Initial Radiation Safety Training at McMaster University

McMaster Health Physics

Part 1 – Radiation Safety
- Campus areas with special hazards
- Radioactive materials and radiation
- Dose and Exposure to radiation
- Effects of Radiation
- Regulatory Controls
- Hazard Awareness and Good Practices
- Emergencies, Incidents, and Upsets

Campus Areas with Radiation Hazards
- Nuclear Facilities
  - McMaster Nuclear Reactor
  - Accelerator Facilities
  - Taylor Radiobiology Source
- Radioisotope Labs
  - High Level Lab Facility
  - Campus Labs
- Irradiators
- X-Ray Facilities

Campus Areas with Special Hazards
MNR – 5 MW Pool Reactor – Research, Education and Isotope Production
- Includes Hot Cell that utilizes Co-60
  - Irradiators
  - Taylor Source 1 kCi large field irradiator (Class II)
  - Two Nordion Gammacell Irradiators
  - High Risk Sealed Sources
  - Radioisotope Labs
  - X-Ray Facilities

Radioactive Material and Radiation

The Atom
The smallest unit of an element which has all of the physical and chemical properties of that element.

Isotopes of Hydrogen
1. Hydrogen H -1 (Stable)
2. Deuterium H -2 (Stable)
3. Tritium (radioactive H-3) H-3 (Unstable)
**Radiation**

- **Radiation**: the emission or transmission of energy in the form of waves or particles.
- Radiation can refer to waves (or light particles called photons)
- Radiation can also refer to heavier particles emitted from a source

**Ionizing Radiation**

- Certain isotopes have nuclei that are energetically unstable.
- These nuclei undergo a spontaneous process of releasing energy to become more stable.
- The energy emitted by the nucleus is released in the form of particles or electromagnetic radiation.
- This conversion from one nuclear energy state to another is radioactive decay (disintegration).
- The rate at which these decays occurs is called **radioactivity**.

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The Becquerel

- **The Becquerel (Bq):** one nuclear disintegration per second.
- It is a measure of the amount, or activity of a radioactive sample.
- The Becquerel replaces the old unit of radioactivity known as the curie (Ci).
- Kilobecquerel (kBq = 10^3 Bq)
- Megabecquerel (MBq = 10^6 Bq)
- Gigabecquerel (GBq = 10^9 Bq)
- Terabecquerel (TBq = 10^{12} Bq)
- 1 Ci = 37 x 10^9 Bq

Radioactive Decay - A Three Step Process

- Parent with unstable n/p ratio
  - Transformation within nucleus
    - Fast moving particulate radiation emitted
    - Alpha, beta, positron (or e.c.)
- Progeny nucleus in excited state
  - Nucleus de-excites
    - Energy emitted
    - Photons or conversion electrons
- Progeny in nuclear ground state, may be stable or radioactive
  - Re-arrangement of orbital electrons
  - May lead to X-rays and auger electrons

Decay Phenomena

- Unique Constant Characteristics of a radionuclide
  - Half Life
  - Types, energies, and amounts of radiation

Half-Life

- A half-life is the length of time it takes for one half the original number of nuclei of a radioactive sample to undergo radioactive decay.
- The half-life is usually denoted with the symbol \( t_{1/2} \).
Naturally Occurring Radioactive Material

- Naturally Occurring
- Radioactive Material

Reference: NATGAM, Natural Resources Canada

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Types of Ionizing Radiation

Gamma Rays and X-Rays

- Residual energy in a nucleus can be dissipated by emitting photons of electromagnetic radiation called gamma rays (\(\gamma\)-rays).
- Gamma rays are physically identical to X-rays.
- Gamma rays result from nuclear changes and X-rays result from atomic (electronic) changes.
- High-Z materials are used to shield this radiation.
- Some notable gamma-emitters include \(^{60}\)Co, \(^{137}\)Cs, and \(^{40}\)K.

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Bremsstrahlung Radiation

- When high energy beta radiation is absorbed in material, electromagnetic radiation known as ‘Bremsstrahlung’ radiation can be produced.
- Bremsstrahlung means ‘braking’ radiation.
- Bremsstrahlung radiation is more penetrating than the original beta radiation.
- In high-Z metals, such as lead, the production of Bremsstrahlung radiation becomes more significant. Accordingly, beta particles are shielded with low-Z, non-metals, such as Plexiglas.

