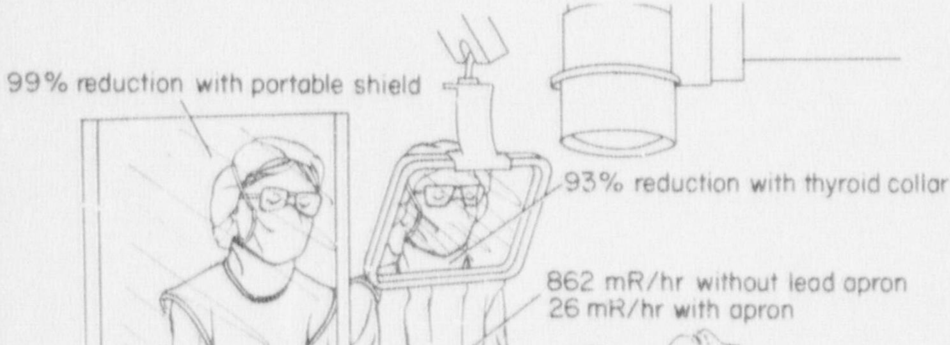
Reduction Due to Protective Devices: Special Procedures

Radiation Exposure	Without	With	Reduction (%)
1. Heavy Lead Gloves	7.78 R/min	144 mR/min	98%
2. Flexible Lead Gloves	7.78 R/min	4.3 R/min	45%
3. Hanging Glass Shield (1/2")	390 mR/hr (fluoroscopy)	4 mR/hr	99%
	5875 mR/hr (cinefluoroscopy)	165 mR/hr	97%
4. Portable Glass Shield (1/2")	228 mR/hr	2.7 mR/hr	99%
5. Thyroid Collars	46 mR/hr	3.4 mR/hr	93%

Reduction of personnel radiation exposure due to use of portable lead shield.



Radiation Exposure Levels in x-ray fluoroscopy patient procedure. Reduction of personnel radiation exposure due to use of lead apron and hanging lead shield. For portable x-ray and mobile C-arm fluoroscopy refer to the table of measurements.

