NUCLEAR 101

INSTRUCTOR'S GUIDEBOOK

AS PRESENTED BY THE
TERRITORIAL PLANNING UNIT

Zhaagimaa Waabo

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Introduction

BOOZHOO!

We welcome you to the Nuclear 101 Instructor's Guidebook.

This guidebook was commissioned by Grand Council Treaty #3 and created in partnership with Grand Council's Territorial Planning Unit. The Nuclear 101 Guidebook was created to help with decision making on future nuclear energy projects using scientific knowledge, traditional teachings and important principles like the Nibi Declaration and the Manito Aki Inakonigaawin.

Chii miigwetch to the many Elders, Women, Men and Youth of Treaty #3 who shared with us their thoughts, feelings, concerns, questions and teachings to help build this program.

The guidebook has been developed for all people in Treaty #3 Territory and can be adapted to fit different ages. There are interactive and self-reflective activities throughout the Guidebook which can done in a facilitated group or done independently.

As an instructor, you may choose to deliver the program in multiple ways. You can present the Powerpoint presentations in either a 2-day or 4-day format. This can be presented in person, or virtually using screen share and a virtual calling platform such as Zoom or Google Meet. You may choose to have the group read certain chapters on their own or do the reflection activities on their own or as a group. Whiteboards, flip charts or sticky note activities can be useful for sharing feelings anonymously. Digital whiteboards such as Google Jamboard can be used in a virtual setting.

Throughout all seven chapters participants will be exploring each topic in relation to the lands, waters, soils and skies around them and how they relate to the Seven Sacred Teachings. A framework diagram for each chapter is presented in the Instructor's Guidebook to give an overview of chapter content and learning outcomes. Each student will have a workbook with the written material, but the workshops can be presented with the Powerpoint presentations only if the workbooks are not available. However, from community focus groups on the Guidebook, community members expressed the wish to be able to preview materials before or after meetings, so we recommend that each participant has a workbook.

While the guidebook is best facilitated in order from chapter 1 to chapter 7, feel free to flip around to concepts you want to teach as they are brought up by participants. Each chapter has a list of terms and places where they can go to learn more about the topic. The end of the guidebook has a glossary to help define the words used in more detail.

Community members stressed the importance of including traditional teachings alongside western science in this program. Teachings are shared as quotes throughout the text as well as QR codes which can be scanned by a smart phone. If preferred, you can play these videos through the Powerpoint presentation or separately.

Introduction

This Instructor's Guidebook contains two interactive activities, **Geiger Counter Goes Bananas** and **The Danger is Still Present**, meant to be completed during chapters 3 and 7 respectively. However, they can be facilitated during different times depending on the flow of your delivery. Suggestions for potential times for these activities are mentioned in each activity section. Each activity contains the written activity material as seen by the participants (these pages can be printed separately from the Guidebook if preferred), plus background information and a list of materials needed.

The purpose of the Nuclear 101 workbook is to assist with informed decision making on major projects such as the Nuclear Waste Management Organization's Deep Geological Repository, but we hope it will be used by anyone looking to increase their understanding of nuclear science as a whole. We also offer this workbook as an example of how Anishinaabe principles, teachings and practices can inform decision making and community planning.

If you have any questions about the development or facilitation of this Guidebook, please contact Lucas King from the Territorial Planning Unit.

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Guidebook Framework

The following frameworks showcase the overall structure for each chapter. Each chapter can be broken down into the following levels to facilitate Guidebook flexibility. For example, the chapter can be broken down to serve a 2-day workshop versus a 4-day workshop.

Chapter 1: The Atom (Wisdom)

Anishinaabe Teaching

Nibwaakaawin (Wisdom) is passed on and continual. If you don't tell someone something that they should know, then wisdom ends. Wisdom must be passed down to everyone. We seek out the wisdom of our Elders because they have the ability to draw on their knowledge and life skills to provide guidance.

Atoms

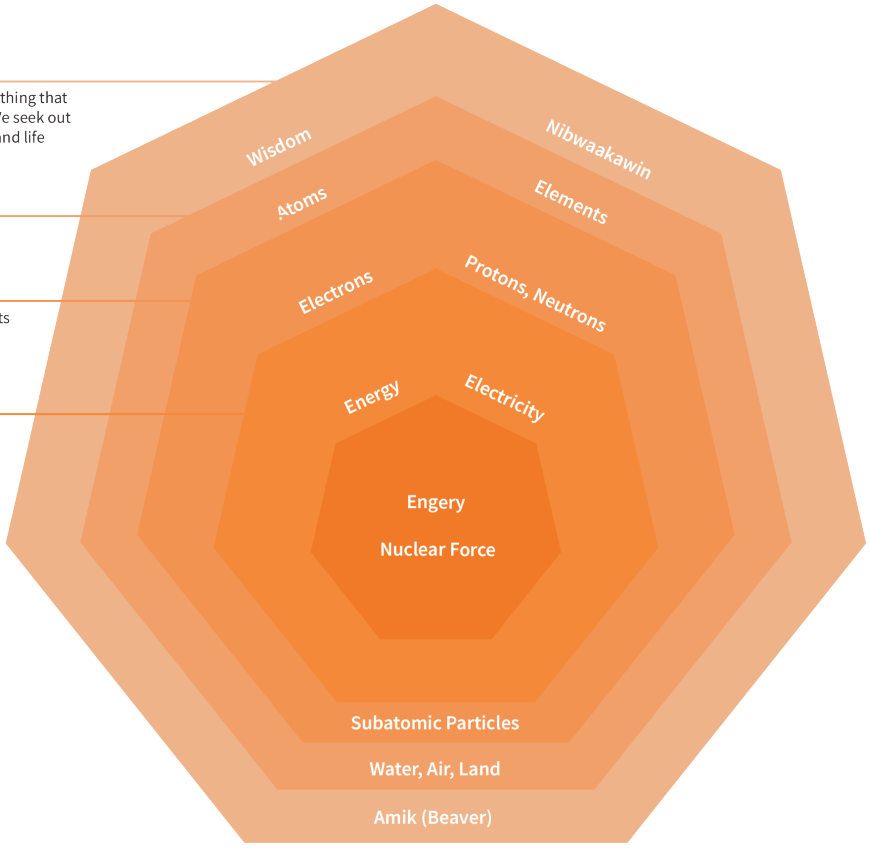
Atoms are the building blocks of life, all elements on earth are made of atoms.