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Characteristic X-rays

Characteristic X-ray Spectra
- Are produced at high voltage as a result of specific electronic transitions that take place within individual atoms of the target material.
- When accelerated electrons strike atoms in the target, they dislodge inner shell electrons resulting in outer shell electrons having to jump to a lower energy shell to replace the dislodged electrons. These electronic transitions result in the generation of X-rays.

Alpha Radiation
- An alpha (α) particle is a He-4 nucleus, consisting of 2 protons and 2 neutrons.
- Alpha decay is the emission of an alpha particle from the nucleus.
- Alpha radiation is easily shielded and is unable to penetrate the skin – an internal hazard only.
- Some notable alpha-emitters include ²⁴¹Am, ²²⁶Ra, ²²²Rn, ²³⁸U, and ²³⁹Pu.

Beta Radiation
- A Beta particle are particles generated by the nucleus that have the same properties of either an electron or a positron, labeled β- or β+ respectively.
- Beta-decay (β decay): any of the processes by which the nucleus alters its atomic number (Z) but not its mass number (A).
- Beta particles are shielded with low-Z, non-metals, such as Plexiglas.
- Some notable beta-emitters include ³H (β-), ¹⁴C(β-), ³⁵S (β-), and ⁰²Na(β+).

Neutron Radiation
- In limited circumstances, neutrons can be emitted from a source, and interact with atoms in a material. At some energies, neutron radiation can be very damaging to tissue.
- Prominent neutron sources include the reactor core, some accelerators, and select spontaneous fission sources such as Cf-252.
- Shielding is difficult, as the neutron is neutrally charged, interactions are less probable.
- Materials with high concentrations of Hydrogen like wax or concrete are used in neutron shielding.
Ionizing Radiation Damage to DNA

- When radiation interacts with a molecule, energy is deposited.
- The molecule absorbs this energy, and if the increase in energy is enough to overcome the bonding forces holding the molecule together, the molecule will break up. When chemical bonds in DNA are broken in this way it is called a ‘direct effect’.
- Ionizing radiation can also produce reactive chemicals that damage DNA.

Dose Units

- Radiation Dose is a measure of the amount of ionizing radiation deposited in material.
  - Absorbed Dose
  - Equivalent Dose
  - Effective Dose
  - Detriment
**Units of Radiation Dose**

- What we care about is the energy deposited per unit mass and the potential for harm in our bodies.
- Units are the gray (Gy) and the sievert (Sv).
- Gy – just the energy deposited.
- Sv – adjusted for potential to cause cancer (and genetic effects).
- For most situations, they are the same.
- Usually talk about doses in terms of mSv.

**What's in a mSv?**

- About 1/10th of a Whole Body CT scan.
- 12 Chest X-Rays.
- About 40 Toronto – Vancouver airline flights.
- Moving to Colorado from Boston (annual dose).

**Sources of Radiation - General Population**

- The average Canadian receives an annual dose of 3.6 mSv of exposure annually.

- Natural Sources:
  - Nuclear Medicine 4%
  - Consumer Products 3%
  - cosmic 11%
  - Other <1%
  - Medical X-rays 11%

- Man Made Sources:
  - Occupational 0.3%
  - Fallout 0.3%
  - Nuclear Power 0.1%
  - Miscellaneous 0.1%
Exposure to Radiation

- People can be exposed to radiation in two ways.
- External exposures are exposures that occur from radioactive sources outside the body.
- Internal exposures are exposures that occur from radioactive sources inside the body.

External Exposure

- Whole Body
- Skin
- Extremity
- Partial

Partial Body Irradiation from an External Source
Ionizing Radiation from Radioactive Samples

The Hazard depends on the Activity, the types of radiation emitted, proximity to the source and the amount of shielding.

- Radioactive sample or stock bottle
- Radioactive decay takes place within the sample.
- Radiation is emitted as a result.

Exposure to Near Contact Radiation Fields

- Penetrating and Non-Penetrating radiation
- High intensity of radiation due to geometry

Ionizing Radiation from Nuclear Reactions

- Non-medical X-ray machines are used by the University to study the structure of materials, proteins, and animals.
- X-ray machines produce:
  - beams of x-rays
  - fields of scattered x-rays
- All rooms which contain X-ray machines have warning signs on doors.
- University policy requires that anyone entering an x-ray room wear an x-ray badge or dosimeter, when x-ray machines are operating.