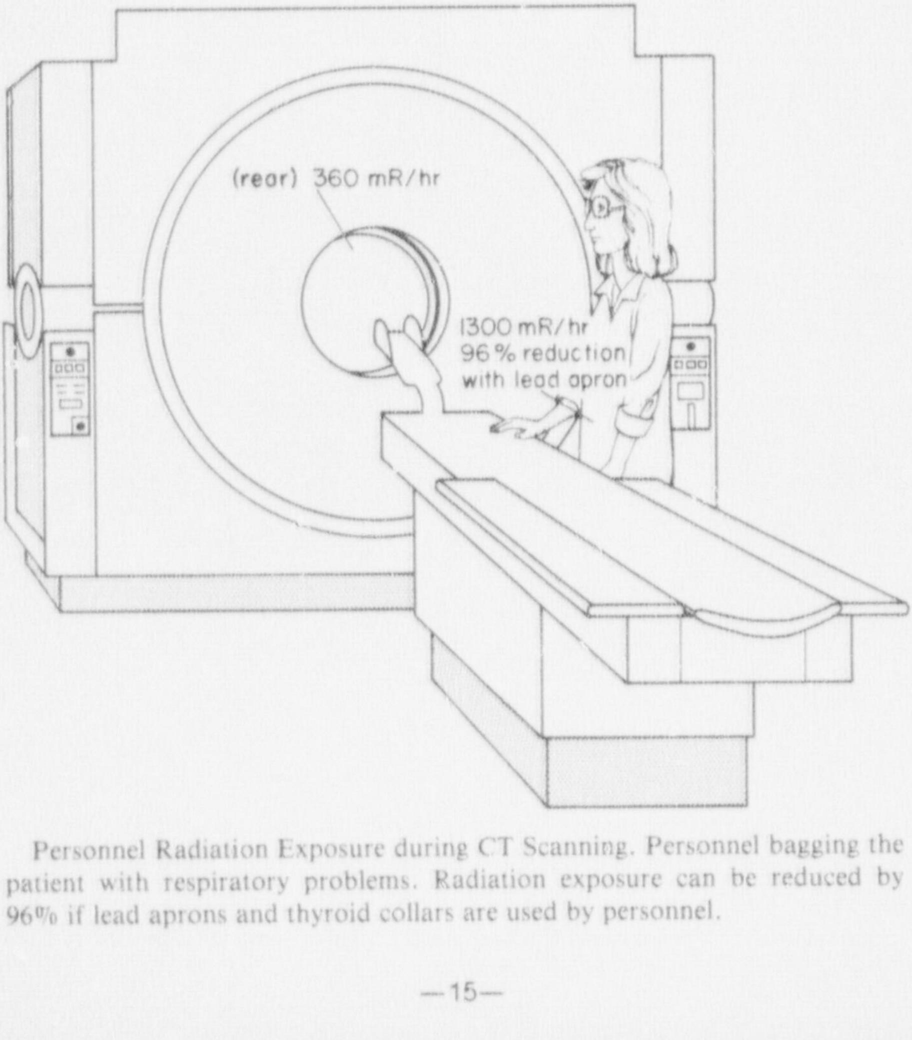


Radiation Exposure Level in x-ray cine-fluoroscopy patient procedure in Cardiac Catheterization Laboratory. Reduction of personnel radiation exposure due to use of portable lead shield, hanging lead shield, lead apron, thyroid lead collar and lead gloves.

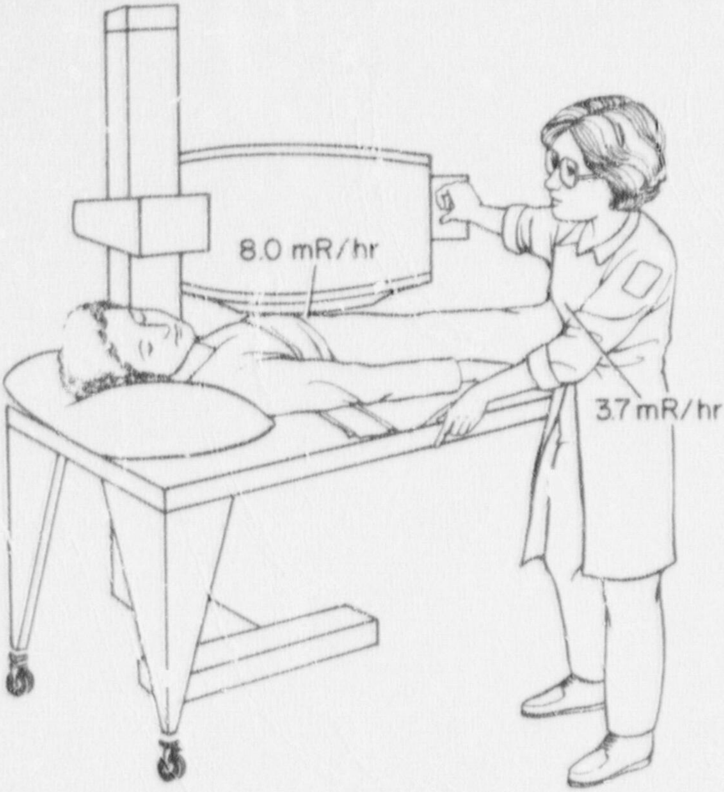
Personnel Radiation Exposure (mR/hr) During CT Scanning
(Personnel Bagging the Patient with Respiratory Problems)

CT Scanner: Technicare 2060; 120 kVp; 10 mm slice

Scan Study	Front		Rear	
	12 inch	36 inch	12 inch	36 inch
Head 400 mAs 25 cm dia.	1300 mR/hr	140 - 150 mR/hr	360 mR/hr	35 - 45 mR/hr
Abdomen Spine 200 mAs 40 cm dia.	Large: Small:	795 - 1006 mR/hr 370 - 545 mR/hr	Large: Small:	245 - 325 mR/hr 70 - 120 mR/hr



Personnel Radiation Exposure during CT Scanning. Personnel bagging the patient with respiratory problems. Radiation exposure can be reduced by 96% if lead aprons and thyroid collars are used by personnel.



Personnel Radiation Exposure Levels in Nuclear Medicine patient procedure. Reduction in exposure can be achieved by increasing the distance from the patient.

What are the radiation levels on the surface of a radioactive package?

