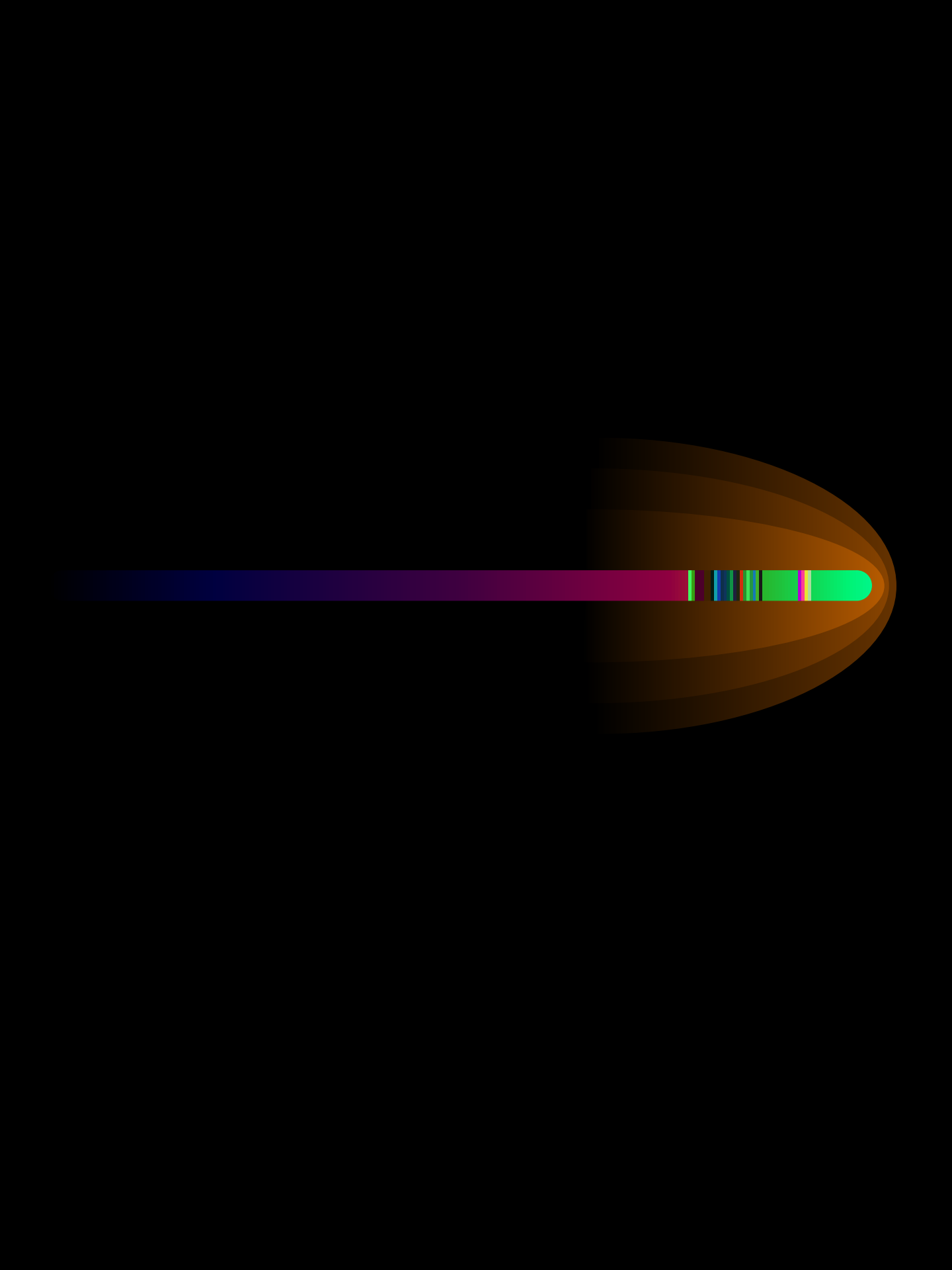