X-ray Hazards
Contamination Vs. Exposure

Internal Exposure Routes

Radioactive material inside the body is metabolized like the stable element – decays while in the body result in energy deposition (dose) until material is excreted or decays

Effects of Radiation

Deterministic Effects

- Radiation Injuries
- Acute exposures
- Threshold
- Severity of effect increases with dose
- Local - e.g. erythema, burns, cataracts...
- Whole body – e.g. ARS (LD50 ~ 4 Gy)
Stochastic Effects

- Cancer and genetic effects
- Chronic, long term exposures
- Assume no threshold
- Probability of effect increases with dose (not severity of effect)
- Genetic effects not observed in humans

Summary of Effects

<table>
<thead>
<tr>
<th>Stochastic Effects</th>
<th>Deterministic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>no threshold (statistical probability)</td>
<td>threshold</td>
</tr>
<tr>
<td>possibility of stochastic effect with any dose – probability increases with dose</td>
<td>no effect will be seen for doses below threshold</td>
</tr>
<tr>
<td>severity of effect is not related to dose received</td>
<td>above threshold severity of effect depends on dose</td>
</tr>
<tr>
<td>cancer</td>
<td>effect is seen due to death of cells → enough cells to affect/impair this function of a tissue or organ</td>
</tr>
<tr>
<td>genetic effects</td>
<td>radiation burns</td>
</tr>
<tr>
<td></td>
<td>blood effects</td>
</tr>
<tr>
<td></td>
<td>cataracts (lens of eye)</td>
</tr>
<tr>
<td></td>
<td>Acute Radiation Syndromes</td>
</tr>
</tbody>
</table>

Harmful Effects - Categories

- Stochastic Effects (Hereditary)
  - cell irradiated
  - DNA damage
  - incorrectly repaired damage - cell remains viable
  - germinal cell forms sperm or ovum with faulty genetic information
  - cell triggers into division and multiplication
  - repair can be re-done, cell death at reproduction
  - germinal cell forms sperm or ovum with faulty genetic information
  - cell remains viable

- Deterministic Effects
  - cell death at reproduction

Linear No Threshold Model

Assumed Risk of Exposure
Fatal Cancer Risk (adult worker) 0.005% per mSv
Scaled up to 0.007% per mSv to account for non-fatal cancer and possibility of hereditary effects

Source – ICRP 60
Cancer Risk

- **Fatal Cancer Risk**
  - Adult Workers: 4.0% per Sv
  - Whole Population: 5.0% per Sv

- **Non-Fatal Cancer Risk**
  - Adult Workers: 0.8% per Sv
  - Whole Population: 1.0% per Sv

Example – 100,000 workers each given 10 mSv
Expected (4/100)*(10E-3/1)*100,000 = 40 additional cancer fatalities

Baseline risk of fatal cancer in the whole population is about 25% or 25,000 in the example population.

Risk in Perspective

<table>
<thead>
<tr>
<th>Cause</th>
<th>Days</th>
<th>Cause</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living in poverty</td>
<td>3,500</td>
<td>Dangerous job accidents</td>
<td>300</td>
</tr>
<tr>
<td>Being unmarried-male</td>
<td>3,500</td>
<td>Motor vehicle accidents</td>
<td>207</td>
</tr>
<tr>
<td>Being unmarried-female</td>
<td>1,600</td>
<td>Accidents in home</td>
<td>95</td>
</tr>
<tr>
<td>Smoking-male</td>
<td>2,250</td>
<td>Average job accidents</td>
<td>74</td>
</tr>
<tr>
<td>Smoking-female</td>
<td>800</td>
<td>Alcohol-average</td>
<td>130</td>
</tr>
<tr>
<td>Being 30% overweight</td>
<td>1,300</td>
<td>Legal drug misuse</td>
<td>95</td>
</tr>
<tr>
<td>Being 20% overweight</td>
<td>900</td>
<td>Radiation in homes</td>
<td>35</td>
</tr>
<tr>
<td>Cancer</td>
<td>980</td>
<td>Radiation-1 mSv per year</td>
<td>10</td>
</tr>
<tr>
<td>Diabetes</td>
<td>95</td>
<td>Coffee</td>
<td>6</td>
</tr>
</tbody>
</table>

