Worker Hazards and Worker Exposure

Bruce Snead – MURC at Kansas State University
U.S. Background

- U.S. EPA-based radon mitigation training has been designed around a set of defined competencies developed by EPA in 1989
  - Other than monitoring worker radon exposure, the worker health and safety competencies have been very limited
    - U.S. EPA Radon Mitigation Standards and ASTM 2121 reflected these limited worker health and safety competencies
    - U.S. EPA 1992 Radon Mitigation Employee Health and Safety: Student Manual goes into greater detail and is described on the next page
- Radon training and standards also are very limited in attention to occupant health and safety ~ mitigation
The MURC Director co-authored this manual

- 45 pages
- Table of Contents (major sections only)
  I. Overview and Introduction
  II. Respiratory Hazards and Protection in Radon Mitigation Work
      (need, selection, inspection procedures, facefit checks, fit-test, cleaning, maintenance, cartridge change, physical examination, documentation)
  III. Monitoring Worker Radon Exposure
  IV. Safe Mitigation Practices
      (radiation, noise and hearing conservation, asbestos, electrical safety, eye safety)
  V. Hazard Communication and Chemical Safety

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Hazards: Alot of Critical Info Beyond U.S. Radon Mitigation Standards!

Standards Partially Addresses:
- Chemical Hazards and Safety
- Electrical Hazards and Safety
- Fire Hazards and Safety
- Respiratory Hazards and Protection
  - Asbestos and Radon and RDPs
- Slips, Trips, and Fall Hazards

Standards Do NOT Address:
- Confined Space Hazards and Safety
- Driving Hazards and Safety
- Ergonomic Safety
- Eye, Face, Foot and Hand Hazards and Protective Clothing
- Heat and Thermal Hazards and Safety
- Lead Hazards and Protection
- Noise Hazards and Hearing Protection
- Tool Safety
EPA Radon Mitigation Standards

So what did the U.S. Radon Mitigation Standards say about worker health and safety?

- **Must (aka shall) comply with OSHA standards** ¹
- Unless a sole proprietor, contractor
  - **Must advise workers of hazards of exposure to radon** ¹
  - **Must have a worker protection plan** that is available to all workers ²
  - **Must ensure ladders are safely installed and used** ²
- **Electrical equipment**
  - **Must be grounded and circuits should be GFIC protected** ³

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¹ EPA and AARST RMS as well as ASTM
² EPA and AARST RMS only
³ EPA RMS only
EPA Radon Mitigation Standards

• If combustible materials are present and work may produce a flame,
  • Must provide a suitable fire extinguisher in the work area
• Must ventilate work areas to reduce worker exposure to
  Radon decay products (more in later slides),
  Dust, and
  Other airborne pollutants

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1 EPA and AARST RMS as well as ASTM
2 EPA RMS only
EPA Radon Mitigation Standards

- In areas where it is suspected that friable asbestos may exist and be disturbed,
  - Must not proceed with mitigation until a trained and certified determines the work will comply with asbestos regulations

- Where sealants, adhesives, paints or other substances are used which may be hazardous, contractors
  - Must provide MSDS and explain the required safety procedures

- Also, all standards require monitoring worker radon exposure which will be described later in this unit

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1 EPA and AARST RMS as well as ASTM
Sample Worker Health and Safety Plan

www.elibrary.dep.state.pa.us/dsweb/View/Collection-9112

- Permanent record required
- Must follow OSHA
- Training required
- Safety equipment must be available
- Worker protection plan required with annual review
- Electrical and ladder requirements
- Must vent work space
- Fire extinguisher required
- Worker exposure must be recorded
### Sample Worker Health and Safety Plan

**COMMONWEALTH OF PENNSYLVANIA**  
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**  
**BUREAU OF RADIATION PROTECTION**