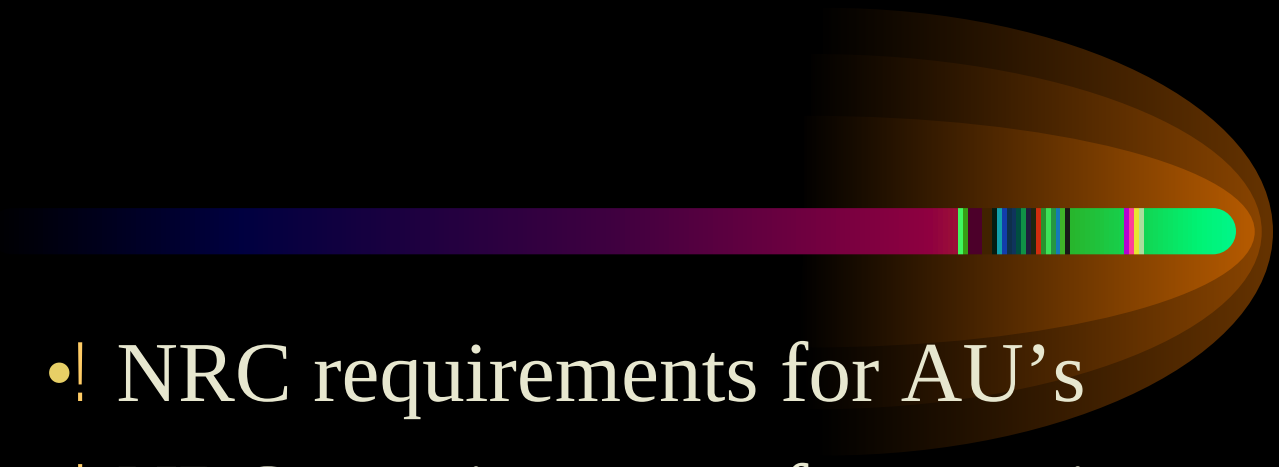