Smoking | 41 | Smoke alarm in home | -10 |

Radiation-1 mSv per year

Deterministic Effects of Acute Whole Body Exposure

- No clinically detectable acute effects below ~0.25 Gy
- No deaths in a population below 1 Gy
- LD50-60 about 3 to 5 Gy without medical intervention
- LD50-60 about 6 to 7 Gy with medical intervention

Nuclear Energy Worker Designation

- At McMaster University, anyone working with nuclear materials is designated as a Nuclear Energy Worker (NEW).
- Authorized workers are individuals who have completed Authorized Radioisotope Users Training and have been classified as Nuclear Energy Workers (NEWs).
- The most important aspect of being designated as an NEW is that there is a different set of dose limits for nuclear energy workers.
Regulatory Dose Limits – Non-NEWs

- Effective Dose
  - 1 mSv in one year

- Equivalent Dose
  - 50 mSv to the skin per year
  - 50 mSv to the extremities per year
  - 15 mSv to the lens of the eye per year

- Lower University limits apply depending on the facility and licence.

Regulatory Dose Limits – Routine Occupational Exposure of NEWs

- Effective Dose
  - 50 mSv in one year
  - 100 mSv in five years

- Equivalent Dose
  - 500 mSv to the skin per year
  - 500 mSv to the extremities per year
  - 150 mSv to the lens of the eye per year

- Lower University limits apply depending on the facility and licence.

Regulatory Dose Limits – Routine Occupational Exposure of Pregnant NEWs

- Effective Dose
  - 50 mSv in one year
  - 100 mSv in five years
  - 4 mSv for the balance of the pregnancy

- Equivalent Dose
  - 500 mSv to the skin per year
  - 500 mSv to the extremities per year
  - 150 mSv to the lens of the eye per year

- Lower University limits apply depending on the facility and licence.

Emergency Dose Limits For Workers

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>EMERGENCY DOSE LIMIT</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urgent actions to prevent capital equipment loss or damage</td>
<td>50 mSv (5 rem)</td>
<td>Applies to any McMaster University employee and volunteers from outside agencies.</td>
</tr>
<tr>
<td>Urgent actions which will prevent or mitigate a serious radiological incident</td>
<td>250 mSv (25 rem)</td>
<td>Applies to any Nuclear Energy Worker and volunteers who are non-NEWs.</td>
</tr>
<tr>
<td>Rescue and Lifesaving</td>
<td>1 Sv (100 rem)</td>
<td>Any volunteer who has been briefed on potential consequences of exposure.</td>
</tr>
</tbody>
</table>

Radiation Protection Regulations:
- During the control of an emergency and the consequent immediate and urgent remedial work, the effective dose and the equivalent dose may exceed the applicable dose limits prescribed by sections 13 and 14, but the effective dose shall not exceed 500 mSv and the equivalent dose received by the skin shall not exceed 5 000 mSv.
- Does not apply in respect of pregnant NEWs
- May be exceeded by a person acting voluntarily to save or protect human life
Measurement and Evaluation of Dose

- Thermoluminescent Dosimeters
- Extremity Dosimeters
- Electronic Personal Dosimeters

Measuring Dose - TLD

- Monthly or Quarterly read-outs
- Measures gamma, x-ray, beta, and some models measure neutrons
- Reports generated by DSP
- Dose record updated with NDR
- HP reviews work and issues badges as needed

Government Regulators

- The Canadian Nuclear Safety Commission
- The Ministry of Health and Long-term Care (X-Ray)
- The Ministry of Labour (X-Ray)
Acts and Regulations

- Nuclear Safety and Control Act
- CNSC Regulations
- Licensing

McMaster University Controls

- HPAC
- NFCC
- HP Department
- Radiation Safety Programs
- Permits

Compliance with Programs

- The Radiation Safety Program is submitted to the CNSC in support of the Licence application and becomes legally binding on the University and those working under the licence.
- The radiation safety program incorporates best practices in addition to legal requirements.
- Radiation safety programs at McMaster University have been designed for specific radiation hazards that may be encountered.
- Strict adherence to these programs is also essential for maintaining ALARA doses.
Hazard Awareness and Good Practices

The ALARA Principle

- This is the guiding principle of Radiation Protection. It states that radiation doses should be maintained:
  - As low as reasonably achievable
  - With social and economic factors being taken into account.