Subatomic Particles

Atoms are made of even smaller particles called subatomic particles. The movements and numbers of these subatomic particles change the nature of each atom.

Energy

There is energy in the movement of electrons and their attraction to protons. There is also the energy holding the protons and neutrons together called the nuclear force.



Guidebook Framework

Chapter 2: Energy (Love)

Anishinaabe Teaching

Zaagi'idiwin (Love) is many things, the love of water, the love of children, the love of life. To love something, regardless of what is it is, makes it better. To love somebody or something other than yourself in unselfish.

Electricity

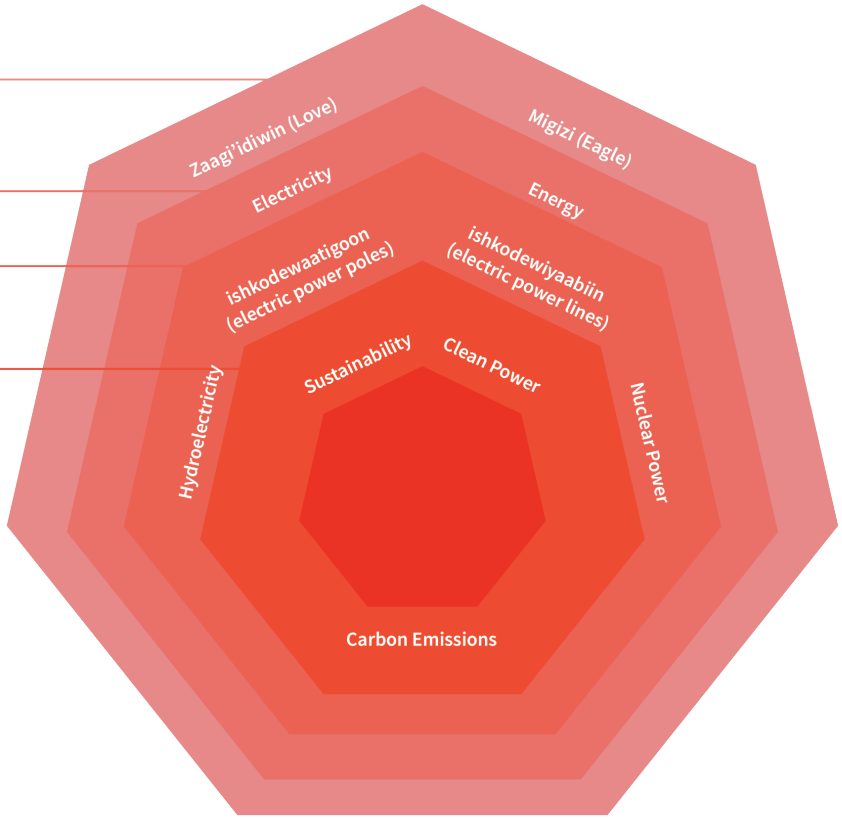
Electricity is caused by the movements of electrons, electrons transfer energy.

Sources of Electricity in Ontario

Ontario gets its electricity from multiple sources, including hydroelectricity and nuclear power.

Green Energy and Sustainability

What makes energy "clean" or "green"? We will discuss sustainability in energy production and energy use.



Guidebook Framework

Chapter 3: Radiation (Bravery)

Anishinaabe Teaching

Zoongide'ewin (Bravery) is having the strength to do things in the way that you feel is right, even when you face opposition. Bravery is also about having the courage to open your mind and listen to others who might have different opinions

Radiation

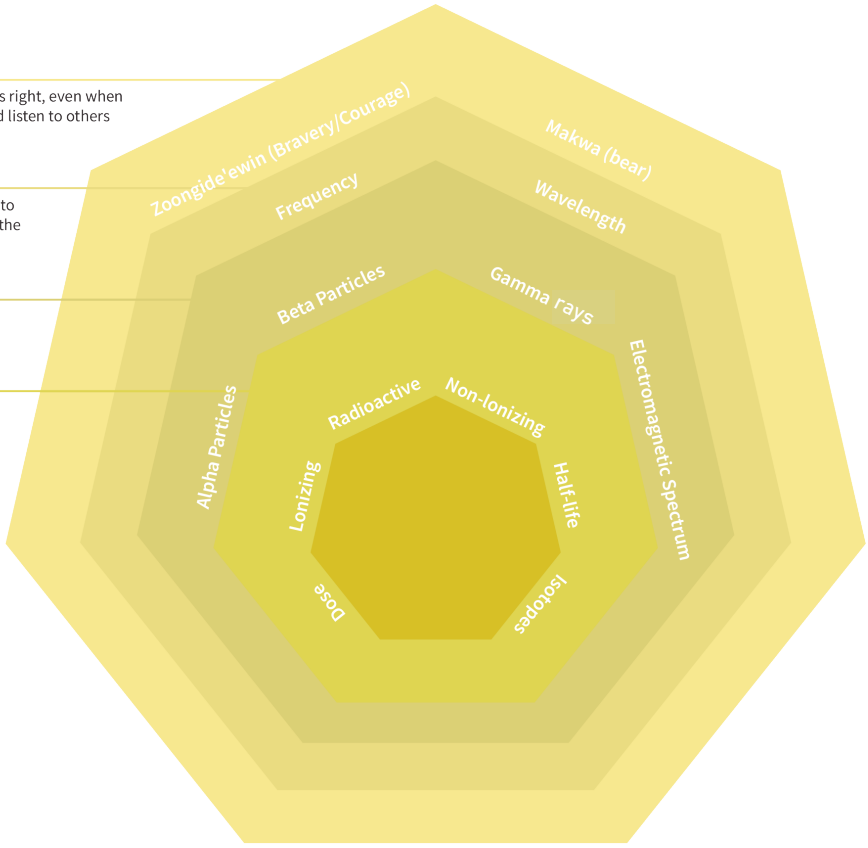
Radiation is another word for energy, it is the transmission of energy from one thing to something else. Radiation is in waves; how long and how tall the wave is represents the amount of energy in the wave, as well as the nature of the wave.