- NRC requirements for AU’s
- NRC requirements for certain expected radiation levels
- To promote safe lab practice
- To inform users/non-users
-

First, some jargon:

- Nuclear Regulatory Commission, NRC
- Radiation Safety Officer, RSO
- Authorized User, AU
- Radioactive Isotope
- Radiation
- “As Low As Reasonably Achievable”, ALARA

SUPPLEMENTARY SHEET

Authorized Users Material and Use

not be put into use until tested.

(i) they contain only hydrogen-3; or

(ii) the half-life of the isotope is 30 days or less; or

By law, our training must include the following:

- **Characteristics of Ionizing Radiation**
  - i. ! , - , # –emission
  - ii. Penetrating power and Halflife
-

- **Radiation Protection Principles**
  - i. Time, Distance and Shielding
  - ii. ALARA

Alpha ( ) Particles

Beta ( ) Particles

Gamma ( ) Ray

REM

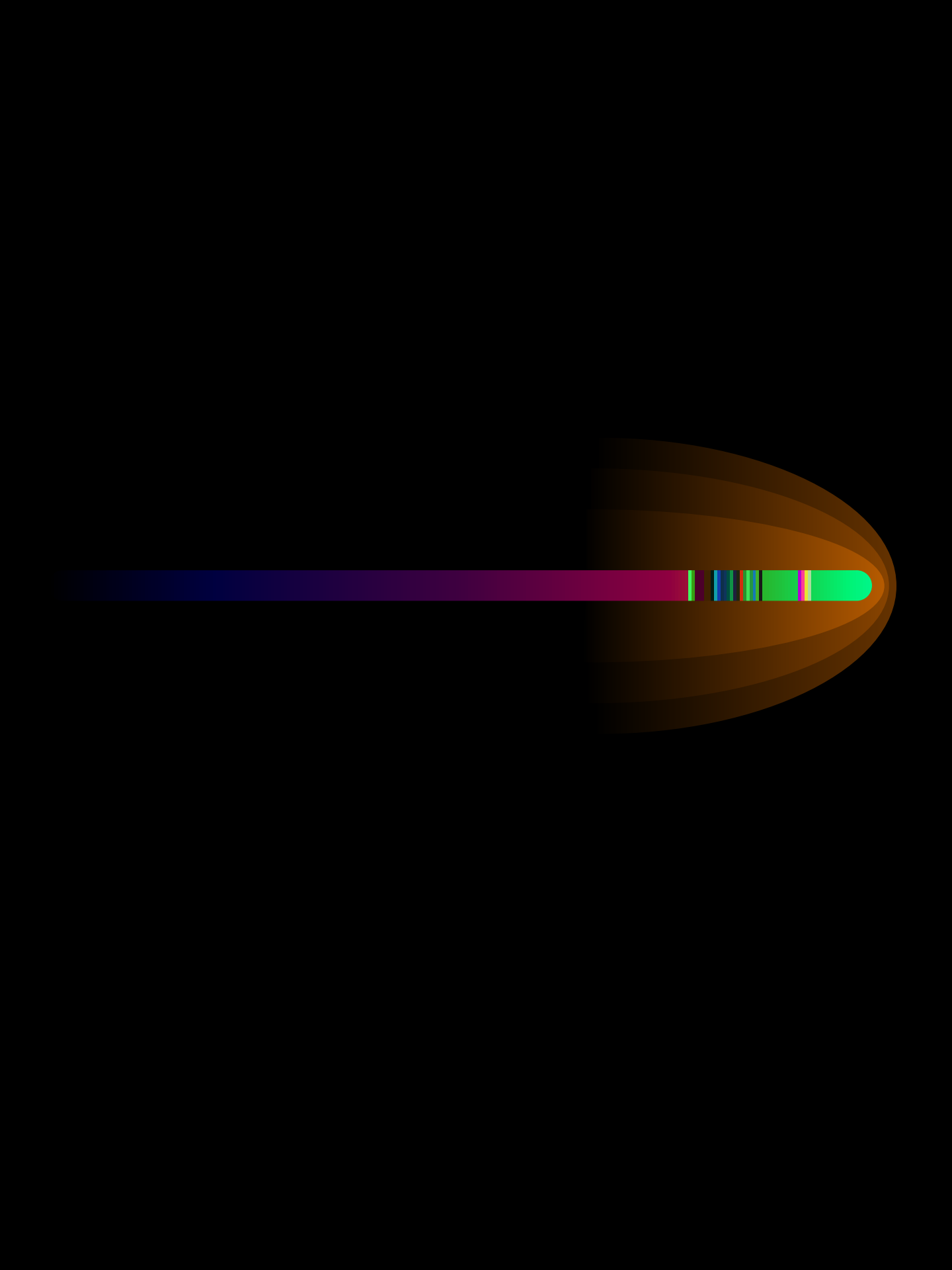
-Reflects the dose absorbed by the body

-Characterizes the levels which indicate safe vs. unsafe physiological conditions

The NRC designates various allowable dose limits for respective organs:

