ICWUC CENTER FOR WORKER
HEALTH AND SAFETY EDUCATION
PLUME MODELING

DAY ONE - MONDAY

8:30-9:00 **Register for class & Class Photo**

9:00-10:00 **Student Trainer introductions**

- **Program goals**
- **Logistics of the Center**
- **Overview of what will take place during the week**

10:00-10:15 **BREAK**

10:15-12:30 **EMERGENCY RESPONSE GUIDEBOOK**

- **Review of the DOT Guidebook**
- **Small group activity**

12:30-1:30 **LUNCH**

1:30-3:00 **Introduction to the CAMEO software**

- **Explanation of RIDS**
- **Explanations of Databases**

3:00-3:15 **BREAK**

3:15-4:30 **Introduction to the CAMEO software**

- **Using Cameo menus**
- **Using Cameo submenus**

DAY TWO - TUESDAY

8:30-10:00 **Alphabet Soup**

- **Defining acronyms**
- **Small group activity**

10:00-10:15 **BREAK**

10:15-12:00 **USING & COMPARING RESOURCES**

- **Identifying online resources**
- **Identifying strengths and weaknesses of each resource**

12:00-1:00 **LUNCH**

1:00-2:30 **TOXICOLOGY**

- **Toxicity of Chemicals**
- **Basic toxicological terminology**

2:30-2:45 **BREAK**

2:45-4:30 **INTRODUCTION TO MARPLOT**

- **Explanation of Marplot menus**
- **Explanation of Marplot layers**

DAY THREE - WEDNESDAY

8:30-10:30 **INTRODUCTION TO MARPLOT**

- **Using Marplot menus**
- **Using Marplot submenus**

10:30-10:45 **BREAK**

10:45-12:00 **INTRODUCTION TO MARPLOT**

- **Importing objects into Marplot**
- **Geo-reference of objects**

12:00-1:00 **LUNCH**

1:00-1:45 **LEVELS OF CONCERN**

- **Explanation of Levels of Concern**
- **Small group Activity**

1:45-3:00 **INTRODUCTION TO ALOHA**

- **Limitations of Aloha**
- **Air dispersion modeling**

3:00-3:15 **BREAK**

3:15-4:30 **INTRODUCTION TO ALOHA**

- **Using Aloha menus**
- **Inputting Aloha data**
- **Generating a plume**

DAY FOUR - THURSDAY

8:30-10:00 **AEGL LIMITS**

- **As a Level of Concern**
- **Methodology**

10:00-10:15 **BREAK**

10:15-12:00 **USING THE SOFTWARE (SCENARIOS)**

- **Utilizing Aloha**
- **Utilizing Marplot**
- **Utilizing Cameo**