Types of Radiation

Radiation comes in many forms such as light, heat and UV. Radiation can be harmless, useful, or harmful.

Radioactivity

Some elements are naturally radioactive, some can be made radioactive.



Guidebook Framework

Chapter 4: Uranium (Respect)

Anishinaabe Teaching

Respect (Manaaji'idiwin) takes time. It is a cycle that can be built up in many different ways from respecting yourself, to the land you walk on, to the skies above you, to the animals around you or the people you meet.

Uranium

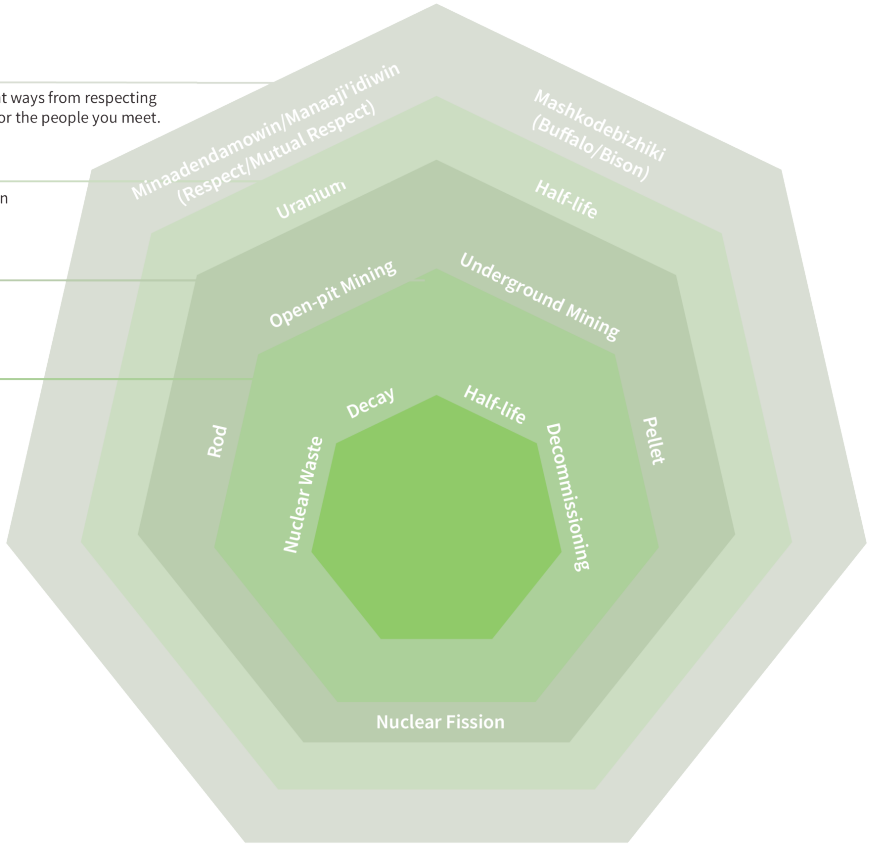
Uranium is a natural substance found in the Earth. Uranium is usually found in certain types of rocks.

Lifecycle

We follow uranium from mining, to transport, to use in nuclear power to waste storage.

Nuclear Fuel

Uranium rods are used to fuel nuclear power plants. Uranium is radioactive and the waste produced is also radioactive.



Guidebook Framework

Chapter 5: Nuclear Waste (Humility)

Anishinaabe Teaching

Dabaadendiziwin (Humility) is to know your place within Aki (the world). It is important to be humble and know that you can learn from anyone in any situation.

History of Nuclear Science

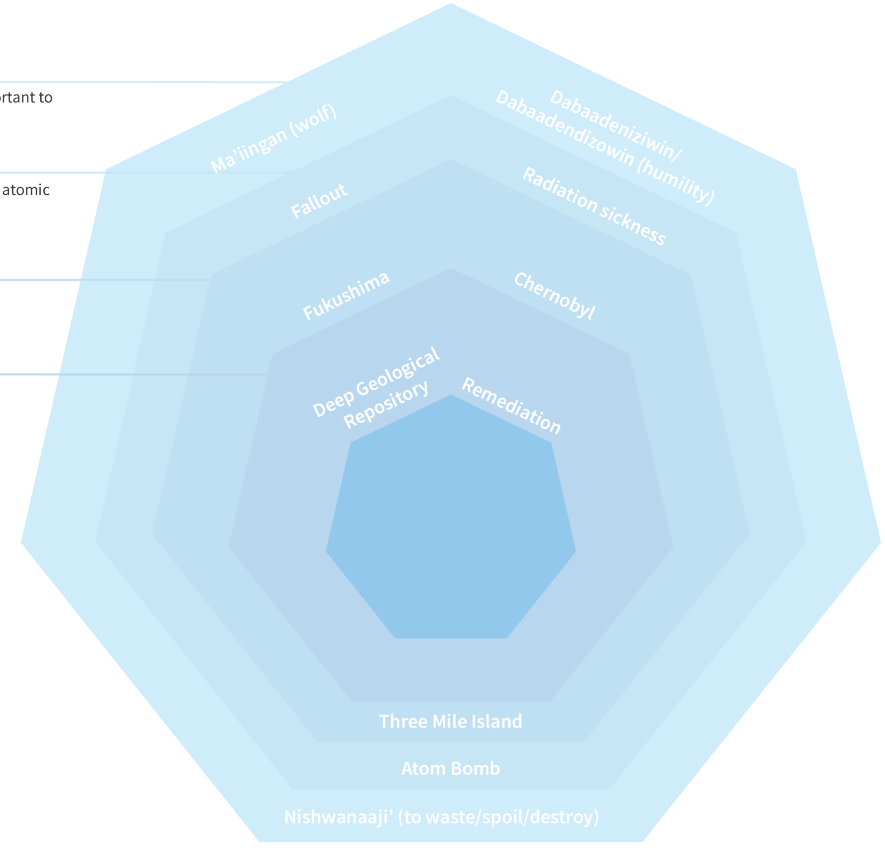
Nuclear science has been used in the past not for energy but for war in the form of atomic bombs. Nuclear fallout from these bombs was harmful to human health.

Impacts of Nuclear Waste

History of past nuclear accidents and the potential impacts of nuclear waste and nuclear fallout.