#### 2.7 EXAMPLE OF RADON EXPOSURE TRACKING RECORD

<table>
<thead>
<tr>
<th>Date</th>
<th>Job Site or Number</th>
<th>Radon Level (pCi/L)</th>
<th>Working Level (WL)</th>
<th>Hours of Exposure (HR)</th>
<th>Working Level (WLM)</th>
<th>Cumulative Exposure (WLM)</th>
<th>Method Used to Assess Exposure</th>
<th>Serial Number</th>
<th>Supervisor Initials</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>+200=</td>
<td>X</td>
<td></td>
<td>+170=</td>
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<td></td>
<td>+170=</td>
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<td>X</td>
<td></td>
<td>+170=</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Based upon an annual recommended health and safety limit of 4 working level months (WLM)  
   \[ WL = \text{pCi/L} \text{ (Assuming 50\% ER)} \]  
   \[ 200 \]  

2. Highest Premitigation Level (a)  
   - On-Site Measurement (b)  

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*This documentation is not required to be submitted but must be available for review as part of the Department’s inspection program.*

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What’s the Research? NIOSH Radon Mitigation Worker Exposure Study – (Bloom, 1996)

- The National Institute for Occupational Health and Safety Institute (NIOSH) studied occupational exposures of mitigation workers in 21 job sittings
  - Equivalent radon decay product exposures in 2 sites with 95 and 192 pCi/L exceeded NIOSH’s Recommended Exposure Limit (REL) of 1 Working Level Month if experienced 40 hours per week over a year
  - These findings reinforce the need for adequate ventilation of the mitigation work area
NIOSH Radon Mitigation Worker Exposure Study  (Bloom, 1996)

- Mitigation workers may be exposed to elevated noise during drilling, hammer drilling, chiseling, and vacuuming.
- The standards for noise for 8 hours of continuous exposure are:
  - NIOSH Recommended Exposure Limit (REL) for exposure to noise is 85 decibels (dBA)
    - One hour NIOSH REL is 100 dBA
  - OSHA Permissible Exposure Level (PEL) limits exposure to 90 dBA
    - One hour OSHA PEL is 105 dBA
- In the NIOSH study of 21 mitigation jobs, short-term exposure to noise ranged from 99 to 112 dBA
  - Ear (hearing) protection would preclude hearing loss.
### Typical Decibel (dBA) Levels

[www.sengpielaudio.com/TableOfSoundPressureLevels.htm](http://www.sengpielaudio.com/TableOfSoundPressureLevels.htm) and [www.brandontoolhire.co.uk/safety/vibration/downloads/eav/media/pdf/Brandon_EAV_Power_Tools_V1_03_11b.pdf](http://www.brandontoolhire.co.uk/safety/vibration/downloads/eav/media/pdf/Brandon_EAV_Power_Tools_V1_03_11b.pdf)

<table>
<thead>
<tr>
<th>Tools</th>
<th>dBa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drills, Cordless</td>
<td>70-89</td>
</tr>
<tr>
<td>Drills, Percussion</td>
<td>99</td>
</tr>
<tr>
<td>Drills, Hammer</td>
<td>89-108</td>
</tr>
<tr>
<td>Drills, Dry Diamond</td>
<td>94</td>
</tr>
<tr>
<td>Saws, Circular Wood</td>
<td>80-108</td>
</tr>
<tr>
<td>Saws, Jig</td>
<td>73-85</td>
</tr>
<tr>
<td>Saws, Reciprocating</td>
<td>83-88</td>
</tr>
</tbody>
</table>

### Reference Levels

- **Threshold of pain**: 130
- **OSHA 1 Hour Permissible Exposure Level**: 105
- **NIOSH 8 Hour Recommended Exposure Level**: 85
NIOSH Radon Mitigation Worker Exposure Study  (Bloom, 1996)

- Organic solvents from glues and sealants used in mitigation observed during the NIOSH study contained:
  - Acetone .......................... Narcosis (unconsciousness), eye irritation
  - Methyl Ethyl Ketone ...... Sensory irritation
  - Tetrahydrofuran .............. Narcosis, systemic (whole body) effects

- Maximum organic vapor concentrations, sampled from ½ to 4 hours:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Maximum Measured</th>
<th>NIOSH REL TWA</th>
<th>OSHA PEL TWA</th>
<th>STEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl Ethyl Ketone</td>
<td>67 ppm</td>
<td>200 ppm</td>
<td>300 ppm</td>
<td>200 ppm</td>
</tr>
<tr>
<td>Acetone</td>
<td>23 ppm</td>
<td>250 ppm</td>
<td>- -</td>
<td>1,000 ppm</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>32 ppm</td>
<td>200 ppm</td>
<td>250 ppm</td>
<td>200 ppm</td>
</tr>
</tbody>
</table>