The measured radiation levels on the surface of a radioactive package received at BMC are:

1. On Surface: 0.5 mR/hr to 110 mR/hr
   (Small package to large package)
   (Diagnostic dose to therapy dose)
2. At 3 feet: 0 mR/hr to 6 mR/hr

SOURCES OF RADIATION EXPOSURE IN NUCLEAR MEDICINE LABORATORY

(Yearly frequency and Exposure Times are based on BMC Lab's average per technologist)

Exposure Studies	Activity	Frequency per Year	Exposure Time	Exposure Rate mR/hr	Yearly Exposure mR
1. Exposure from patients injected with 20 mCi Tc-99m					
- to fingertips during patient positioning	20 mCi	1000	1 min	20	400
- to whole body due to Tc-99m patient at 3 ft.	20 mCi	1000	10 min	1	200
2. Exposure to fingertips from top of Tc-99m generator during placement and removal of saline and vacuum vials	1600 mCi	250	10 sec	80	60

Scatter Radiation Exposures: Therapeutic Procedures

Type of Treatment	Location of Personnel from Patient			Annual Personnel Exposures Records 1983
	Bedside	3 ft.	6 ft.	
Cs-137 (capsules) 55 mg Ra Eq	45.0 mR/hr	12.0 mR/hr	4.0 mR/hr	45.0 mR
Cs-137 (needles) 10-15 mg Ra Eq	22.0 mR/hr	6.0 mR/hr	2.0 mR/hr	
Ir-192 (seeds) 18-22 mg Ra Eq	18.0 mR/hr	5.0 mR/hr	1.0 mR/hr	
I-131 (liquid) 150 mCi	50.0 mR/hr	15.0 mR/hr	5.0 mR/hr	

Radiation Exposure to Nursing Staff working with Brachytherapy (Cs-137, Ir-192, I-131, etc.) patient. Reduction in personnel exposure can be achieved by increasing the distance and by reducing the time spent at bedside. For needles and seeds implants refer to the table of measurements.

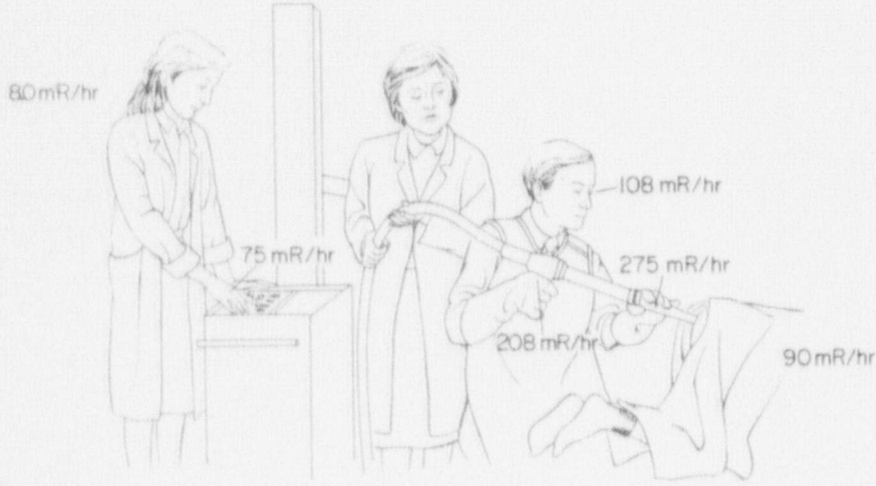
Radiation Exposures (mR/hr) During Rectal Therapy

Technique Factors: 50 KV; 2 mA; 1.0 mm Al filter; 3.0 cm cone

Measurements: Calibrated Survey Meter and Patient Phantom

Location	Distance*	Scattered Exposure Level	Personnel
Right Side of the Patient	15"	90 mR/hr	Nurse
Center of X-ray Tube Assembly	13"	275 mR/hr	Therapist
Hand Grip on Tube Assembly	21"	208 mR/hr	Therapist
Control Console	54"	75 mR/hr	Technologist
Eye-level of Therapist	30"	108 mR/hr	Therapist
Right Side of the Patient	36"	112 mR/hr	Dosimetrist
Towards the Entrance Door	72"	8 mR/hr	Visitor

* All distances from end of cone.



Personnel Radiation Exposure during Rectal Therapy treatment of a patient. Reduction of radiation exposure can be achieved by use of lead apron, thyroid collars and increased distance for support staff. For other staff locations refer to the table of measurements.