Nuclear Waste

Nuclear waste must be stored away from where it could harm living things. A Deep Geological Repository is one way to store nuclear waste.



Guidebook Framework

Chapter 6: The NWMO Project (Honesty)

Anishinaabe Teaching

Gwayakwaadizin (Honesty) is extremely important in meeting with others, especially when discussing serious issues or decisions.

Nuclear Waste Management Organization

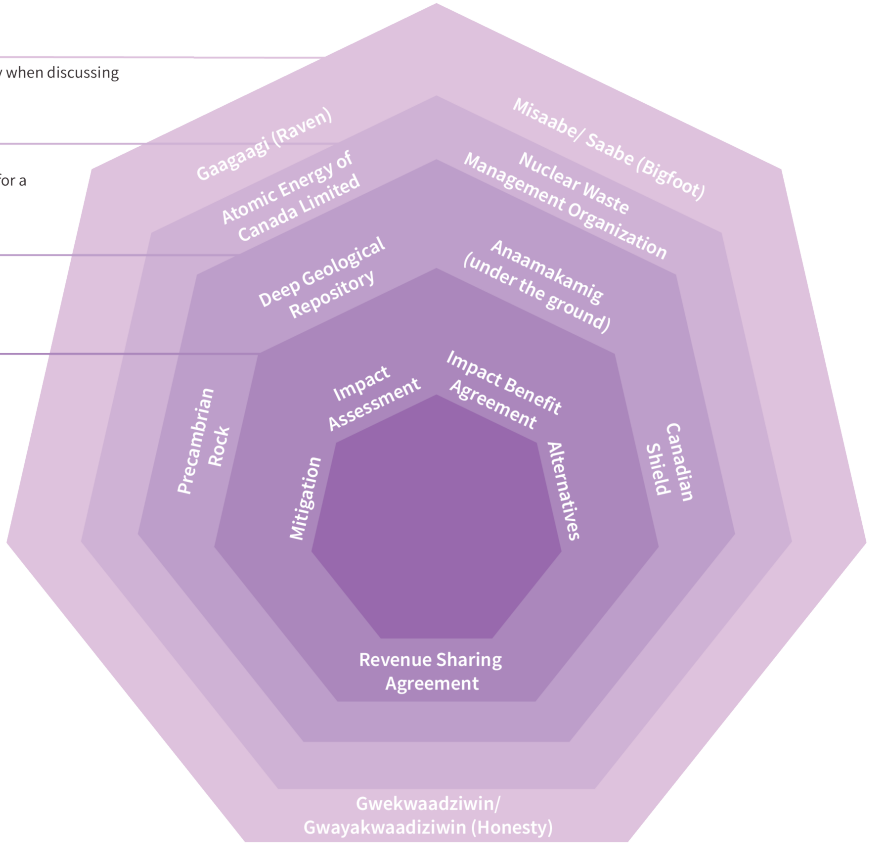
The Nuclear Waste Management Organization of Canada is responsible for Canada's long-term used nuclear fuel management. NWMO is in the process of selecting sites for a potential Deep Geological Repository.

Deep Geological Repository

We will explore the size, extent and qualities of a DGR. What is NWMO looking for in a particular location? Where would waste come from?

Potential Impacts and Alternatives

There are many environmental and social impacts that could occur as a result of this project. We will discuss alternatives to a DGR.



Guidebook Framework

Chapter 7: The Future (Truth)

Anishinaabe Teaching

The teaching of Debewin (Truth) is necessary to know all of the other teachings. Truth is important in making long-term decisions.

Emergency and Safety Planning

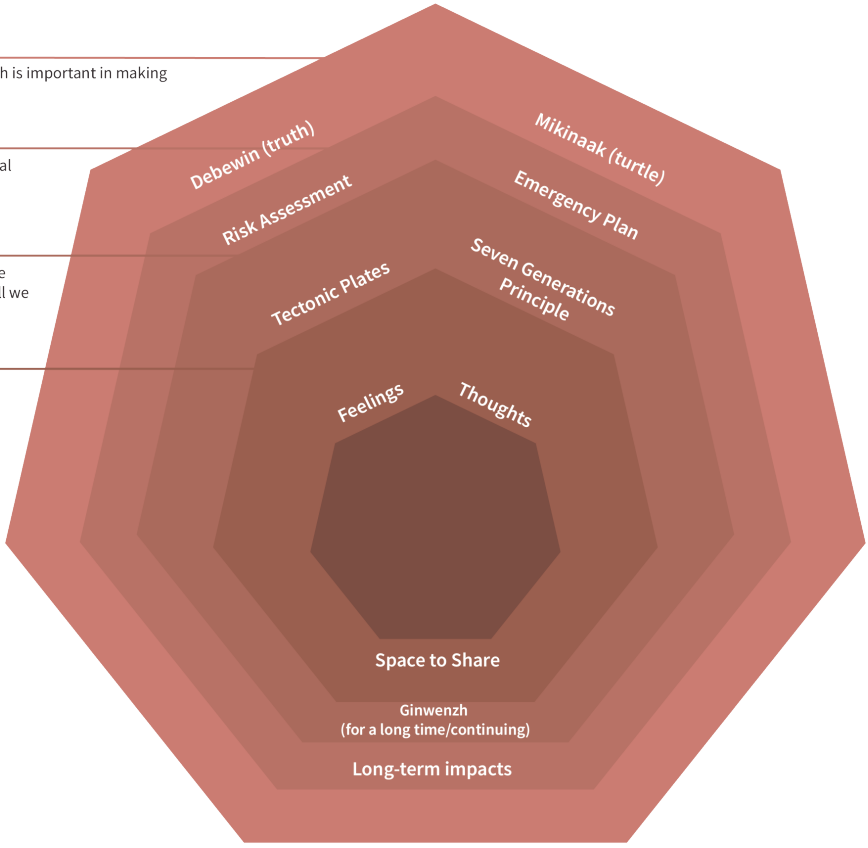
How will the NWMO plan for emergencies and everyday safety? What are the potential long-term impacts of the DGR?

The Future

What happens if natural disasters or shifting tectonic plates expose the uranium? The decisions we make now will have an effect on many generations that follow. How will we warn people in the futureabout the existence of a DGR?