12:00-1:00 **LUNCH**

1:00-3:00 **INTRODUCTION TO LANDVIEW**

- **Census data**
- **Expanded Marplot layers**

3:00-3:15 **BREAK**

3:15-4:30 **INTRODUCTION TO LANDVIEW**

- **Utilizing Census data**
- **Census data searches**

DAY FIVE - FRIDAY

8:30-10:00 **USING THE SOFTWARE (SCENARIOS)**

- **Small Group activity and projections**

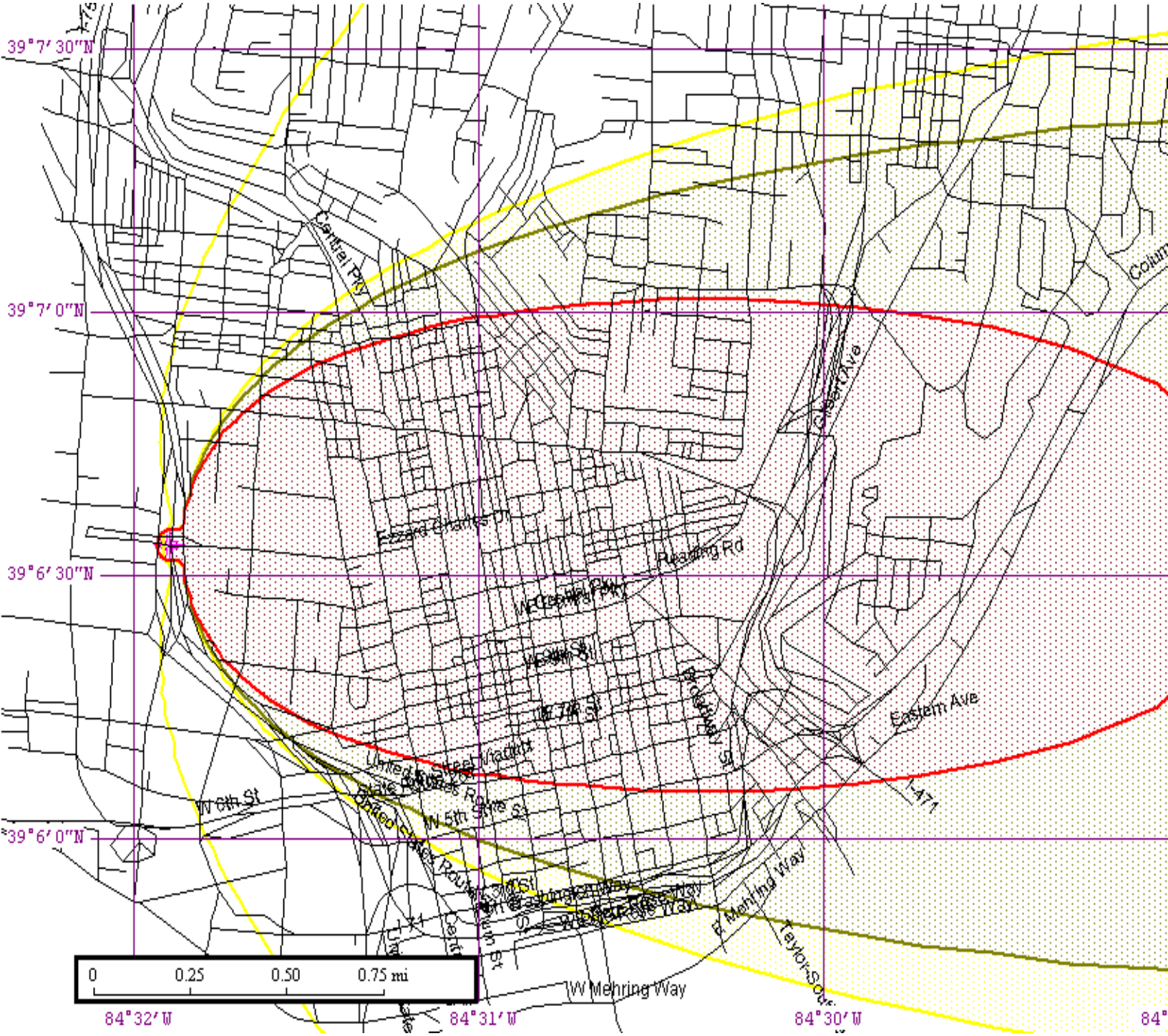
10:00-10:15 **BREAK**

10:15-11:00 **OTHER CAPABILITIES OF THE SOFTWARE**

- **Tier II Submit**

11:00- 12:30 **REVIEW**

12:30-1:00 **WRAP-UP & CERTIFICATES**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- **Utilizing a scenario with limited information as a trigger, students will look up data in the ERG book. This will be accomplished using an instructor led skit utilizing a staged 911 call.**
    - **One instructor leaves classroom and calls in that he has witnesses a truck overturn downtown(Give specific location so this can be mapped later). Classroom instructor assumes the role of a 911 operator and takes information from caller. Information is as follows.**
        - **Truck with tank has overturned.**
        - **Steam or smoke coming out of tank**
        - **Placard containing numbers 1017 on tank**
        - **No one is injured but people are running away from the scene**
- **Instruct students to assume the role of the first police officer that arrives and determine how far to keep people away from the accident scene.**
- **In a small group activity students will then plot isolation and evacuation distances, on a map of the city, using information found in the orange or green section of ERG.**
- **After completing the activity an instructor led discussion will follow on the limited data supplied in the ERG. Using a flip chart questions will be asked to collect ideas on information that could affect or influence the scenario. Emphasis will be placed on information that can be input into the ALOHA program ie.. temp., size of the leak, elevation of the leak, wind speed direction etc…**