- TWA = time weighted average as measured over an 8 hour day
- STEL = short-term exposure limit as measured over a 15 minute sampling period
- ppm = parts per million
Objective

- Prevent toxic exposure to workers

Specification

- The least toxic suitable material will be chosen
- Hazards associated with
  - Contaminated drywall
  - Fibers
  - Insulation
  - Foams
  - Lead
  - Defective or improperly used respirators and Personal Protective Equipment (PPE)
  - Sealants
  - VOCs

... will be eliminated

- All employees who may be exposed to hazardous chemicals need to be trained in the dangers of the chemicals and the precautions they are to take.
- There are four major elements of compliance required by the Hazardous Communication Standard:
  1. Material Safety Data Sheets (MSDSs)
     - You must have an MSDS for each hazardous substance you use.
     - The MSDSs must be available at each jobsite.
  2. Labels (e.g., portable containers)
     - All hazardous substance containers must be clearly labeled.
  3. Employee training.
  4. Written Hazard Communication Plan
     - A description of all activities in the previous three steps including a list of all hazardous substances used on the job as well as MSDSs.

For more information, see: [www.osha.gov/dsg/hazcom/index.html](http://www.osha.gov/dsg/hazcom/index.html)
Chemical Safety: SDS Example for a Brand of Polyurethane Caulk (page 1 of 3) – FYI

- Options?
  - Substitute product?
  - Ventilate workspace
  - Use NIOSH approved respirator
  - Wear safety glasses
  - Minimize skin contact
  - Do not ingest
  - Wash hands after handling

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1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: 3300 Colors

DISTRIBUTOR
Geocel, LLC
PO Box 398
Elkhart, IN 46515-0398
Product Stewardship: 574-264-0645

24 HR. EMERGENCY TELEPHONE NUMBERS
ChemTel - 800-255-3924

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
IMMEDIATE CONCERNS: CAUTION! May cause eye and skin irritation. May be harmful if swallowed.

POSSIBLE HEALTH EFFECTS

EYES: Contact may cause eye irritation.
SKIN: May cause moderate irritation. Repeated skin contact may cause sensitization or allergic skin reaction
INGESTION: Substance may be harmful if swallowed.
INHALATION: Possible respiratory irritant and potential respiratory sensitizer.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

EYES: Causes eye irritation.
SKIN: Irritation of the skin.
INGESTION: Ingestion of this material can cause mouth, throat, esophageal, and gastrointestinal tract irritation.
INHALATION: This product may be a respiratory irritant and potential respiratory sensitizer.

TARGET ORGAN STATEMENT: The eyes, lungs and skin may be targeted and damaged by components of the product.

HEALTH HAZARDS: This product contains Methylene Diphenyl Isocyanate (MDI) which is a potential skin sensitizer. Risk to your health depends on duration and concentration of exposure.

COMMENTS: Signs and symptoms of overexposure to this product include headache, irritation of upper respiratory tract, asthmatic symptoms, chest tightness, breathing difficulty, coughing, dizziness, weakness, fatigue, eye irritation, skin irritation, diarrhea.

3. COMPOSITION / INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS</th>
<th>EINECS</th>
</tr>
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<tbody>
<tr>
<td>Methylene Diphenyl Isocyanate</td>
<td>101-68-8</td>
<td>202-966-0</td>
</tr>
<tr>
<td>Polymeric Isocyanates</td>
<td>9016-87-9</td>
<td>-</td>
</tr>
<tr>
<td>1,2-Benzenedicarboxylic Acid DIC9-11 Branched Alkyl esters, C10 Rich</td>
<td>68515-49-1</td>
<td></td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

EYES: Immediately flush with plenty of water for at least 15 minutes. Get medical attention or advice.
SKIN: Remove contaminated clothing to prevent further skin exposure and dispose of properly. In situations involving considerable skin contact, place the contaminated person in a deluge shower for at least 15 minutes. For minor exposures, wash thoroughly with soap and cold water. Get medical attention if irritation persists.
INGESTION: If ingested, get immediate medical attention. Do not induce vomiting unless instructed to do so by medical personnel. Never give anything by mouth to a victim who is unconscious or has ingesting.
INHALATION: Remove to fresh air. Get medical attention immediately for a large dose exposure or if cough or other symptoms develop. Administer oxygen or artificial respiration as needed.