Your Feelings

In this chapter, we will have a special focus on sharing your current thoughts and feelings on the project.



Chapter 3

Radiation (Bravery)

Interactive Activity:
Geiger Counter Goes Bananas

Chapter 3
Geiger Counter Goes Bananas

You might have seen people in TV shows or movies about radiation holding a small device that crackles or beeps. This is called a Geiger-Müller Counter or more commonly, a Geiger Counter. Geiger Counters measure the amount of ionizing radiation in the nearby area. Ionizing radiation is the kind of high energy radiation, like gamma rays, that has the power to create ions (atoms with a charge). The clicks or beeps you hear are the sound of free electrons created from radiation hitting gas atoms inside the tube.

Radiation is all around us naturally, coming from inside our bodies, from the ground, water, air and from space from the sun and stars. We can use a Geiger Counter to measure the difference between safe levels of radiation from a naturally occurring source and unsafe levels of radiation.

Using a Geiger Counter with your group, check the background radiation of the room you are in right now. Does the number surprise you?

Using a Geiger Counter, try testing everyday items like fruits and vegetables. Were there any that had higher levels than others? Were you surprised about which ones they were?

You might have noticed a reading on your Counter when you moved closed to a banana. This is because bananas contain potassium. The isotope potassium-40 naturally decays into argon-40 over time, releasing safe levels of radiation. You can also see this in salt substitutes that have potassium in them instead of sodium (ex. Windsor Brand Salt Free Salt Substitute).

Eating one banana is about 0.1 microsieverts of radiation. Since the banana is a known amount of radiation, sometimes people use "banana equivalent dose" as an easy way to think about radiation. For example, getting an x-ray is the same amount of radiation as eating 50 bananas. Smoking one pack of cigarettes a day is the same as 240, 000 bananas. You'd have to eat 10 million bananas to get temporary radiation sickness (1 million microsieverts).

With your group leader, test some items that are known to be more radioactive, to compare the results to the low-level radiation you registered before. How do different containers change how much radiation is measured?

Chapter 3
Geiger Counter Goes Bananas

Facilitator Instructions

Activity Introduction

The idea of this activity is to show that radiation is all around us and not necessarily a scary thing. The activity should begin by explaining how the Geiger Counter works in simple terms. Begin by turning it on, showing the features and display and what the numbers, lights or sounds indicate. Show the level of background radiation in the room (may be non-existent). If you have a flip chart or whiteboard, it might be fun to write this number down to compare it to other things later. If presenting over video, hold the counter up to the camera to show the features or present a slide with the features labelled.

Take one of the radioactive items (ex. KCl salt or banana) and show what happens when the counter becomes close to it. Beeping is key here! Adjust the sensitivity on the counter if it's not reacting. If you don't want to spoil the fact that these every day objects are radioactive, you can pour some of the KCl into a little bag or bowl before hand and simply tell the group that it is a radioactive substance.

Comparing Levels of Radiation in Ordinary Objects

Using the natural occurring radioactive materials like potassium in bananas and KCl salt, compare to other ordinary objects like apples or NaCl salt. For these safe to handle materials like the banana, pass the Geiger Counter around, to let everyone try reading them. Alternatively, you can have them displayed on a table and have volunteers come up to try scanning each item. Let them choose what they want to test and poll the group on which object they think has more radiation. You can throw whatever non-radioactive materials you want on the table as red herrings.

If presenting over video, hold each object up to the camera for testing and get the group to guess which will have more radiation.

Higher Level Radioactive Objects

To show higher levels of radiation rather than background or low-level naturally occurring radiation, you may want to use the Geiger Counter on radioactive objects like a uranium ore samples or antique products that use radioactive paint (See Activity Materials for some suggestions). Only the facilitator who understands the appropriate safety regulations and dangers of handling radioactive material should handle these objects. When not being tested they should be in a protective case away from any food products. Wear gloves and wash hands after handling.

Chapter 3
Geiger Counter Goes Bananas

Optional: Balloon Experiment

You can test the amount radiation in the air from radon by using a statically charged balloon. This takes about 60 minutes for the radiation to build up. **The balloon must be charged and suspended in the air at least 60 minutes before you want to do this experiment!**

The radon is attracted to the balloon because the products of its decay are positively charged, and the balloon is negatively charged. The balloon's radioactivity will appear much higher than the air because some of the radioactive atoms have moved into one location, the balloon.

If presenting this experiment in-person along with the other chapters of the Guidebook, you could integrate the charging of the balloon into your explanation of electrons, protons, and neutrons from Chapter 1: The Atom (Wisdom) or your explanation of how electricity works from Chapter 2: Energy (Love).

The Geiger Counter Goes Bananas activity is meant to be done in conjunction with Chapter 3: Radiation (Bravery). If it has already been 60 minutes since you have charged and suspended the balloon, feel free to begin this activity before you begin Chapter 3, in the middle or after you have finished Chapter 3.

This experiment may be useful to do after you have explained there is natural background radiation in the air but can be done whenever you feel it fits best.

Steps

1. Electrostatically charge the balloon by rubbing against a cloth, fabric, or someone's hair. A fun part of the demonstration can be getting a volunteer and making their hair stand on end. Rubbing the balloon around makes electrons stick to the balloon. The balloon becomes negative compared to the person's head. The hairs will have a different charge than the balloon (positive) and will stick to it. The hairs have the same charge as each other so they tend to fan away from each other. You can also try sticking the balloon to the wall for a few seconds. If it is a very humid day, the static electricity may be less noticeable as any free electrons may have jumped to the water in the air. If you've had some fun with static electricity, make sure to recharge the balloon on a cloth or someone's hair before suspending.

2. Carefully tie the balloon using a string or twist tie. You want to be able to remove the tie easily instead of popping the balloon because you need to keep the radioactive material on the balloon's surface.

3. Hang the balloon from a rope or string from the ceiling or the underside of a table using masking tape. Make sure it is hung somewhere out of the way where it won't be touched for an hour.

4. Deflate the balloon carefully **(do not pop it!**), place it on the table next to a Geiger Counter that can detect alpha particles. **This experiment will not work if you do not have a Geiger Counter that can detect alpha particles.**

5. Move the Geiger Counter away and towards the balloon to show the difference between the background radiation and the radon accumulated on the balloon. It should be about 10x more on the balloon.