Facilitators guide

Review of Emergency Response Guidebook

- **Direct students to the ERG book, page 295-301, "INTRODUCTION TO THE TABLE OF INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES" and discuss topics in this section related to the science(how and why) behind plume modeling.**

Topics to cover:
- **♦Isolation distances based on *vapor* cloud at 30 minutes**
- **♦Atmospheric conditions**
- **♦Thousands of release models calculated for each chemical**
- **♦Shelter in place reasoning**
- **♦Toxicological short-term exposure guidelines**

Ask students:

Considering what we just discussed, would you want to change the footprint for the release plotted earlier? Tell students this is why you are here, to learn the science behind plume modeling and then using that science actually plot and map toxic release plumes using the CAMEO, ALOHA and MARPLOT(Landview) software programs.

- **Begin 911 call again having callers from various locations outside of plotted plume call in saying that people are sick or dead in their areas. Have students plot this new location on the maps they generated earlier. End class here by leaving them wondering about these new developments.**

Facilitators guide
Review of Emergency Response Guidebook

SKIT DIALOGE (#1)

911 Dispatcher: **911, what is your emergency?**

911 Caller: **Yes, I am at the intersection of I-75 and Ezzard Charles Drive and a truck carrying a big tank has overturn.**

911 Dispatcher: **Are you in a safe location?**

911 Caller: **Yes, the wind is blowing away form me and I am running upwind from the accident. Everyone around the scene is running away.**

911 Dispatcher: **I am dispatching EMS personnel to the scene. Does anyone appear injured?**

911 Caller: **No, not as far as I can tell. The truck driver got out and is running upwind.**

911 Dispatcher: **Is the tank leaking and can you see any numbers on the tank?**

911 Caller: **There appears to be what looks like steam coming out of the tank. I can see a diamond on the back of the tank and there are some numbers in the diamond. Are those the numbers you are asking about?**

911 Dispatcher: **Yes, those are the numbers we need.**

911 Caller: **I can see four numbers. They are 1017.**

911 Dispatcher: **Thank you for the information. Get as far away from accident as you can and keep others away until EMS arrives.**

Facilitators guide
Review of Emergency Response Guidebook

SKIT DIALOGE (#2)
(30 minutes after the accident)

911 Dispatcher: **911, what is your emergency?**

911 Caller #2: **My mother just came in from getting the mail and passed out.**

911 Dispatcher: **I am dispatching EMS personnel to the scene. Is she breathing?**

911 Caller #2: **No and I can't find a pulse.**

911 Dispatcher: **Can you confirm your address at East Pete Rose Way and Eastern Avenue.**

911 Caller #2: **Yes, that is correct.**

911 Dispatcher: **Do you know how to perform CPR.**

911 Caller #2: **Yes**

911 Dispatcher: **Start CPR and keep this line open with me if you need assistance. EMS will be there in two minutes.**

_____Caller #3_____

911 Caller #3: **I live at the corner of Forest and Gump Street and I feel really sick and my lungs are burning. Can you send an ambulance for me?**

911 Dispatcher: **Yes, I will dispatch one now. Are you in a safe location?**

911 Caller #3: (No Response)

911 Dispatcher: **Sir, are you there? Can you speak? Sir? Sir.? Can you hear me?**

911 Caller #3: (No Response)

911 Dispatcher: **911, what is your emergency?**

----------Caller # 4----------

911 Caller #4: **I am the principal at Central Grade School on the corner of Cletus and Main Street and several of our children came in from recess coughing with burning eyes and throats.**
Please send EMS to check them out.

