



***FIELD ENVIRONMENTAL  
INSTRUMENTS, INC.***

# **Radiation Safety Training**

PADEP Approved 2014

# Presentation Objectives

- End User Safe Radiation Handling
  - ▣ Educate end user on radiation and how to protect themselves.
  - ▣ Cover the details of safe, proper analyzer operation.
  - ▣ Provide quick, **easy-to-understand** radiation safety training for certification.
- End User Requirements
  - ▣ Take and pass the radiation safety training test.
  - ▣ Understand end user responsibility.

# Radiation Overview

- Radiation = form of energy (particles/waves)
- Electromagnetic Radiation Spectrum—EMR
  - ▣ Radio frequency
  - ▣ Microwave
  - ▣ Infra-red
  - ▣ Visible Light
  - ▣ Ultraviolet - UV
  - ▣ X-Ray (THIS IS WHAT THE XRF UNIT PRODUCES)
  - ▣ Gamma Radiation

# Types of Radiation

- Ionizing >10eV
  - ▣ Cause ionization of atoms.
  - ▣ Eject electrons atoms—make “charged” atoms.
- Non-ionizing
  - ▣ Does NOT **cause** ionization.

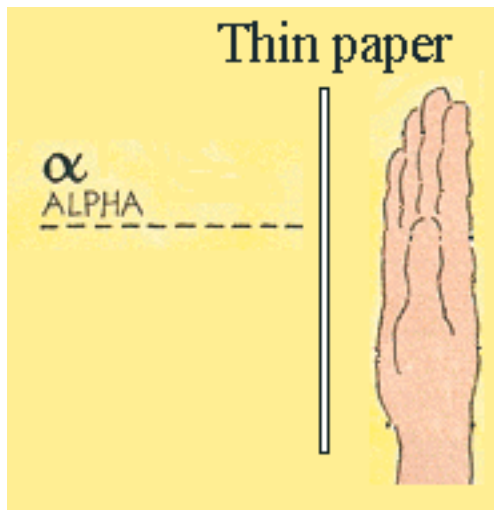
# Ionizing Radiation

- Particles (FAST!)
  - Alpha particles (2 neutrons + 2 protons)
  - Beta particles (electrons)
  - Neutrons
- Waves (High Energy Light!)
  - X-Rays
  - Gamma Rays

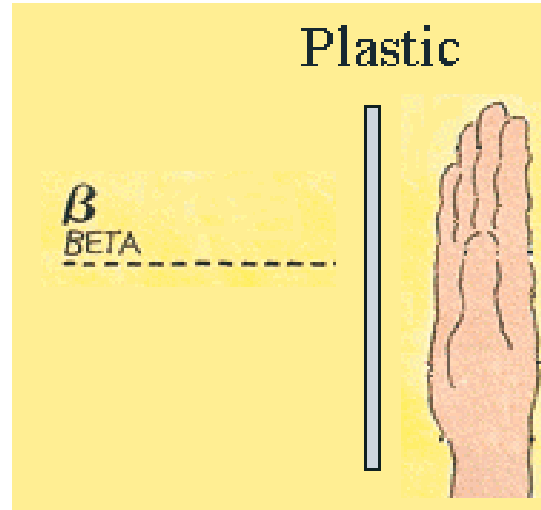
# Penetration of Ionizing Radiation

Following are examples of materials that can block the different types of ionized radiation

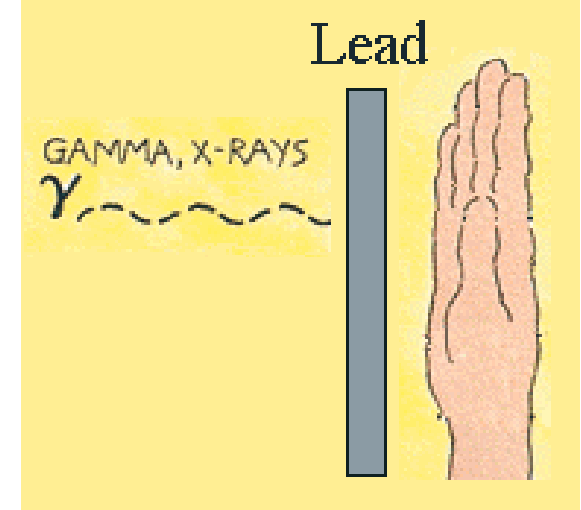
## ALPHA



## BETA



## GAMMA & X-Ray



# Radiation Safety Definitions

- RAD = Radiation Absorbed Dose
- REM = Roentgen Equivalent Man
- A REM = RAD X Factor
  - ▣ (Factors X-Ray=1, Alpha=20)