Chapter 3
Geiger Counter Goes Bananas

Background Information

The device used in this experiment is officially called a Geiger-Müller Counter, named after the two scientists who invented it, Hans Geiger and Walter Müller. Hans Geiger wrote about the idea of a method for counting particles from radioactive substances in 1908. It wasn't until 1928 that he and Walter Müller perfected the design. Most people call it simply a Geiger Counter since Hans Geiger came up with the original principle. It's called a Counter because it can measure the radiation in counts per minute, but it can also measure the radiation in units like Sieverts or Roentgens.

The main part of the Counter is the Geiger-Müller or GM tube. Inside the GM tube is an inert gas, one that doesn't undergo any chemical reactions, and a positively charged metal rod in the centre. When the ionizing radiation hits the gas, it creates free electrons which are attracted towards the positively charged tube in the centre. The electrons bounce around the tube creating more electrons in a domino effect called a Townsend avalanche. Eventually there is enough movement of electrons inside the tube to conduct electricity between the rod and the walls of the tube. The little crackles you hear are the electrical current affecting the speaker. Some Geiger Counters convert the number of electrons being created as a beep or flash or light instead.

When the positively charged ions created by the radiation removing electrons hit the walls of the tube, they pick up a free electron and become neutral again. This resets the tube and allows the gas atoms to be hit and become ions over and over again. This way you can keep testing the same area indefinitely. There is a bit of a lag time while these atoms "reset".

There are multiple different types of Geiger-Counter designs, depending on what type of radiation you are measuring for (alpha, beta, or gamma). It also matters what kind of gas you put inside the tube.

Geiger Counters do have their limitations, they only detect radiation as a whole, they can't tell you if what you are picking up is alpha versus beta unless they have been designed to only measure a certain type. Because of the lag time for resetting the tube, any "extra" radiation following through the device doesn't get counted. So, if you have something with really high radiation levels, it might measure slightly lower than the true level in the environment. However, high levels will be quite obvious on the Counter and if you are already experiencing the highest-level reading on the lowest sensitivity setting, it will be quite clear that there is a large amount of radiation in the vicinity. For the purposes of this experiment, these limitations aren't applicable.

Chapter 3
Geiger Counter Goes Bananas

Activity Materials

Geiger Counter
For highest effectiveness of the activity, it is best to have a Geiger Counter that has an audio output. The "beeps" of radiation are helpful in illustrating radioactivity, especially when used farther or closer to an object.

Any Geiger counter that detects gamma rays will be fine for using with bananas and KCl salt. Make sure the counter you use tests for the type of radiation you want to check for. Ex. Retro Fiesta Ware emits gamma, beta, and alpha radiation.

The balloon experiment needs a Geiger counter that can detect alpha radiation.

Potential Models
Mazur Instruments- PRM-8000 or PRM-9000 Digital Radiation Detectors
https://www.mazurinstruments.com/buy-a-geiger-counter/
Simple controls, digital display, audio output. Handheld.
Detects alpha, beta, gamma, and x-rays.
$589-$745 CAD, 3-7 business days, $45 USD shipping
Also available on Amazon: https://www.amazon.ca/s?k=Mazur+instruments&ref=nb_sb_noss_2
Mazur PRM-7000 model not recommended for food testing.

Radiation Alert- MONITOR 4 or MONITOR 4EC Analog Radiation Detectors
https://seintl.com/categories/analog-radiation-detectors
Runs on a 9v battery, handheld. Audio (including headphone jack) and LED output. Simple controls, easy to read display. Display is analog- with a needle that moves back and forth to indicate radiation.

Detects alpha, beta, gamma, and x-rays.
$430-$472 CAD
Also available on Amazon: https://www.amazon.ca/Radiation-Alert-MONITOR4-Analog-Based-Ionizing/dp/B004CCRIJ8/ref=sr_1_5?dchild=1&keywords=Radiation+Alert&qid=1630955957&sr=8-5

GQ Electronics- GMC 300E Plus Digital Monitor
https://www.gqelectronicsllc.com/comersus/store/comersus_viewItem.asp?idProduct=4570
$109.35 CAD
USB charging, audio and LED output. Handheld. Can connect to computers and tablets for analyzing data with free software. Digital screen.

Chapter 3
Geiger Counter Goes Bananas

Detects beta, gamma and x-ray. If you want alpha detection, bump up to the GMC-600 plus for $398 (https://www.gqelectronicsllc.com/comersus/store/comersus_viewItem.asp?idProduct=5637)

The 300E Plus model does work on Fiesta Ware: https://youtu.be/cyvFGxCAUWg?t=136
Also available on Amazon: https://www.amazon.ca/GQ-GMC300EPlus-Fulfill-Radiation-Detector/dp/B00IN8TJYY/ref=sr_1_4?dchild=1&keywords=GMC-300E-Plus&qid=1630956848&sr=8-4

For more models of Geiger Counters see: https://www.geigercounters.com/ (All prices in USD)
It is not advisable to buy a Geiger Counter less than $100 as the quality is usually poor.

Radioactive Items

CAUTION: Be very aware of what type of radiation each emits as well as how they should be stored when not being tested.

Naturally occurring radioactive materials

- Bananas
- Potassium chloride (KCl) salt (not NaCl salt) such as Windsor Salt Free Salt Substitute: https://www.realcanadiansuperstore.ca/salt-free-salt-substitute/p/20701904_EA

  Both bananas and KCl are completely safe to store, eat and handle)

- Uranium ore: can be found in the environment or on small sample cards for Geiger Counter testing (This testing card of carnotite uranium ore has mixed reviews on Amazon: https://www.amazon.com/United-Nuclear-Geiger-Counter-Test/dp/B08SDTNC2X/ref=sr_1_6?dchild=1&keywords=uranium+ore&qid=1630962639&sr=8-6)

  Uranium ore should not be touched with bare hands or inhaled. Plastic containers one cm thick can block alpha and beta radiation. Gamma radiation should be blocked with a container made of lead or tungsten. If you will be working with multiple radioactive objects including some human made radioactive materials, you might want to consider a lead or tungsten storage container for all activity materials.