Internal organs - 50 rem/year

Lens of the eye - 15 rem/year



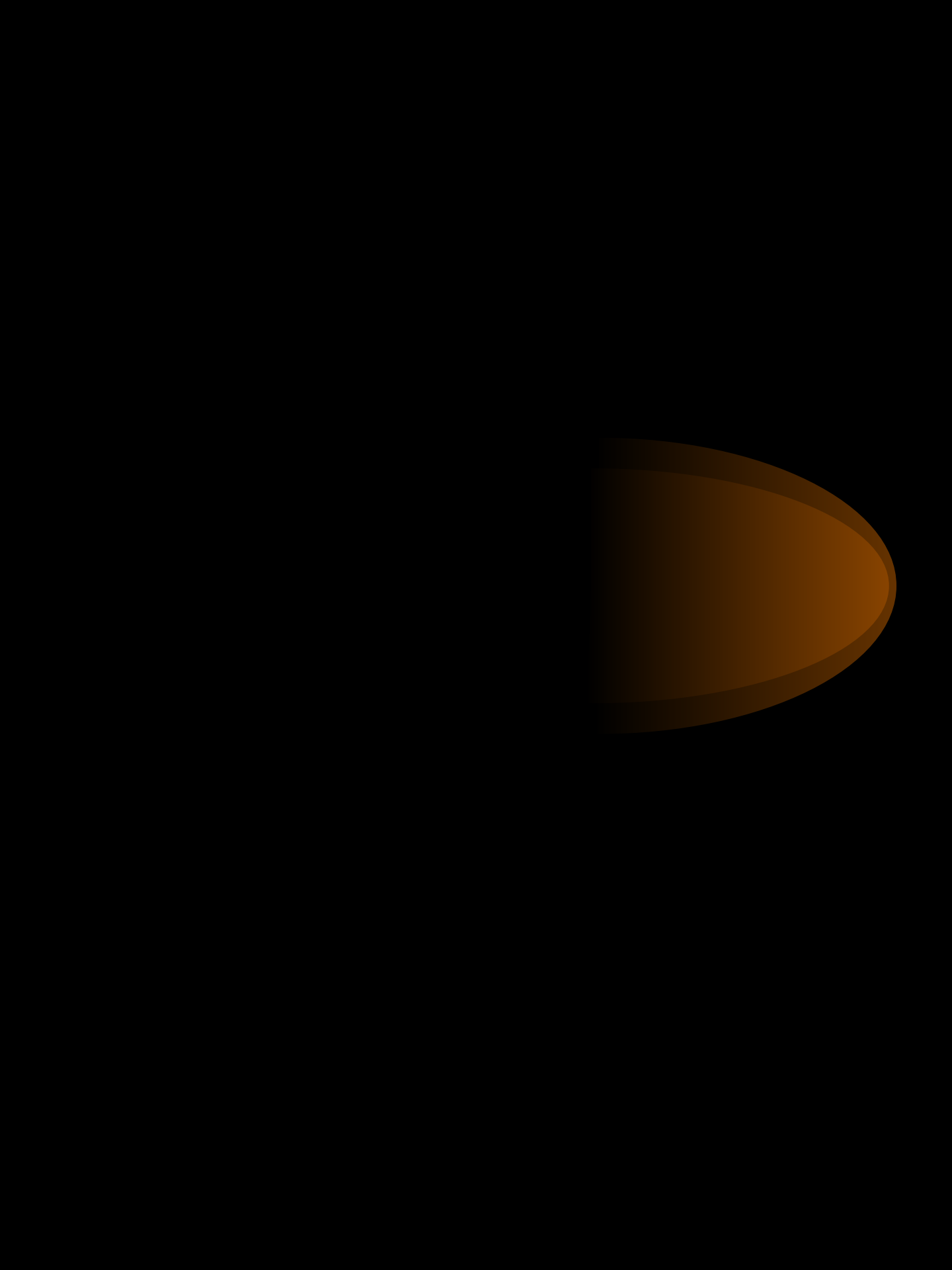
Naturally-Occurring Radiation

Every year you receive 360 mrem of dose from Natural and Man-made sources!

Natural	Man-made
Cosmic-27 mrem	Medical-53 mrem
Terrestrial-28 mrem	Weapons-1 mrem
Airborne-200 mrem	Reactor-0.4 mrem
Internal-40 mrem	Occupational-4 mrem

Consumer Products

Tobacco - Pb^{210}, Po^{210}
Illumination - H^{3}, Ra^{226}
Smoke Detectors - Am^{241}
Fuels - $Radon^{222}$
Building Materials - U, Th
Fiesta Ware - U
Lantern Mantles - Th
Lite Salt - P^{40}