911 Dispatcher: **EMS is in route. Keep the children calm and quiet until EMS arrives.**

CAMEO*fm* OBJECTIVES

Terminal Objective: At the end of this session participants will demonstrate the ability to Navigate and use the menus associated with CAMEO*fm*

Enabling Objectives:

1. Identify the menu items in CAMEO*fm*
2. Use the navigator menu in CAMEO*fm*
3. Do chemical and facility searches in CAMEO*fm*
4. Access the chemical database in CAMEO*fm*
5. Utilize the RIDS data in CAMEO*fm*

Alphabet Soup

Terminal Objective:

To introduce students to new terminology utilized in CAMEO, ALOHA and Landview software programs. To reacquaint students with commonly used Health and Safety terminologies.

Enabling Objectives:

Using the provided resources, students will research and document terminologies related to Health and Safety, CAMEO, ALOHA and Landview, working together in small group.

Utilizing a group report back and class discussion students will correctly identify terms related to Health and Safety, CAMEO, ALOHA and Landview.

Students will be provided a copy of the worksheet with correct answers for future reference.

Alphabet Soup

Facilitators Guide

- Instruct students that the purpose of this exercise is to refresh their memory of useful terms used in Health and Safety training and to introduce new terminology specific to the training they are receiving this week. Hand out work sheet and instruct students to use all resources in the classroom for this exercise. Ask students to fill in an answer for the acronyms that have been left blank.

- When students have completed the exercise, review the worksheet with the class. Ensure students understand the newly introduced terminology by spending adequate time on these topics.

- Provide students with a copy of the worksheet with all correct answers for them to reference back to during the remaining training.

Alphabet Soup

ABS	Absorption
ACGIH	American Conference of Governmental Industrial Hygienists
AEGLS	_____
AL0HA	_____
APR	Air-Purifying Respirator
BEI	Biological Exposure Indices
CAMEO	_____
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
CON	Contact
CNS	Central Nervous System
CPC	Chemical Protective Clothing
CVS	Cardio-Vascular System
DEGADIS	_____
DOT	U.S. Department of Transportation
EHS	Extremely Hazardous Substances
EMS	Emergency Management System
ENT	Ear, Nose and Throat
EPA	Environmental Protection Agency
EPCRA	_____
ERG	Emergency Response Guidebook
FEMA	Federal Emergency Management Agency
HAZWOPER	Hazardous Waste Operations and Emergency Response training

HMEP	Hazardous Materials Emergency Preparedness
HMIS	Hazardous Materials Identification System
ICS	Incident Command System
IDLH	Immediately Dangerous to Life and Health
ING	Ingestion
INH	Inhalation
LEPC	_____
LEL	Lower Explosive Limit
LOC	_____
MARPLOT	_____
MSDS	Material Safety Data Sheet
MW	Molecular Weight
NOAA	_____
NFPA	National institute of Occupational Safety and Health
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Clothing
POTW	Publicly-Owned Treatment Works
REL	NIOSH Recommended Exposure Limits
RMP	_____
RIDS	_____
SAR	Supplied Air Respirators
SCBA	Self-contained Breathing Apparatus

STEL	Short Term Exposure Limits (15 minutes)
SWAG/WAG	_____
TEELS	_____
TLVs	Threshold Limit Values
TRI	Toxic Release Inventory
TWA	Time-Weighted Average
UEL	Upper Explosive Limit
VD	Vapor Density
VP	Vapor Pressure

Alphabet Soup

ABS	Absorption
ACGIH	American Conference of Governmental Industrial Hygienists
AEGLS	Acute Exposure Guidelines Level
AL0HA	Areal Location of Hazardous Atmospheres
APR	Air-Purifying Respirator
BEI	Biological Exposure Indices
CAMEO	Computer Aided Management of Emergency Operations
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
CON	Contact
CNS	Central Nervous System
CPC	Chemical Protective Clothing
CVS	Cardio-Vascular System
DEGADIS	Dense Gas Dispersion Model
DOT	U.S. Department of Transportation
EHS	Extremely Hazardous Substances
EMS	Emergency Management System
ENT	Ear, Nose and Throat
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ERG	Emergency Response Guidebook
ERPG	Emergency Response Planning Guideline
FEMA	Federal Emergency Management Agency