Chapter 3
Geiger Counter Goes Bananas

Human-made radioactive materials

- Retro glassware with radioactive ceramic glaze, ex. Caliente, Early California, Poppytrail, Stangl, Vistosa and Fiesta Ware brands. Any red glaze is the most radioactive ex. Fiesta Ware from 1936-1969.

  Can be found on eBay: https://www.ebay.ca/sch/i.html?_from=R40&_trksid=p2334524.m570.l1313&_nkw=radioactive+fiesta+ware&_sacat=0&LH_TitleDesc=0&_odkw=retro+fiesta+ware&_osacat=0

- Fiesta Ware should not be used to eat food on: https://www.mcall.com/news/mc-xpm-1986-05-24-2523980-story.html and could have the potential to emit radon gas https://www.latimes.com/archives/la-xpm-1994-04-23-hm-49397-story.html

- The US Food and Drug Administration deemed Fiesta Ware safe to display or house in a cupboard. If you are nervous, store outdoors, in a well-ventilated area or in a lead box.

- **Not advised:** Retro watches, clocks and pocket watches painted with glow-in-the-dark radium paint. The glass face has to be removed so the paint is exposed to the counter but then it is also exposed to the person interacting with it. Radium paint is harmful if ingested or inhaled.

Other supplies

- Balloons
- Plastic twist ties
- Timer for timing balloon
- Masking tape
- String for tying or hanging balloon
- Wool or fuzzy cloth for charging balloon
- Plates or bowls for pouring salt into for testing (if necessary)
- Regular plates/bowls to compare against radioactive plates
- Everyday items that are not radioactive such as apples, oranges, regular salt
- Gloves for handling materials
- Storage containers for safe handling of radioactive materials

Sources and Further Reading

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Chapter 7

The Future (Truth)

Interactive Activity:
The Danger is Still Present

The Danger is Still Present

We review symbols and messaging proposed to warn future generations about nuclear waste. What symbols, words, sounds or textures would you use to warn people of radioactive waste?

What do you think of when you see this image? What emotions do you feel?

Do you know what this is? If not, what do you think it's for?

This symbol is commonly called the "trefoil" or nuclear warning symbol. It is designed to warn people that there are radioactive materials nearby.

The Danger is Still Present

If you never knew it was a nuclear symbol, what other things could it be a symbol of?
Ex. flower

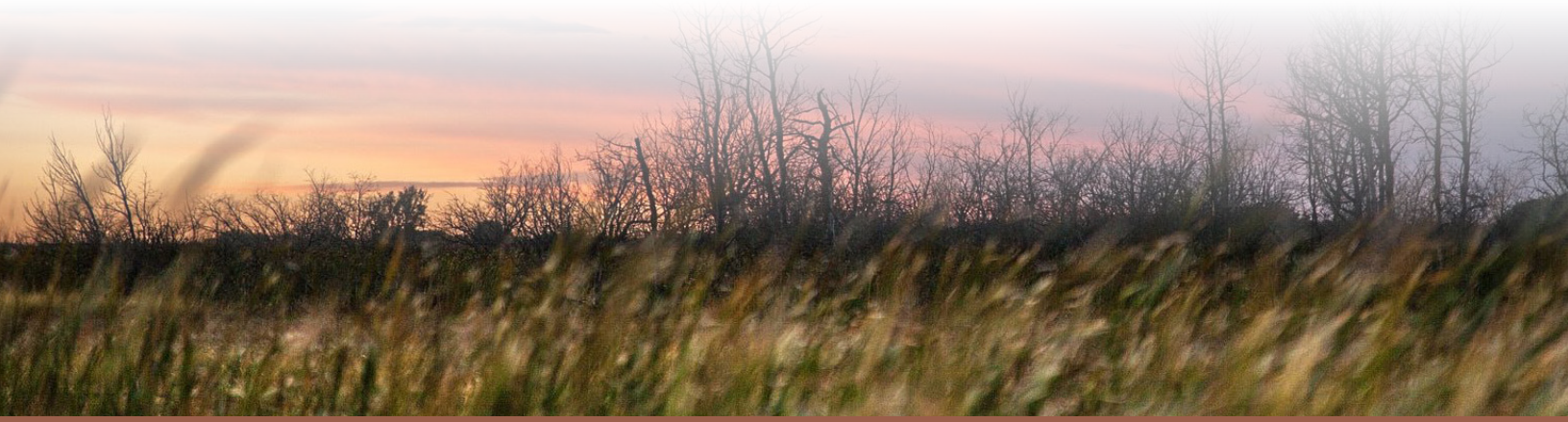
What about this symbol? What do you think it's trying to say? What emotions do you feel when you look at it?

Do you think this picture says "danger!" much better than the other symbol? Or is it more confusing?

The Danger is Still Present

Scientists, governments and concerned public have been trying to find a way to leave future generations a message about the dangers of nuclear waste for decades. Future generations may not speak the same language or be able to read and write the same language that we do now. You might have your own experience of trying to understand someone else or trying to be understood. The children's game of telephone is an easy way to show how quickly messages can change over time.
Sandia National Laboratories in New Mexico tried to come up with images that would speak to certain feelings and go along with a written warning at a long-term nuclear waste site. They tried to find images that spoke to the dangers of what would be buried, both physically and mentally.

What emotions do you feel when you look at these images?



The Danger is Still Present

The group of people who come up with these suggestions wanted any images at the site to act as a visual representation of certain warnings and feelings. The words they said the images represent, almost look like a poem.

This place is a message...and part of a
system of messages ...pay attention to it!

Sending this message was important to us.
We considered ourselves to be a powerful culture.

This place is not a place of honor...no highly esteemed deed is commemorated here
. . .nothing valued is here.

What is here was dangerous and repulsive to us.
This message is a warning about danger.

The danger is in a particular location...
it increases towards a center...the
center of danger is here… of a
particular size and shape, and below us.

The danger is still present, in your time, as
it was in ours.

The danger is to the body, and it can kill.

The form of the danger is an emanation
of energy.

The danger is unleashed only if you
substantially disturb this place physically.
This place is best shunned and left uninhabited.

What feelings do you feel when you read this "poem"? Do you think it get its message across?

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Nuclear waste can remain a danger to humans for thousands to hundreds of thousands of years. That is a very long time in the future to keep a location safe and to warn people not to disturb it.