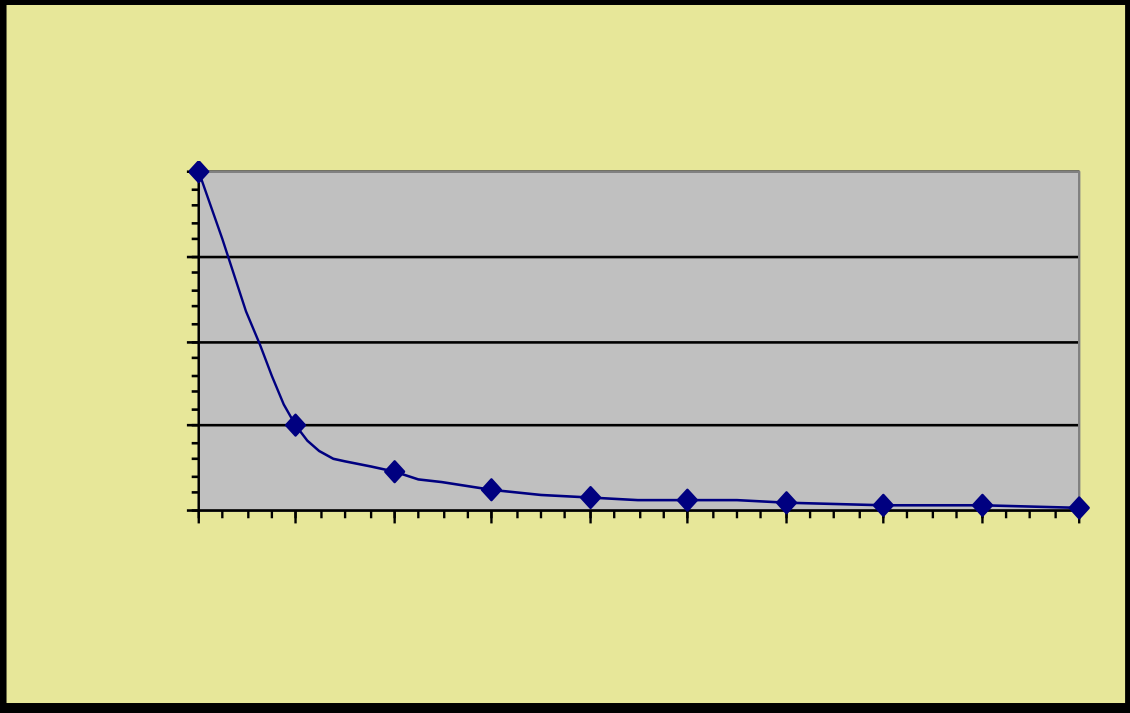


Time

- Radioactivity, by nature, is time dependent.
  - The source you finish a study with is not the source you began with.
- Rates of external exposure are linear with the time spent near the source.
  - Double the time, Double the exposure.
- There are a variety of ways to limit the time (exposure) to radioactive sources.
  - Dry runs and training
  - Separate work and documentation areas
  -

Distance

The strength of a radioactive source decreases with the square of the distance from it.

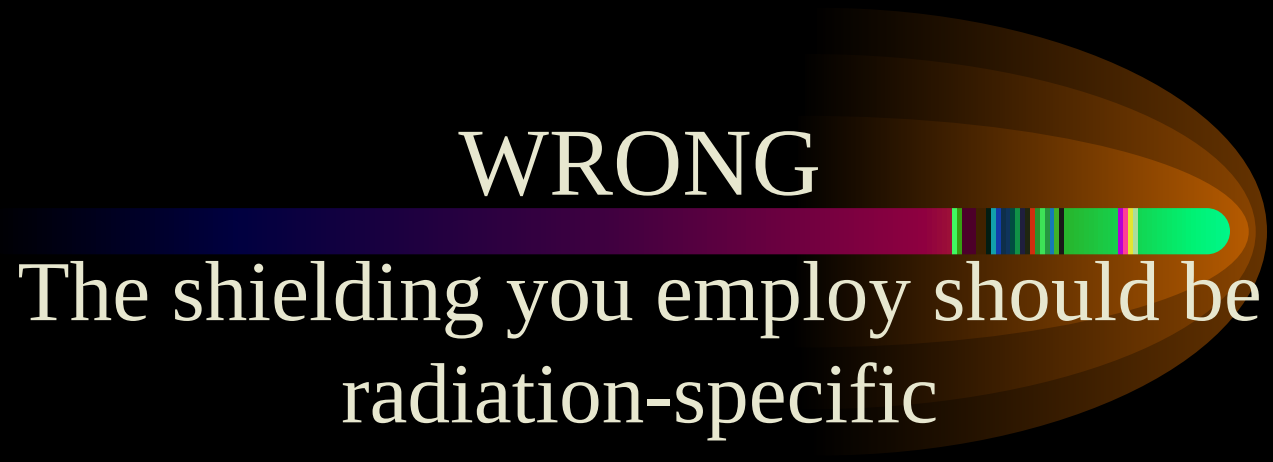


Shielding

Everyone knows that lead is the best shield for any type of radiation.

Right?