# Biological Effects of Radiation

- Most Sensitive—Rapidly dividing cells
  - ▣ Bone marrow
  - ▣ Lining of digestive tract
  - ▣ Some skin cells
- Least Sensitive
  - ▣ Bone
  - ▣ Muscle
  - ▣ Nerves



# Standards & Guidelines

- Maximum Permissible Limits (MPL's) determined by:
  - ▣ National Council on Radiation Protection
  - ▣ International Commission on Radiological Protection
- ALARA **(REMEMBER THIS!!!!!!!)**
  - ▣ All radiation exposure should be “As Low As Reasonably Achievable.”
- Typical Allowable Radiation Doses
  - ▣ 5 rems per year (whole body)
  - ▣ 50 rems (extremity or individual organ)
  - ▣ 0.5 rems during pregnancy

# Typical Radiation Exposure

□ Airline Attendant	1,000 mR/yr
□ Nuclear Power Worker	700 mR/yr
□ Grand Central Station	120 mR/yr
□ Medical Personnel	70 mR/yr
□ Lead Inspector	20 mR/yr
□ University Researcher	<10 mR/yr
□ Chest X-Ray	100 mR/each

# Safety Factors to Follow

- Time, Distance, Shielding
  - ▣ Time—Limit Exposure Dose
  - ▣ Distance—Maintain Safe Distance
  - ▣ Shielding—High Density Materials

# Specific to Innov-X XRF Units

- Minimize exposure during use
- Safety features
- Misuse examples
- Use common sense

# Exposure Calculations @ Trigger

$$\begin{aligned} <0.1 \text{ mREM/hr} \times 24 \text{ hr/day} &= 2.4 \text{ mREM/day} \\ \times 365 \text{ days/year} &= 876 \text{ mREM/year} \end{aligned}$$

That means that using the XRF nonstop for an entire year is less than 1 REM/year = 20% of reportable exposure

# Exposure During Use

- Do not put fingers, or any other body part in front of the analyzer window.
- Verify that no one else stands within three paces of the analyzer window when instrument is on.
- Correct operation of instrument involves leaving one hand on handle, and making sure the other hand is away from the window.

# Safety Features

- “Deadman” Trigger
- Software trigger lock
- Software “proximity sensor”
- Test Stand
- Use Common Sense

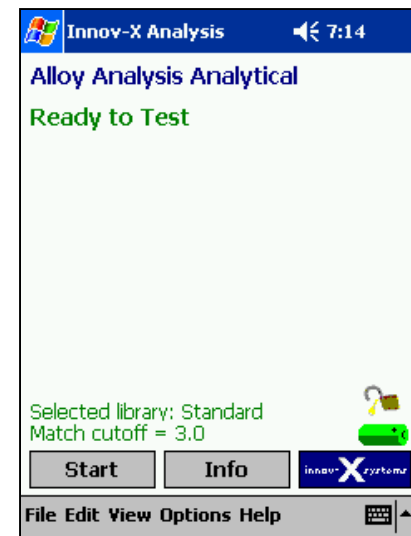
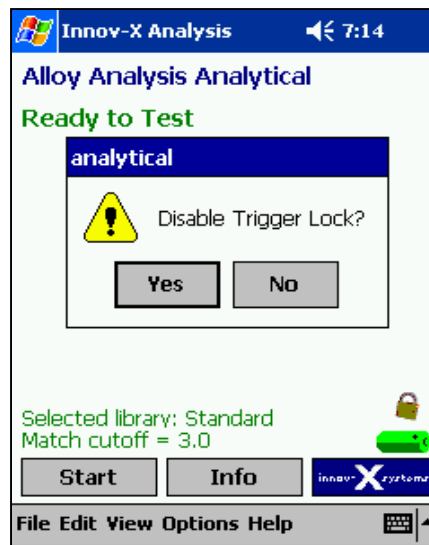
# Deadman Trigger

- Proper use means trigger must be held for duration of test and released to end the test.
- Ensures the users intentionally start each test.
- Prevents user from walking away and leaving instrument on.
- If user picks up analyzer and inadvertently pulls trigger, test will end as soon as trigger is released.
- Deactivation is NOT recommended and can only be instructed by FEI under special circumstances.



# Software Trigger Lock

- User must release software trigger lock before testing.
- Once released, trigger lock remains disabled until five minutes elapse after the end of a test.