NOTES TO PHYSICIAN: Symptomatic and supportive therapy as needed.

5. FIRE FIGHTING MEASURES

FLASHPOINT AND METHOD: Not Established
EXTINGUISHING MEDIA: Dry chemical, foam, carbon dioxide (CO2), sand.
Respiratory Hazards

- Asbestos
- Blastomycosis (from a fungus in acidic soils with rotten organic material)
- Hantavirus (from infected rodents or their urine or droppings)
- Histoplasmosis (from a fungus in bat, bird, and other animal droppings)
- Radon
  - Particulate filtering respirators offer no protection against radon
    - However, majority of health risk is from radon decay products
- **Radon Decay Products (RDPs)**
  - **High Efficiency Particulate Air Filters (HEPA)**
    - Purple or magenta filters (same as for asbestos)
Respiratory Hazard Assessment: Radon and RDP

Opportunities for Exposure

- Entering a home with a “potential” radon problem
- Investigating a “known” radon concern - - - *Ignorance of radon levels is not an excuse*
- Installing radon systems
- Repairing radon systems

What does the U.S. standards say?

1. **Must record worker radon exposure at each jobsite** (e.g., CRM or ATD) or using highest previous radon measurement
2. **Must ensure workers are not exposed to more than 4 WLM/year**
3. **Recommend health and safety records, including WLM exposure logs, are kept for 20 years**
Respiratory Hazard Assessment: Short-term Radon Exposure During Diagnostics

- House was passively ventilated with vacuum cleaner outside.
- Diagnostic activities can create large exposures.
Measuring Worker Exposure to Radon and RDPs

<table>
<thead>
<tr>
<th>Working Level (WL)</th>
<th>Hours</th>
<th>WL Hours (WLH)</th>
<th>Working Level Month = WLH/170</th>
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<tr>
<td>1.10</td>
<td>2</td>
<td>2.20</td>
<td>0.0129</td>
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<td>0.5</td>
<td>8</td>
<td>4.00</td>
<td>0.0235</td>
</tr>
<tr>
<td>0.65</td>
<td>4</td>
<td>2.60</td>
<td>0.0153</td>
</tr>
<tr>
<td>0.04</td>
<td>3</td>
<td>0.12</td>
<td>0.0007</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>0.0524</td>
</tr>
</tbody>
</table>
Converting from pCi/L to WL for Calculating Employee Exposures

- Reminder - - - converting pCi/L to WL
  - \( Rn = \frac{100 \times WL}{ER} \)
  - Where \( ER = 0.50 \) or 50%
Calculating Exposure Based on Highest Radon Measurements

<table>
<thead>
<tr>
<th>House</th>
<th>Hours Worked</th>
<th>Highest Radon (pCi/L)</th>
<th>Working Level (Rn x 0.5)/100</th>
<th>Working Level Hours (WL x Hours)</th>
<th>Working Level Month (WLH/170)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>25</td>
<td>0.125</td>
<td>0.75</td>
<td>0.0044</td>
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<td>B</td>
<td>10</td>
<td>4</td>
<td>0.02</td>
<td>0.2</td>
<td>0.00012</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>4</td>
<td>0.02</td>
<td>0.2</td>
<td>0.00012</td>
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<tr>
<td>Total</td>
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<td></td>
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<td></td>
<td>0.00464</td>
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</table>
What Standards Apply?