WRONG



The shielding you employ should be radiation-specific

<u>Using the wrong shielding can</u>:

- Cause unnecessary weight
- Take up unnecessary space
- Introduce new, undesirable radiation

Shielding

- Alpha (!) particles are totally absorbed by a few centimeters of air or few sheets of paper
- Beta ( ) particles are stopped in a few meters of air or a few centimeters of plexiglass.
  - Absorption is energy dependent
  - Use of lead, unless sufficiently thick, can bring about unabsorbed x-rays.
  - Plexiglass absorbs ’s without the x-ray production
- Gamma absorption requires lead or other High-Z material
  - Absorption is exponential

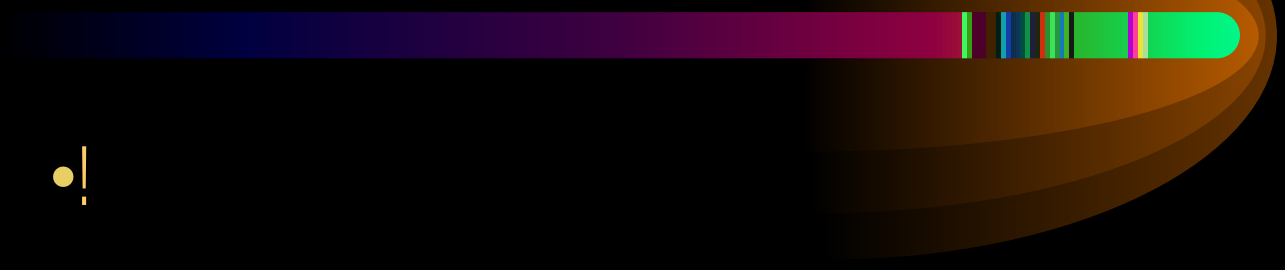
Isotope Inventory

Now, how do we use each detector and what are we reading when we do?

Detectors

- GM Probes
  - Detect #/ radiation
  - Reads out milli-roentgen (mr)/hr
  - Only used for surveys, not for exposure
- Bicron Survey Meter
  - Only detector that measures exposure
  - Detects all radiation
- NaI Gamma (#) Probe
  - Primarily a # detector.
  - Will indicate presence of decays through secondary x-rays
  - Need thin window probe for I^{125}
- Liquid Scintillation Counter
  - Used primarily to detect presence of H^3, C^{14}, S^{35} and other low energy radiation.
  -

Radiation Risk Factors



- !

Somatic Effects

Since it is impossible to attribute a single individual's cancer to a single cause, the only way to designate radiation as a cause is to look at statistics with large sample populations.

Data

Normal incidence of cancer is ~30%

Normal death rate due to cancer is 20%

Cancer risk due to radiation

0.04% / rem (for high dose rate)

So if you were to absorb 1 rem in a rapid manner the overall risk grows to

20.04%

(Data from Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences)

Genetic Effects

Our only data, similar to somatic studies, is of large populations that have been exposed.

Of all the Japanese survivors of the Hiroshima and Nagasa[2 0.2 ([8

Embryonic Effects

Effects suffered by an individual due to exposure while still an embryo/ fetus

Remember that the NRC limit for the duration of a pregnancy is 500 mrem or 10% of the normal yearly dose limit if declared.