HAZWOPER	Hazardous Waste Operations and Emergency Response training
HMEP	Hazardous Materials Emergency Preparedness
HMIS	Hazardous Materials Identification System
ICS	Incident Command System
IDLH	Immediately Dangerous to Life and Health
ING	Ingestion
INH	Inhalation
LEPC	Local Emergency Planning Committee
LEL	Lower Explosive Limit
LOC	Level of Concern
MSDS	Material Safety Data Sheet
MW	Molecular Weight
MARPLOT	Mapping Application for Response Planning and Local Operational tasks
NOAA	National Oceanic and Atmospheric Administration
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PPE	Personal Protective Clothing
POTW	Publicly-Owned Treatment Works
REL	NIOSH Recommended Exposure Limits
RMP	Risk Management Plan
RIDS	Response Information Data Sheets
SAR	Supplied Air Respirators

SCBA	Self-contained Breathing Apparatus
STEL	Short Term Exposure Limits (15 minutes)
SWAG/WAG	Scientific wild Ass Guess/Wild Ass Guess
TEELS	Temporary Emergency Exposure Limit
TLVs	Threshold Limit Values
TRI	Toxic Release Inventory
TWA	Time-Weighted Average
UEL	Upper Explosive Limit
VD	Vapor Density
VP	Vapor Pressure

Chemicals of Concern
(Toxicology Matrix)

chemical?

1. Physical description?

2. Routes of entry?

3. Target Organs?

4. Health Hazards?

5. Incompatible with?

6. VP

7. VD?

8. LEL?

9. UEL?

10. PEL?

11. TLV?

12. AEGL3? ***(Acute Exposure Guidelines Level)*** *for 60 mins?*

Chemicals of Concern
(Toxicology Matrix)
ATSDR ANSWER KEY

Chemical *CHLORINE*

1. Physical description? ***At room temp yellow-green gas that is heavier than air , and has a strong irritating odor.***

2. Routes of entry? ***Inhale chlorine gas or get it on their skin***

3. Target Organs? ***Respiratory tract, skin and eyes.***

4. Health Hazards? ***Irritating and corrosive to the respiratory tract, eyes, skin. May cause sore throat, coughing, eye and skin irritation. Higher concentrations can cause burns to eyes and skin. Accumulation of fluid in the lungs, and pain in the lung region.***

5. Incompatible with? ***It reacts with water to form hydrochloric acid***

6. VP? ***Not given***

7. VD? ***Not given***

8. LEL? ***Not Flammable***

9. UEL ***Not Flammable***

10. PEL? ***1ppm***

11. TLV? ***0.5ppm***

12. AEGL3? ***(Acute Rxposure Guidelines Level)****for 60 mins?* **Not given**

Chemicals of Concern
(Toxicology Matrix)
CAMEO ANSWER KEY

Chemical *CHLORINE*

1. Physical description? ***Greenish yellow gas with a pungent suffocating odor, and vapor is heavier than air.***

2. Routes of entry? ***Inhalation, contact***

3. Target Organs? ***Skin and eyes , respiratory tract***

4. Health Hazards? ***Can burn skin and eyes, bronchitis or cause chronic lung condition.***

5. Incompatible with? ***Alcohols- molten aluminum***

6. VP? ***7600 mm Hg @86 F***

7. VD? ***2.49***

8. LEL? ***Not Flammable***

9. UEL? ***Not Flammable***

10. PEL? **Not given**

11. TLV? ***0.5 ppm***

12. AEGL3? ***(Acute Exposure Guidelines Level)*** *for 60 mins? 20ppm*

Chemicals of Concern
(Toxicology Matrix)
NIOSH ANSWER KEY

Chemical - CHLORINE

1. Physical description? ***Greenish – yellow gas with a pungent, irritating odor***

2. Routes of entry? ***Inhalation, skin and/or eye contact***

3. Target Organs? ***Eyes, Skin, Respiratory system***

4. Health Hazards? ***Burning of eyes, nose ,mouth (discharge of tears) cough, choking, nausea, vomiting, headache dizziness, frostbite, and pulmonary edema.***