- **Accumulative time-dose exposure shall not exceed:**
  - 4 WLM per consecutive 12 month period ~ OSHA

- Respiratory protection shall be worn when levels are above:
  - 30 pCi/L ~ EPA RMS and ASTM only
Respiratory Protection: Common Interpretations and Actions for Radon

- According to the EPA RMS and ASTM, **if pre-mitigation radon measurements are > 30 pCi/L**
  
  - Usually the first action that is taken in mitigation is to **ventilate the workspace by using a fan to bring outdoor air into the workspace**
  
  - If it is not possible to ventilate the workspace with outdoor air, workers must be supplied
    - An appropriate respirator
    - The workspace is monitored with a continuous radon monitor

- Employee personnel monitoring equipment should also be used and it is required by ASTM E 2121

- However, 2121 does NOT describe how this should be done

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Installing Radon Mitigation Systems

First, implement engineering controls, e.g.,

- **Ventilate work area to less than 0.3 WL**
  - . . . or 30 pCi/L assuming 100% (1.0) ER

If engineering control is insufficient,

- **Ensure available respiratory protection equipment in areas greater than 0.3 WL**
  - . . . or 30 pCi/L assuming 100% (1.0) ER
When Performing ASD Diagnostics, Limit High Radon Exposures

This is an engineering control
Respiratory Protection

**Objective**
- Minimize exposure to airborne contaminants,
  - e.g., insulation material, mold spores, feces, bacteria, chemicals
- Protect workers from toxic exposure

**Specification**
- Respirators appropriate for the contaminants present will be worn
  - e.g., N-95 or equivalent
  - OSHA Technical Manual Section VII: Chapter 2, part IV
- If friable asbestos (e.g., vermiculite), OSHA asbestos abatement protocol 1926.1101 will be followed

Respiratory Protection

OSHA specified permissible practices

- Those in the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination.
  - This shall be accomplished as far as feasible by accepted engineering control measures (e.g., enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials).
  - When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.
OSHA specified permissible practices (continued)

- A respirator shall be provided to each employee when such equipment is necessary to protect the health of such employee
- The employer shall provide the respirators which are applicable and suitable for the purpose intended
- The employer shall be responsible for the establishment and maintenance of a respiratory protection program, which shall include the requirements outlined in paragraph (c) of this section (OSHA 1910, I, 1910.134)
- The program shall cover each employee required by this section to use a respirator
Respiratory Protection

Respiratory protection must be worn whenever you are working in a hazardous atmosphere.

The appropriate respirator will depend on the:
- Contaminant(s) to which you are exposed and
- Protection factor (PF) required

Required respirators must be:
- NIOSH-approved and
- Before use
  - Medical evaluation and
  - Training must be provided
Respiratory Protection


- **Single-strap dust masks** are usually **not** NIOSH-approved
  - They must not be used to protect from hazardous atmospheres

- **Approved filtering facepieces** (dust masks) can be used for dust, mists, welding fumes, etc.
  - They do not provide protection from gases or vapors. DO NOT USE FOR ASBESTOS OR LEAD; instead, select from the respirators below

- **Half-face respirators** can be used for protection against most vapors, acid gases, dust or welding fumes
  - Cartridges/filters must match contaminant(s) and be changed periodically
Respiratory Protection

- **Full-face respirators** are more protective than half-face respirators
  - They can also be used for protection against most vapors, acid gases, dust or welding fumes
  - The face-shield protects face and eyes from irritants and contaminants
  - Cartridges/filters must match contaminant(s) and be changed periodically

- **Loose-fitting powered-air-purifying respirators** (PAPR) offer breathing comfort from a battery-powered fan which pulls air through filters and circulates air throughout helmet/hood
  - They can be worn by most workers who have beards
  - Cartridges/filters must match contaminant(s) and be changed periodically

- **A Self-Contained Breathing Apparatus** (SCBA) is used for entry and escape from atmospheres that are considered immediately dangerous to life and health (IDLH) or oxygen deficient
Before getting onto roof surfaces,

- Inspect for and remove frost and other slipping hazards

**When the roof pitch is**

- **Over 4:12 and up to 6:12,**
  - Install slide guards along the roof eave after the first 3 rows of roofing material

- **Exceeds 6:12,**
  - Install slide guards along the roof eave after the first 3 rows of roofing material are installed and again every 8 feet up the roof

- **Greater than 8:12 or if the ground-to-eave height exceeds 25 feet,**
  - Use a safety harness system with a solid anchor point