Childhood Cancer

Mental Retardation

Hands-On Use

- Safety/Emergency Procedures
- Ordering, Receiving, and Opening Packages
-

APPENDIX B

Operating Procedures
for the
Safe Use of Radioactive Isotopes

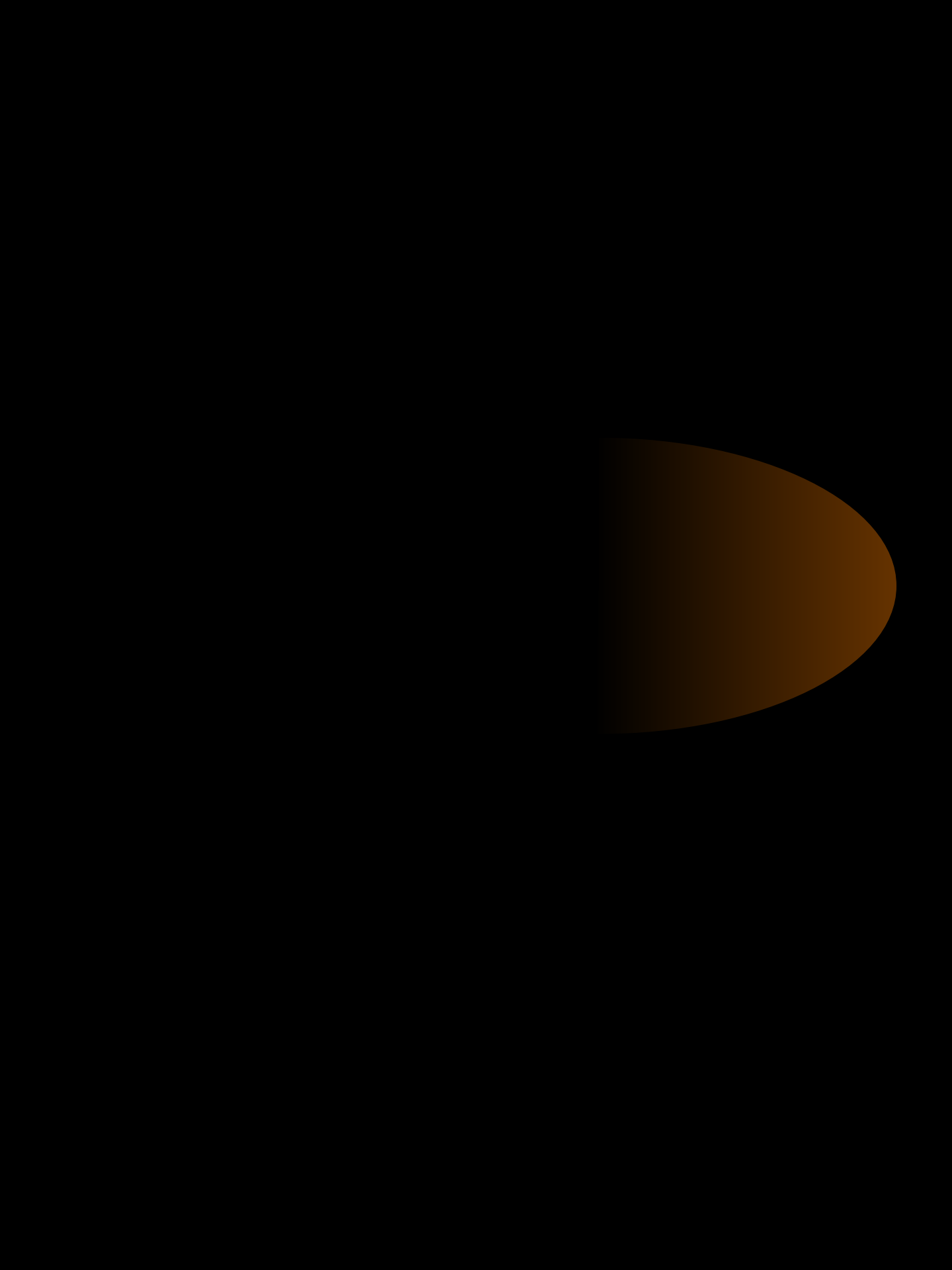
1) All use of radioisotope material shall be conducted under the supervision of a faculty member certified as an Authorized User (AU).

2) The AU shall limit the quantity of radioactive material used by students under his supervision so as not to exceed the maximum dose allowed by regulation.

3) Adequate personal protection equipment must be worn or used by all individuals using radioactive material. This shall include, but is not limited to, rubber gloves and a laboratory coat.

4) Active participation in laboratory exercises during which radioactive isotopes are utilized by students that are known to be pregnant is strictly prohibited.

5)



Receiving and Opening Packages

Care is taken in the receipt and opening of

Receipt of material is the responsibility of the AU in accordance with procedures in Appendix A of our application

RADIOACTIVE SHIPMENT RECEIPT/USAGE REPORT

1. **ISOTOPE_____ ACTIVITY_____(mCi, µCi) Volume_____(L, mL)**

2. **P.O. No._____ Survey Date_____ Time_____**

Surveyor_____ Signature_____ _____

3. **CONDITION OF PACKAGE**
Comment_____

4. **RADIATION UNITS OF LABEL _____Units (mR/hr)**
Label: White I_____ Yellow II_____ Yellow III_____

5. **MEASURED RADIATION LEVELS**
a. Package Surface _____mR/hr
b. Three feet from surface _____mR/hr

6. **DO PACKING SLIP ATf ( ) 1f ( )**

Real-time Inventory & Disposal

- Notice that the Radioactive Shipment Receipt/Usage Form serves a dual role:
  - Records the receipt of material
  - Records the real time use and disposal of the contents of that shipment
- Each container of a shipment requires a form
- When a container is emptied, the form is completed and returned to RSO