BMC ANNUAL STATISTICAL SUMMARIES: PERSONNEL RADIATION MONITORING

Range of Exposures in REM

Year	Total #	NME	0-0.1	0.1-0.25	0.25-0.5	0.5-0.75	0.75-1.0	1-2	2-3	3-4
1978	182	59	57	29	13	5	10	8	1	—
1979	194	62	52	35	13	14	5	12	1	—
1980	214	48	72	42	26	11	6	6	0	3
1981	215	50	75	37	22	11	4	12	1	3
1982	218	80	70	20	23	9	4	7	2	3
1983	206	85	57	24	14	12	5	8	1	—

(Numbers of employees in Range of Exposures in Rem)

Analysis of Radiation Monitoring of Medical Workers

Permanently Assigned Medical Workers in Specialty Group
Average Annual Exposures - mR

Year	Cardiac Cath Laboratory	Nuclear Medicine Laboratory	Special Proc. Laboratory	Nursing Staff Brachytherapy Patient
1979	1984	1026	1785	120
1980	1866	774	1527	83
1981	1715	771	1463	66
1982	1624	720	1306	51
1983	1232	680	1001	45
5 year Reduction	38%	34%	44%	63%

Rules of Safety: Portable X-rays

a. All personnel within 3 feet of fluoro patient shall wear lead aprons.

b. No personnel shall intercept the primary beam with any part of their body during fluoro study.

c. All others keep a distance of 6 feet or more from patient.

d. No pregnant employee shall be within 6 feet when x-rays are produced.

e. No one under 18 years shall be allowed to work with radiation.

f. If nursing procedures permit, a lead apron or portable lead shield may be used for increased protection during x-ray production.

g. Refer to Hazardous Dose Limits and Personnel Dose Limits.

h. Persons beyond 6 feet perimeter from x-ray 'ube head receive radiation exposures far less than the annual exposure due to background radiation.

BAYSTATE MEDICAL CENTER
Policy for Pregnant Nonradiological Employees

Radiation Dose Limit

"During the entire gestation period, the maximum permissible dose equivalent to the *fetus* from occupational exposure of the expectant mother should not exceed *0.5 rem* or *500 mrem*."

Note: The occupational exposure of the expectant mother should not exceed the maximum permissible dose limit of 1300 mrems to 1500 mrems during the entire gestation period.

This National Council on Radiation Protection recommendation is also the maximum permissible dose limit prescribed by Nuclear Regulatory Commission and other regulatory agencies.

To comply with the above requirement all BMC nonradiological employees shall follow the following procedures:

— Whenever an individual employee suspects she may be pregnant (interruption of regular menstrual cycle) she will report to Health Service where a pregnancy test will be done free of charge.

— Such individual employees with suspected pregnancy will also report to their immediate supervisor.

— The supervisor shall ensure that an individual employee with suspected pregnancy shall not be assigned to take care of a Radioactive Therapy (Cesium-137, Radon-222, Iodine-131, Iodine-125, Iridium-192, etc.) patient or assigned to work in Radiation Areas (X-ray rooms, Nuclear Medicine Labs, Radiation Therapy, etc.) with active sources. Employees with suspected pregnancies can continue to work with Nuclear Medicine patients and they can enter Radiation Areas temporarily.

— If the pregnancy is confirmed, then the pregnant employee shall not work with Radioactive Therapy patients or be present during Cardiac Cath, Portable X-rays, Special Procedures involving radiation.

— However, pregnant employees can assist in the care of Nuclear Medicine patients and they can enter Radiation Areas temporarily.

— It is highly recommended that supervisors shall make every effort to assign pregnant employees to a safe radiation free environment.

Note: Radiation Safety Officer will be available to answer any questions that a pregnant employee may have concerning radiation effects, risks and safe procedures. Phone: 787-5405.

BAYSTATE MEDICAL CENTER

Policy for Pregnant Radiological Employees

Radiation Dose Limit

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Note: The occupational exposure of the expectant mother should not exceed maximum permissible dose limit of 1300 mrems to 1500 mrems during the entire gestation period.

This National Council on Radiation Protection recommendation is also the maximum permissible dose limit prescribed by Nuclear Regulatory Commission and other regulatory agencies.

To comply with the above requirement all BMC Radiological employees shall follow the following procedures:

— Whenever an individual employee (student or technologist) is routinely assigned to a Radiation Area, (Diagnostic X-rays, Radiation Therapy, Nuclear Medicine, Ultrasound, Thermography, C.T. Scanning, Radiation Safety, etc.) and suspects she may be pregnant (interruption of regular menstrual cycle) she will report to Health Service where a pregnancy test will be done free of charge.

— The individual employee will also report to her immediate Supervisor and Radiation Safety Officer.