What would you use to warn people about the dangers of nuclear waste? Would you use visual or non-visual tools (ex. a drawing versus a sound recording). Feel free to use the space below to outline what your nuclear waste warning images or system would look like.

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Facilitator Instructions

This activity can be modified in different ways to be completed in person or online as either a group activity or an individual reflection piece.

In-Person Facilitation Suggestions: Present each image on a card or a Powerpoint slide and discuss as a group, or break into groups and have each group view one image and discuss how they feel about it. Images could be posted on boards and have participants write their feelings and suggestions on sticky notes to go on each board. Each person could write their feelings on each image in their own personal workbook or sketchbook. The entire group could work to create one new warning image or warning system or work in breakout groups.

Online Facilitation Suggestions: Present each image on a Powerpoint slide or on a collaborative whiteboard program such as Google Jamboard. Participants can write their feelings and suggestions using the digital sticky note tools. You can form digital break-out rooms or keep everyone in the same "room". Alternatively, the entire group could share their feelings aloud without using a whiteboard program or some combination of the two. Google Jamboard also has a draw function which could be used for the creation of the warning image(s)/systems.

Individual Reflection: Images can be left in the workbook with a space for participants to write how they feel about each one. As well there would be a large space for them to share their design of a nuclear warning symbol or system.

Icebreaker Game

To be played at the beginning to introduce the topic or as a "tone break" when things get too heavy. You can play variations on the classic game "telephone". One person starts with a simple phrase and whispers it to the ear of the person next to them, by the end of the line the last person shares what the message is. The message is usually garbled. A fun variation is to have someone write the phrase down and then have another person try to draw it. Once the picture is drawn, the next person has to write down what they think the picture represents. Once you reach the end of the group, the results are hilariously different. An online version of this is Gartic Phone (https://garticphone.com/) A free game which can be played on desktop or browser.

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Background Information

The three-bladed radiation warning symbol, also know as the "radiation trefoil," originated at the University of California Radiation Laboratory in Berkeley, California in 1946. The trefoil symbol, known as such through its resemblance to the three-leafed plant of the same name, is designed to represent activity radiating from an atom. The first signs using the trefoil were magenta in colour on a blue background, used in part due to the distinctive shades that did not conflict with other colour coded symbology and was not currently used in most areas where radioactive work was carried out. Not everyone agreed that these were the optimal colours, so over the next few years (1040s-1950s) multiple variations were suggested and implemented. The present design, magenta or black on yellow, was codified in the late 1950s and continues to be used today to alert anyone to the danger of being close to a strong source of ionizing radiation.

The ISO 21482:2007 ionizing-radiation warning supplementary symbology was created in response to individuals, particularly those with insufficient technical education or background, being seriously injured or killed by handling sealed radioactive sources without understanding the meaning of the radiation trefoil on the source. The ISO symbol is red in colour, with symbology depicting the radiation trefoil emitting secretions downwards towards a skull-and-crossbones and an individual running away. This symbol is not intended to replace the radiation trefoil, but rather to supplement the trefoil by including further information on the dangers associated with radioactive sources and to alert untrained members of the public to the potential dangers of being close to a radioactive source.

The Waste Isolation Pilot Plant (WIPP) project of Sandia National Laboratories in Albuquerque, New Mexico, performed a study with the purpose of designing markers and messages to communicate with future societies about the location and dangers of the buried nuclear waste at the WIPP.

Two teams of experts were assembled including professionals from the following disciplines: anthropology, archaeology, architecture, astronomy, communications, design, engineering, geology/geophysics, modern languages, linguistics, materials science, psychology, semiotics, and sociology. Considered topics of importance during the development of these markers included physical properties—marker durability under current conditions, mechanism of attaching or inscribing messages, and the interaction of the elements with marker materials; marker interpretation or graphic/pictorial messages independent of culture; and marker interpretation of written messages independent of culture. How to communicate to future generations about nuclear waste is a continuing field in it's own right, called nuclear semiotics.

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Activity Materials

Figure 1: Radiation Warning Symbol "Trefoil". Symbol under public domain.

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Figure 2: Radiation Warning Symbol “Trefoil” in triangle. Symbol under public domain.

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Figure 3: ISO 21482:2007 Ionizing-radiation warning — Supplementary symbol. Symbol under public domain.

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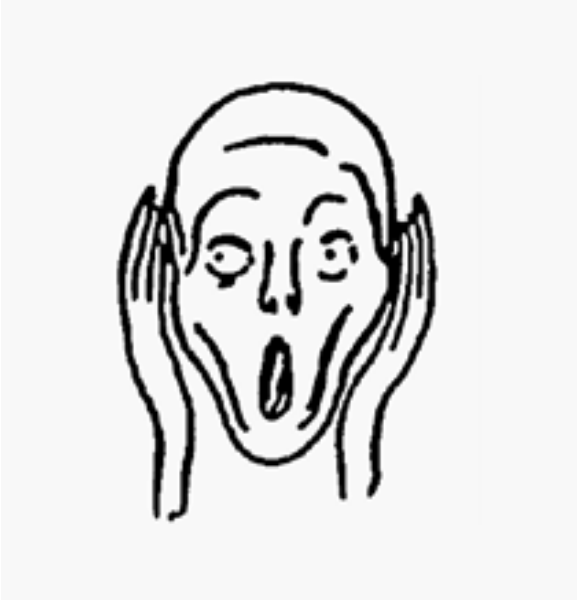

Figure 4: Symbol proposed by the Sandia Report proposed to be used as part of a nuclear warning message, the face denotes horror. (Trauth et al., 1993)

Figure 5: Symbology proposed to be used as part of a nuclear warning message. The face denotes nausea or sickness. Originally published in Eibl-Eibesfeldt, Irantius. Human Ethology. (New York: Aldine de Gruyter) Copyright 1989 by Iranaus Eibl-Eibesfeldt.

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This place is best shunned and left uninhabited.

The images proposed to be used at the Waste Isolation Pilot Plant were meant convey this meaning of warning. (Trauth et al., 1993)

Sources and Further Reading

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Trauth Kathleen, Hora Stephen C., Guzowski Robert V., Expert Judgement on Marks to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant (Albuquerque, NM: Sandia National Laboratories, 1993)


Zhaagimaa Waabo