Principles of Radiation Protection

1. Source Reduction
   - Reducing activity reduces dose.

2. Time
   - Reducing exposure time reduces dose.

3. Distance
   - Reduction factor $r^2$
   - (Approximation is only useful for point sources).

4. Shielding
   - Increased shielding reduces dose.
Planning and Requirements for Work Review

- All radiological work at McMaster University is to be carefully planned and executed.
- Each plan must incorporate steps to control and optimize exposures and contamination spread.
- Work that may result in exceeding any Administrative Control Level requires the prior approval of the NFCC and HPAC.

Contamination Hazards

- Radioactive contamination is the uncontrolled presence of radioactive material found in unwanted areas, out of containment. Contamination presents a radiological hazard because it demonstrates a loss of control of nuclear materials. There are different types of contamination that present unique possible hazards.
  - Loose Surface Contamination
  - Fixed Surface Contamination
  - Airborne Contamination
  - Liquid Contamination
  - External Personnel Contamination
  - Internal Personnel Contamination

Loose Surface Contamination

- Loose surface contamination is nuclear material found out of containment, deposited on a surface that is easily removed by simple decontamination methods.
- Loose contamination is easily spread, and may even be distributed to uncontrolled areas.
- This type of contamination should be cleaned as soon as practical to eliminate the potential hazards.

Fixed Surface Contamination

- Fixed contamination is nuclear material found out of containment, deposited on a surface that is not easily removed by simple decontamination methods.
- This type of contamination, while not easily spread, may present unnecessary increases to personnel dose if the source is large enough.
- An additional concern is that over time, the fixed contamination may become loose.
Airborne Contamination
- Airborne contamination is an undesirable presence of nuclear material in the air.
- This material may come in the form of particulate matter or gas.
- This type of contamination may present an internal radiation hazard if it is inhaled by personnel.
- One of the main airborne contamination hazards at the McMaster Nuclear Reactor is airborne radioiodine, arising from the production of Iodine-125.

Liquid Contamination
- Liquid contamination is nuclear material found out of containment, deposited on a surface, and in liquid form.
- Often, this contamination results from a spill, and may also be easily spread like loose contamination.
- It should be cleaned up according to procedures as soon as practical.

External Personnel Contamination
- This contamination arises from nuclear materials deposited on the skin or clothes of personnel.
- The increased risk of this contamination is the close contact to the nuclear material.
- Skin contamination may diffuse through the skin and become a more harmful internal hazard.
- All instances of personnel contamination must be reported to Health Physics.

Internal Personnel Contamination
- This contamination arises from nuclear materials following one of the four main pathways into the body.
- Generally, there is an increased risk of an isotope being an internal hazard, rather than an external hazard.
- There is not usually an easy method of removing the isotope.
- The isotope is eliminated biologically or by radioactive decay.
### Units of Contamination

<table>
<thead>
<tr>
<th>Type of Contamination</th>
<th>Unit</th>
<th>Limiting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Contamination</td>
<td>Becquerel (Bq)</td>
<td>Annual Limit on Intake (ALI)</td>
</tr>
<tr>
<td>Surface Contamination</td>
<td>Bq/cm²</td>
<td>Derived Working Limit (DWL)</td>
</tr>
<tr>
<td>Airborne Contamination</td>
<td>Bq/m³</td>
<td>Derived Air Concentration (DAC)</td>
</tr>
</tbody>
</table>

### Control of Contamination

- The ability to demonstrate control of contamination is a key indication that a radiation safety program is successful.
- All radioactive work is to be approached with the philosophy that it is safer and cheaper to prevent contamination spread than it is to clean up contamination.
- While performing radiological work, personnel must check themselves and their work area frequently for contamination, where there is a risk of contamination spread.
- Personnel must also monitor themselves again upon completion of work involving potential for contamination spread.
- All instances of personnel contamination must be immediately reported to Health Physics.

### Contamination Monitoring

- Contamination monitoring is necessary in maintaining the control of nuclear materials at McMaster University.

- There are two main methods of contamination monitoring:
  - Direct Contamination Monitoring
  - Indirect Contamination Monitoring

### Direct vs Indirect Monitoring

**DIRECT method:** detects both loose and fixed contamination

**INDIRECT method:** means taking a wipe sample, and detects only the loose or removable contamination
Operational Monitoring of Hands

- Monitor your hands thoroughly and often for any sign of contamination.
- Should contamination be found, decontaminate immediately.