— Until the results of pregnancy are conclusive the supervisor shall ensure that the individual employee has her duties restricted as follows:

1. Diagnostic Radiology - *Cannot work* during Fluoroscopy, Special Procedures and with Portable X-ray Equipment.
   Can work in Diagnostic X-ray Room, Darkroom, Front Desk, File Room, etc.
2. Radiation Therapy - *Cannot work* in Cobalt or with Brachytherapy Sources or Radioactive Therapy patients.
3. Nuclear Medicine - *Cannot work* in Hot lab but *Can Work* in Nuclear Medicine Lab. Do not handle high activities.
4. Ultrasound - *Can work* in Ultrasound and Thermography areas.
5. C.T. Scanning - *Can work* in Control Room Area and Assist in patient setups.

— The restrictions will continue during the entire gestation period if the pregnancy is confirmed.

— Supervisors shall ensure that the employees are assigned to a safe radiation free environment.

— Radiation Safety Officer will review periodically the occupational radiation exposure of the pregnant employee.

Note: Radiation Safety Officer will be available to answer any questions that a pregnant employee may have concerning radiation effects, risks and safe procedures. Phone: 787-5405.

Policy for Holding Patients

The following procedures are developed and based on the recommendation of National Council on Radiation Protection Report No. 48 (1976).

1. Under normal conditions and circumstances, patients having x-rays do not require additional personnel to aid the patient.
2. Occasions may arise when the patient must be restrained during the x-ray exposure. Some examples of patients requiring restraints are:
   a. pediatric patients
   b. mentally and physically handicapped patients
   c. geriatric patients
3. If patients require restraining several choices of restraints are available.
   a. mechanical devices, i.e., sponges, straps, tape, etc.
   b. personnel other than radiology technologists, i.e., family members, nursing, other hospital staff and paramedics.
4. Any individual who holds a patient and those within six feet (6 ft.) of the patient shall follow proper radiation protection precautions.
5. Proper radiation protection precautions include:
   a. use lead apron; use lead gloves - if applicable
   b. stay out of path of direct x-ray beam
   c. no pregnant person shall hold the patient
6. X-ray technologists and supervisors shall enforce the proper radiation protection precautions.
7. The personnel who occasionally encounter radiation exposure while working with patients receive radiation exposure (30 mR) *far less than* the *background radiation exposure* (100 mR per year).

BAYSTATE MEDICAL CENTER

NURSING INSTRUCTIONS & RADIATION SURVEYS: TEMPORARY IMPLANTS

☐ SPRINGFIELD HOSPITAL UNIT ☐ WESSON WOMEN'S UNIT ☐ WESSON MEMORIAL UNIT

Patient's Name ____________ Physician's Name ____________ Room # ______

Isotope ____________ Total Activity ____________ Total Number of Sources ____________

Brachytherapy Started: Date ____________ Time ____________

Sources to be Removed: Date ____________ Time ____________

I. **NURSING INSTRUCTIONS**: Comply with all checked (✓) items.

- ☐ Patient must have private room.
- ☐ Patient may not leave room.
- ☐ Visitors, employees and other personnel under 18 years are not permitted.
- ☐ Pregnant visitors, employees and other personnel are not permitted.
- ☐ Visiting time permitted: ____________ minutes.
- ☐ Visitors must remain: ____________ feet from patient.
- ☐ Place laundry in linen bag and save.
- ☐ Radiation monitors must be worn.
- ☐ Housekeeping may not enter the room.
- ☐ A dismissal radiation monitoring must be done before patient is discharged.
- ☐ All items must remain in the room until OK'd by Radiation Safety Officer.
- ☐ Do not release the room to Admitting until OK'd by Radiation Safety Officer.
- ☐ Do not exceed the occupancy times at each location given below.
- ☐ Phlebotomy work must be deferred until the end of therapy.
- ☐ Other instructions: ____________

NOTE: 1. Follow all the routine radiation precautions in nursing care of radioactive patient.
2. When radiation sources are removed from the patient, **physician or his assistant must complete the details of Item III below.**
3. After patient is discharged from the unit, please return the completed form to:

SURESH M. BRAHMAVAR, PH.D.
Director, Medical Physics & Radiation Safety Service

II. **INITIAL RADIATION SURVEY**:

Date: ______ Time ____________ Survey By: ____________

USE and COMPLETE THESE TAGS ☐ Door ☐ Chart ☐ Bed ☐ Other

Survey Meter ____________ ____________ Date of Calibration: ____________

LOCATION	BEDSIDE	3 FEET	6 FEET	ENTRANCE DOOR	ADJACENT ROOM #	
					Patient Site	Other
mR/hr						
OCCUPANCY TIME (100 mR per wk.)						