Disposal of Radioactive Waste

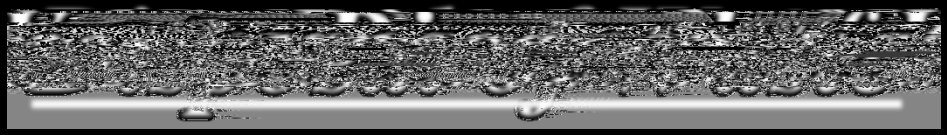
- The methods of disposal of radioactive material depend on:
  - Form (solid or liquid)
  - Type (!, , #)
  - Half-life (short- vs. long-lived)
- Items requiring special storage consideration are:
  - Used/Unused portions of isotope material
  - Contaminated items such as gloves, absorbent paper, LSC vials, etc.
- Methods of disposal available to us are:
  - Decay-in-storage (DIS)
  - Release into sanitary sewage
  - Disposal as if not radioactive

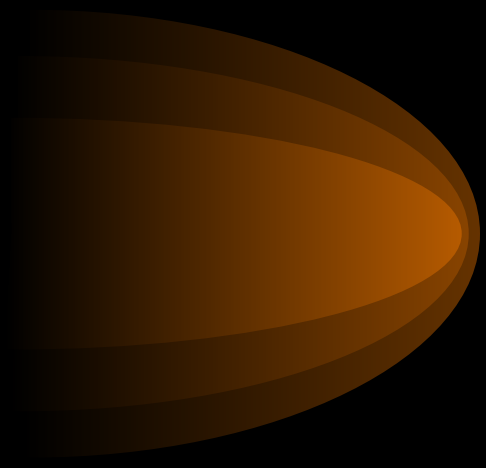
Decay-in-storage

- Isotopes with half-lives of 65 days or less have been designated by the NRC as appropriate for DIS
- What goes into DIS?
  - Used/unused portions that qualify
  - Objects contaminated with qualifying isotope material
- What is the rule?
  - Waste must be held for at least 10 half-lives of the longest lived isotope in the waste AND until the container's radiation levels are indistinguishable from background

Disposal in Sanitary Sewers

- All of our permitted levels of radiation which are liquids or soluble forms can be disposed of in designated “hot-sinks”
  - 5 Ci of H^3, 1 Ci of C^{14}, 1 Ci of all others
- Disposal of these forms must be accompanied by adequate dilution by running water during disposal
- Disposal must be limited to designated hot sinks
  - Provides notice to any maintenance personnel of potential radioactivity
  - Provides containment of waste to specified areas





Surveys / Records

- Places to Survey
  - Facilities
  - Equipment
  - Personnel
  - Restricted and Unrestricted areas
- Types of Surveys
  - General Area
  - Contamination
    - Fixed vs. Removable
  - Leak Tests

General Area Surveys

- Using appropriate monitor (GM or Rem), scan area with probe looking for hot spots.
  - Floor / Benchtops
  - Equipment
  - Individuals
  - Restricted and Unrestricted areas
    - Restricted levels should be <2.5 mrem/hr
    - Unrestricted levels should be <2 mrem in any one hour

- Contamination surveys should be completed on a periodic basis or:
  - After a spill
  - When processes have changed
  - Before leaving a radiation area
  - Near areas adjacent to presence or storage

Bi-annual Inventory / Records

- All isotope material must be inventoried twice a year

- On April 15th and October 15th of each year must identify and document on provided forms the type and quantity of radioactive material on hand

APPENDIX D

Student Training Certification
and
Disposition to Safely Handle Radioactive Material

Name:_____ Age:____ Gender: __M __F

Address:_____ Phone:_____

Class for which certification is required:_____Semester/Year_____

Isotopes to be used:_____

Instructor:_____

By signing below I affirm that I have received training on the safe handling and use of radioactive isotopes. I understand that my participation in exercises utilizing radioactive material requires the highest levels of safety and that any breach of safe operating procedures on my part will result in my dismissal from said exercises. I affirm that I am not pregnant at this time and that if this disposition changes I am obliged to inform my instructor before further participation in exercises using radioactive materials.

Signature:_____Date:_____