Protective Equipment

- For work with open nuclear materials, personal protective equipment offers a barrier between the worker and the radioactive substances.
- Requirements for use of certain equipment will be established by Health Physics for routine tasks and determined for unique situations in the work planning phase of the task.
  - Gloves
  - Lab Coats
  - Shoe Covers (aka Booties)
  - Coveralls
  - Respirators and Air Supplied Hoods

Gloves

- Gloves are essential items for basic personnel protection.
- Hands are the most likely to become contaminated from handling open sources of radioactive material.
- Several gloves can be layered at the start of a procedure, and removed to expose a fresh clean glove as the task progresses.
- Gloves must be worn any time that open sources of radioactive material is handled, including contaminated objects.
- For more hazardous situations, 'heavy-duty' gloves used for specialized purposes.

Lab Coats

- In conjunction with gloves, lab coats offer a basic level of whole body protection against personnel contamination incidents.
- They protect not only the skin, but also clothes.
- Lab coats should be worn during the handling of radioactive materials.
- If lab coats become contaminated, they are easily cleaned, and failing that, inexpensive to replace.
- At the end of work, lab coats should be checked for contamination and cleaned if necessary.
Shoe Covers (aka Booties)

- When working in areas known to contain floor contamination, shoe covers (aka booties) are extremely useful in preventing contamination of personnel footwear.
- Booties should be donned prior to entering the area and removed (with gloves on) just before leaving the contamination area.
- For some areas booties may be routinely mandatory on entrance as required.
- The requirement for booties may be declared non-routinely at the entrance to an area.

Coveralls

- Instead of lab coats, coveralls may be recommended for work with open radioactive materials or in contaminated areas.
- Disposable coveralls offer protection for the whole body.
- When required, they are to be worn before entering the area, and like the booties, removed immediately before leaving the area.
- Non-disposable coveralls may be used as well, but are more expensive to replace.

Respirators and Air Supplied Hoods

- In areas of airborne contamination, or potential for airborne contamination to arise, respirators must be worn.
- There are two main types of respirators that are for different applications.
  - Air purifying respirators
  - Air supplied respirators
- Each type of respirator has a protection factor that describes how effective it is at providing breathable air.
- Requirements for respirators will be established by Health Physics as the need arises.

General Approach to Protection

- All exposures should be justified
  - do more good than harm
- All exposures should be kept ALARA
  - minimize the chance of cancer and hereditary effects as low as reasonable
- All exposures should be under dose limits
  - Avoids the possibility of deterministic effects and limits overall accumulation of risk for the individual
General Approach to Safety

- Use time, distance and shielding to minimize external exposure around known or suspected sources
- Don’t pick up items that are sources or are suspect
- Cordon and contain problems for further evaluation
- Use safety indicators – area monitors, exit monitors, survey meters

Emergencies, Incidents, and Upsets

Safe Backout

- When adverse conditions are encountered during work with radioactive material, the following practices should be used to ensure a safe backout.
  - if it is safe to do so, take immediate steps to stabilize the area or equipment to prevent further degradation of conditions
  - safely leave the area
  - alert Health Physics immediately
  - guard the area to prevent entry
  - if there is a need to leave, the area should be posted

Adverse Situations – When to Contact Health Physics

- In all situations when Health Physics is contacted, every effort will be made to ensure the safety of personnel is maintained. The goal of the Health Physics Department is to safely and quickly aid in the resolution of a potentially adverse situation.
  - Loss of Material
  - Spills Response
  - Release of Nuclear Substances
  - Suspected Exposures and Intakes
  - Personnel Contamination
What to Report to Health Physics

- If you are an NEW, you are required to report pregnancy as soon as it has been medically confirmed.
- Any suspected overexposure to radiation that is likely to exceed your regulatory or administrative control limits.
- Any personal contamination incidents, immediately.
- Any fire in a radiological work area.
- A major spill of radioactivity.
- Any theft or loss of (missing) radioactive material or breach/attempted breach of security provisions.
- Any damage to or leakage from a radioactive parcel, or evidence of tampering.
- Any radiation hazard that you may feel has been overlooked or neglected.
- Any radiation detection instrument that is not working.
- An unexpected release of radioactive material to the environment.
- Loss of a personal dosimeter.
- Any radiation safety or nuclear security concern - anytime.

Contacting Health Physics

- For more information, training and Health Physics assistance please contact our department at Extension 24226.
- You may contact individual members of the Department using the contact sheet shown.

Thank you