III. **SOURCE REMOVAL & RADIATION MONITORING**:

Total Activity ____________ Number of Sources: ____________ Isotope ____________

Date of Removal: ____________ Time of Removal ____________

- ☐ Radiation sources were returned to the storage safe in "hot lab."
- ☐ Radiation monitoring indicated that no sealed sources remained in the patient.
- ☐ Radiation monitoring of room and patient items indicated no significant radiation levels present in the room.
- ☐ Discharge instructions were given to patient and nursing staff.

Radiation sources removal and monitoring by: ____________

IV. **RADIATION SAFETY OFFICE**:

Radiation Safety Officer Inspection ____________ Date: ____________

Items of Non-Compliance: ☐ I ☐ II ☐ III ☐ None

Corrective Action ____________

RSO #57 PROSPECT PARK PRESS 1 BL

BAYSTATE MEDICAL CENTER

NURSING INSTRUCTIONS & RADIATION SURVEYS: PERMANENT IMPLANTS & ISOTOPE THERAPY

☐ SPRINGFIELD HOSPITAL UNIT ☐ WESSON WOMEN'S UNIT ☐ WESSON MEMORIAL UNIT

Patient's Name: ____________ Physician's Name: ____________ Isotope: ____________

Total Activity ____________ Date of Assay ____________ Time of Assay ____________

Therapy Started: Date ____________ Time ____________ Room # ____________

I. NURSING INSTRUCTIONS: Comply with all checked (✓) items)

- ☐ Patient must have private room and may not leave room.
- ☐ Visitors, employees and other personnel under 18 years are not permitted.
- ☐ Pregnant visitors, employees and other personnel are not permitted.
- ☐ Visiting time permitted: ____________ minutes.
- ☐ Visitors must remain: ____________ feet from patient.
- ☐ Place laundry in linen bag and save.
- ☐ Retain all disposable items used by patient.
- ☐ Radiation monitors must be worn.
- ☐ Housekeeping may not enter the room.
- ☐ A dismissal radiation monitoring must be done before patient is discharged.
- ☐ All items must remain in the room until OK'd by Radiation Safety Officer.
- ☐ Disposable gloves must be worn during patient care.
- ☐ Do not exceed the occupancy times at each location given below.
- ☐ Phlebotomy work must be deferred at least for 48 hours.
- ☐ Patient shall be discharged only when activity is less than ____________
- ☐ Phlebotomy technicians should call RSO for instructions.
- ☐ Other instructions: ____________

NOTE: 1. Follow all the routine radiation precautions in nursing care of radioactive patient.
2. When the patient is discharged from hospital, **physician or his assistant must complete the details of Item III below.**
3. After the patient is discharged from unit, please return the completed form to:

SURESH M. BRAHMAVAR, PH.D.
Director, Medical Physics & Radiation Safety Service

II. INITIAL RADIATION SURVEY:

Date: ____________ Time: ____________ Room #: ____________ Survey By: ____________

USE AND COMPLETE THE FOLLOWING TAGS:

☐ Door ☐ Chart ☐ Bed ☐ Other ____________

Survey Meter: ____________ Date of Calibration: ____________

LOCATION	BEDSIDE	3 FEET	6 FEET	ENTRANCE DOOR	ADJACENT ROOM # Patient Site	ADJACENT ROOM # Other
mR/hr						
OCCUPANCY TIME (100mR/wk)						

III. RADIATION MONITORING & PATIENT DISCHARGE:

ISOTOPE ASSAY	DATE					
ACTIVITY IN PATIENT	mR/hr at 1 m					
	mCi					

ACTIVITY AT DISCHARGE SHALL BE LESS THAN ____________ mCi.

Activity at Discharge ____________ Isotope ____________ Date ____________ Time ____________

☐ Radiation monitoring of room and patients items indicated no significant radiation levels present in the room.

☐ Discharge instructions were given to the patient regarding household members.