- Wear shoes with slip-resistant soles

- . . . OR use Kozy Kollars
Beyond U.S. Radon Mitigation Standards

- Confined Space Hazards and Safety
- Driving Hazards and Safety
- Ergonomic Safety
- Eye, Face, Foot and Hand Hazards and Protective Clothing
- Heat and Thermal Hazards and Safety
- Lead Hazards and Protection
- Noise Hazards and Hearing Protection
- Tool Safety
Crawl Space/Confined Space Protection

www.osha.gov/Publications/osha3138.html

- **Crawl Spaces**
  - Durable, wrist protecting gloves will be worn
  - Respirators appropriate for contaminants present will be worn
  - Electrical safety assessment will be conducted
    - Special precautions if knob and tube wiring is present
  - Eye protection will always be worn, e.g.,
    - Safety glasses, goggles or full face respirator

- **Confined space** (in addition to the above)
  - Access and egress points will be identified before entry
  - Adequate ventilation will be provided
  - Use of toxic materials will be avoided
Driving Hazards

- According to the Bureau of Labor Statistics, more than 2,400 deaths a year result from occupational motor vehicle incidents.
  - That number is more than 42 percent of the annual number of fatalities from occupational injuries.
  - The average crash costs an employer $16,500.
    - When a worker has an on-the-job crash that results in an injury, the cost to their employer is $74,000.
    - Costs can exceed $500,000 when a fatality is involved.
- Some of the issues are:
  - Distracted driving
  - Failure to wear seat belts
  - Fatigue
Noise Hazards

- Noise is a common occupational hazard
  - Operation of drills, grinders, and saws as well as other power tools create noise hazards
    - The extent of damage from high levels of noise depends primarily on the intensity of the noise and the duration of the exposure
    - Noise induced hearing loss can be temporary or permanent
      - Temporary hearing loss is a result of short-term exposure to noise and normal hearing returns after a time of rest
      - Long-term exposure to high noise levels causes permanent damage
Hearing Protection

- Use hearing protection during high noise activities such as hammer drilling
  - Disposable earplugs
  - Reusable earplugs
  - Reusable earmuffs
  - Radio Earmuffs

- To monitor workplace noise, you may buy a
  - Noise indicator is available for $39 or
  - iPhone sound meter app for $20
Protective Clothing
(Appendix D – OSHA Personal Protective Equipment Standards)

- **Objective**
  - Protective worker from skin contact with contaminants
    - Some skin contact hazards will be discussed in the respiratory hazards section
  - Minimize spread of contaminants

- **Specification**
  - If contaminants are present, removable protective clothing will be worn
  - Eye protection will be worn at all times, e.g.,
    - Safety glasses
    - Goggles
    - If not using full face respirator
Ear Muffs, Knee Pads, Drill Braced, Vacuum for Dust

• Where is eye protection?
Caution!

- Every precaution that is suitable for you or your employees should be considered for the occupant as well
- Remember your workplace is another person’s home
Working Level Months

WLM = WL x Hours/170 Hours

For example, if a worker was exposed to

- 2.2 WL for 8 hours and
- 6.4 WL for 6 hours

His or her WLM accumulative exposure would be 0.3294 based upon the following calculation:

- WLM for first 8 hours = 2.2 x 8/170 = 0.1035
- WLM for second 6 hours = 6.4 x 6/170 = 0.2259
- WLM total = 0.1035 + 0.2259 = 0.3294
If radon levels are used to monitor exposure, pCi/L must be converted to WL using an ER of 0.5 and the following formula (based upon ER = WL x 100/pCi/L):

For example, if a worker was exposed to 50 pCi/L for 8 hours and 90 pCi/L for 6 hours, his or her WLM accumulative exposure would be 0.0287 based upon the following calculation:

- WLM for first 8 hours = \((0.5 \times 50/100) \times 8/170 = 0.0128\)
- WLM for second 6 hours = \((0.5 \times 90/100) \times 6/170 = 0.0159\)
- WLM total = 0.0128 + 0.0159 = 0.0287
Remember, the OSHA standard is:

- 4 WLM during any 12 month consecutive period and
- All U.S. radon mitigation standards require that workers wear respiratory protection when radon concentrations are greater than 30 pCi/L
Questions?

Remember the best safety tool you have is the head on your shoulders and your work partner

*If possible, do not work alone!*
Worker Health and Safety References

- NIOSH, 2004, *Respirator Selection Logic*