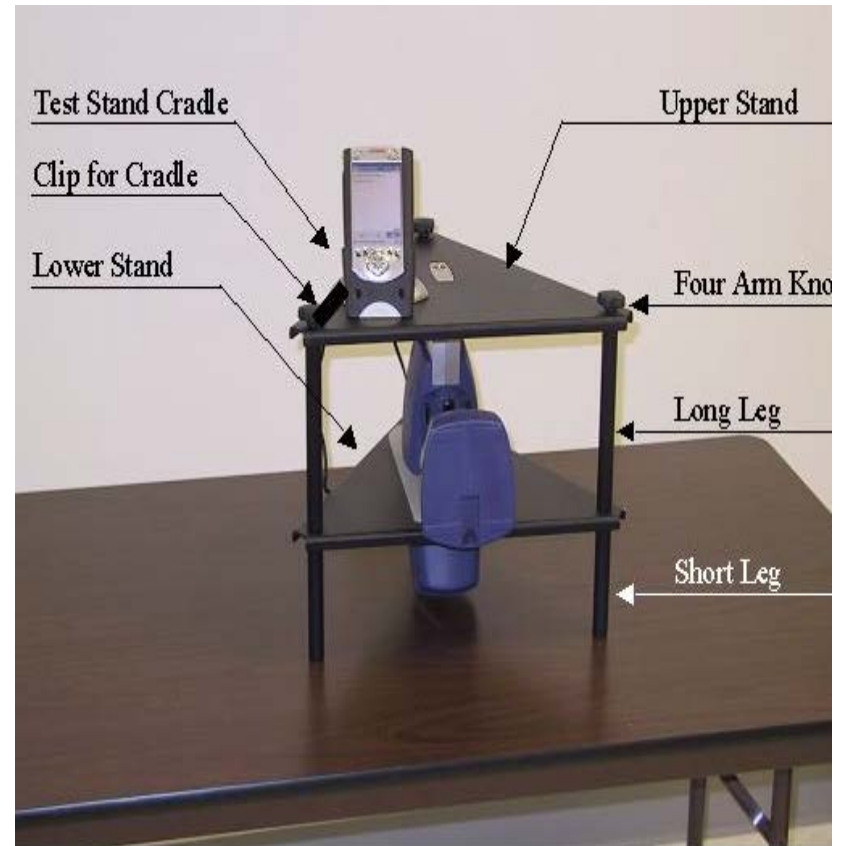


# Software Proximity Sensor

- Instrument will shut off after 1-2 seconds if sample is not present.
  - Analyzer checks count rate, if count rate is not significantly above air rate, X-Rays shut off.

# Test Stand Option

- Allows for “hands-free” operation of instrument.
- Ideal for turnings and other small parts, soil samples, etc.



# Use Common Sense

- Remember, when energized, X-Rays come out of the front of the analyzer and act accordingly.
- Prevent exposure to front of analyzer when instrument is on.
- Pay attention to all warning lights on instrument.
- ALWAYS REMEMBER
  - ALARA **(REMEMBER THIS!!!!!!!)**
    - All radiation exposure should be “As Low As Reasonably Achievable.”

# Know Your Responsibility

- Ultimately, it is up to the end user to understand the regulations within the state of operation.
- FEI is available to assist in answering questions and offer technical/operational/transportation support.
  - 800-393-4009 – keep this number handy for easy access to FEI technical support. If you reach this number after hours, press 2 on the corporate voicemail to be directly connected to FEI tech support.

# Just A Few More Notes

- Make sure there is no one, co-worker or building occupant, is on the other side of a wall or directly in line with where you are operating the unit.
- Pregnant women or women of child bearing years may request a copy of the Regulatory Guide provided by the U.S. Nuclear Regulatory commission by calling FEI at 800-393-4009.
- Recognize and seek medical attention if you see one of these acute exposure signs:
  - ▣ First symptoms – nausea, vomiting, diarrhea
  - ▣ Second symptoms – skin damage like a sunburn, swelling itching and redness
  - ▣ More information can be found at [http://www.epa.gov/radiation/understand/health\\_effects.html](http://www.epa.gov/radiation/understand/health_effects.html)

- Please take the [test](#). This will allow you to access the review test and ensure your competency for the safe handling and operation of the Innov-X Systems' XRF Units and radiation safety.
- Upon passing the test, you will receive via e-mail your certificate for successful completion of the FEI safe radiation handling program and a copy of your test answers. In addition, FEI will send you a business card size certificate and will maintain your records for training and passing of the test within our customer database.