Radiation Monitoring By: ____________ Patient Discharge By: ____________

IV. RADIATION SAFETY OFFICE:

Radiation Safety Officer Inspection: ____________ Date: ____________

Items of Non-Compliance: ☐ I ☐ II ☐ III ☐ None

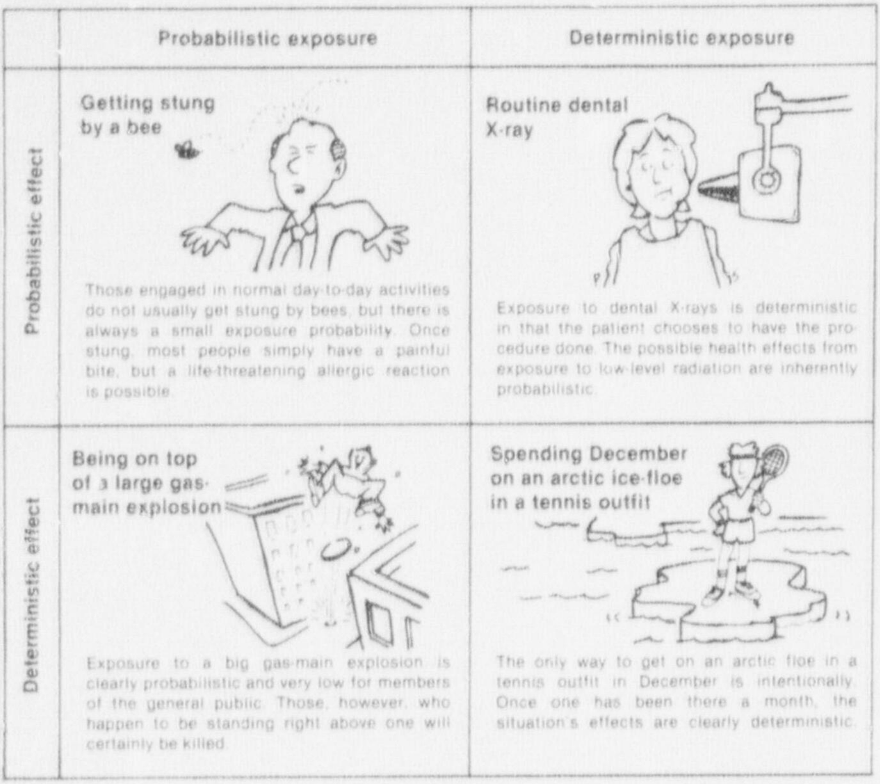
Corrective Action: ____________

RSO #2 PROSPECT PARK PRESS 5 GR

What is meant by risk?

Risk can be defined in general as the probability (chance) of injury, illness, or death resulting from some activity. The intent of this document is to estimate and explain the possible risk of injury, illness, or death resulting from occupational radiation exposure.

Drawing by S. Harris; Copyright 1979, *The New Yorker Magazine.*



Risk involves the exposure to a chance of injury or loss. The chance or probabilistic aspect of risk can be introduced through exposure processes, effects processes, or both, yielding four possible combinations of exposures and effects. (From Morgan, 1981, p. 63. Copyright 1981, IEEE.)

Risk: How People See It

The public's idea of what is most risky usually differs widely from the estimated mortality for each activity. When three groups were asked to rank 30 products or activities from most to least risky, they came up with the ordering below.

Activity and Deaths per year (Est.)	League of Women Voters	College Students	Business and Professional Club Members
1. Smoking (150.000)	4	3	4
2. Alcoholic beverages (100,000)	6	7	5
3. Motor Vehicles (50,000)	2	5	3
4. Handguns (17,000)	3	2	1
5. Electric Power (14,000)	18	19	19
6. Motorcycles (3,000)	5	6	2
7. Swimming (3,000)	19	30	17
8. Surgery (2,800)	10	11	9
9. X-rays (2,300)	22	17	24
10. Railroads (1,950)	24	23	20
11. General (private) aviation (1,300)	7	15	11
12. Large construction (1,000)	12	14	13
13. Bicycles (1,000)	16	24	14
14. Hunting (800)	13	18	10
15. Home appliances (200)	29	27	27
16. Firefighting (195)	11	10	6
17. Police work (160)	8	8	7
18. Contraceptives (150)	20	9	22
19. Commercial aviation (130)	17	16	18
20. Nuclear Power (100)	1	1	8
21. Mountain climbing (30)	15	22	12
22. Power mowers (24)	27	28	25
23. High school and college football (23)	23	26	21
24. Skiing (18)	21	25	16
25. Vaccinations (10)	30	29	29
26. Food coloring*	26	20	30
27. Food preservatives*	25	12	28
28. Pesticides*	9	4	15
29. Prescription antibiotics*	28	21	26
30. Spray cans*	14	13	23

* Data on mortality from these sources are too uncertain to estimate.

How can we compare radiation risk to other kinds of health risks?

Perhaps the most useful unit for comparison among health risks is the average number of days of life expectancy lost per unit of exposure to each particular health risk. Estimates are calculated by looking at a large number of individuals, recording the age when death occurs from apparent causes, and estimating the number of days of life lost as a result of these early deaths. The total number of days of life lost is then averaged over the total group observed.

Several studies have compared the projected loss of life expectancy resulting from exposure to radiation with other health risks. Some representative numbers are presented in the following table.

Estimated Loss of Life Expectancy From Health Risks

Health Risk	Estimates of Days of Life Expectancy Lost, Average
Smoking 20 cigarettes/day	2370 (6.5 years)
Overweight (by 20%)	985 (2.7 years)
All accidents combined	435 (1.2 years)
Auto Accidents	200
Alcohol consumption (U.S. average)	130
Home accidents	95
Drowning	41
Safest jobs (such as teaching)	30
Natural background radiation, calculated	8
Medical x-rays (U.S. average), calculated	6
All catastrophes (earthquake, etc.)	3.5
4 rem occupational radiation dose, calculated (industry average is 0.34 rem/yr)	1
1 rem/yr for 30 years, calculated	30
5 rems/yr for 30 years, calculated	150

These estimates indicate that the health risks from occupational radiation exposure are not greater than the risks associated with many other events or activities we encounter in normal day-to-day activities.

Equivalent Risks

1	Tc-99m brain scan	3	Packs of cigarettes
18	Chest radiographs	10	Pieces of pie (a-la-mode)
1	Small bowel x-ray study	3	Years in Denver

Cohen and Lee, Beir 1980, MIRD

Nobel laureate Dr. Rosalyn Yalow on Radioactive Waste Disposal.

"Let us consider another fact. As *an adult, living, human being my body contains natural radioactivity; 0.1 μCiK-40 and 0.1 μCi C-14 are the predominant radioisotopes.* According to the current rules of the Nuclear Regulatory commission (NRC), if I were a laboratory animal who had received this amount of radioactivity as "by-product material" and died with this radioactivity still in my body, I could not be buried, burned or disposed of in the garbage. My carcass would have to be packed into a small can, inside a larger can and transported to a site for disposal of radioactive wastes."

Dr. Edward Teller on Radiation Exposure.

"Every person in the United States *receives an average of 25 millirems of radioactivity annually from the consumption of food.* This is 2,500 times more than from a nuclear reactor's proximity. A small part of this food-produced radiation is also radiated out of the body. *Thus, when Ralph Nader and the antinuclear groups gather to hold a rally, they receive much more radiation from each other* than any 2,500 nuclear reactors could provide." As *Dr. Edward Teller* once put it, *"In sleeping with a woman one gets just slightly less radioactivity than from a nuclear reactor. But to sleep with two women is very, very dangerous."*

Who to Call for Help?

The Radiation Safety Office is located on Main 4 at the Springfield Unit of Baystate Medical Center.

The following personnel can be contacted to report any radiation-related incident or to obtain specific information involving radiation.

1.	Dr. Suresh M. Brahmavar Director/Radiation Safety Officer	Office: 787-5405 Home: 567-7867
2.	Ms. Martha LaFrance, BS; RTT Dosimetry Physicist	SHU: 787-5405 WMU: 787-3660
3.	Mr. Kevin Maroney, ARRT Dosimetrist	SHU: 787-5755 WMU: 787-3660
4.	Ms. Alanna Tidwell, B.S., ARRT QA Supervisor	SHU: 787-5755 WMU: 787-5802
5.	Ms. Cynthia Vanderlick, ARRT, NMT QA Supervisor	SHU: 787-5755 WMU: 787-5802
6.	Ms. Cathy Miller, ARRT Radiation Safety Technologist	SHU: 787-5405 WMU: 787-5802
7.	Ms. Susan Majka, ARRT Radiation Safety Technologist	SHU: 787-5405 WMU: 787-5802
8.	Ms. Peggy Rishel Secretary, Radiation Safety Office	Office: 787-5405

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RADIATION SAFETY OFFICE

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