5. Incompatible with? ***Acetylene, ether , ammonia, fuel gas, and finely divided metals***

6. VP? ***6.8 atm***

7. VD? ***MW 70.9***

8. LEL? ***Not Flammable***

9. UEL? ***Not Flammable***

10. PEL? ***1 PPM***

11. TLV? ***not given***

12. AEGL3?*(Acute Exposure Guidelines Level)* **for 60 mins?** ***Not given***

FACILITATOR'S GUIDE:
USING AND COMPARING RESOURSES

EXERCISE OBJECTIVES AND INTRODUCTION

Explain exercise involves comparing the information obtained from different resources. Explain that you will briefly go over the CAMEO, NIOSH and ATSDR programs.

CAMEO Computer Aided Management of Emergency Operations.
NIOSH National Institute for Occupational Safety and Health.
ATSDR Agency for Toxic Substances and Disease Registry.

Give brief explanation on how to locate programs on their computers. Make sure class knows that they can ask questions at any time.

SMALL-GROUP EXERCISE

Explain the purpose of this exercise is to compare features and limitations of some sample resources

One group the CAMEO program

One group the NIOSH program

One group the ATSDR program

Each group answers the work sheet using only their assigned resource. If they can't

find the answer in their resource that's what they should mark on their work sheet

LARGE GROUP REPORT-BACK

You will need a large answer chart to fill in during the report-back. Put in three columns on the chart CAMEO,ATSDR, and NIOSH.

Make sure you have your own copy of the exercise. You must know what the answers should be and what to say about each question.

Question#1 ***Play on description of color.***

Question#2 ***same routes.***

Question#3 ***All skin ,eyes, and respiratory tract.***

Question#4 ***All cause Burns and Irritation to the eyes and skin. ATSDR- exposure can cause a Accumulation of fluid in the lungs, NIOSH calls this condition Pulmonary Edema, and CAMEO – bronchitis or can cause chronic lung condition.***

Question#5 ***NIOSH gives incompatibles that can cause an explosive compound. ATSDR no information. CAMEO uses similar incompatibles as NIOSH.***

Question#6 ***NIOSH 6.8 atm , ATSDR no info, and CAMEO gives us 7600mmhg***
ASK: why is VP important and how can we compare atms to mmhg? Answer 1 atm = 760 mmhg at aprox 70F CAMEO uses 86F for there VP.

Question#7 ***ATSDR not given, CAMEO 2.49, and NIOSH MW70.9.***
ASK: What's the difference between CAMEO and NIOSH? Answer divide the MW by 28.8 (air)

Question#8 ,9 ***chlorine is not flammable so no information given.***

Question#10 ***PELs are set by OSHA for work place exposures. CAMEO information is used for nonworking place exposures.***

Question#11 ***NIOSH RELs, PELs for workplace exposures, ATSDR same as NIOSH. CAMEO uses ACGIH TLVs for noworking exposures.***

Question#12 ***ASKS: Why not just use PELs and TLVs for all exposures working and noworking?***

SUMMARIZE

Summarize purpose of the module is to look at ways to find information on chemicals using the computer. Also to keep in mind that the ATSDR and NIOSH are recommendations for work place control of exposures. CAMEO can be used to help Emergency personal in assigning health risks to non workers during a release of a toxic chemicals after an accident.

	NIOSH	ATSDR	CAMEO
Physical description	greenish-yellow gas	yellow-green gas	greenish-yellow gas
Routes of entry	INH CON	INH CON	INH CON
Target Organs	skin,eyes Resp	skin,eyes Resp	skin,eyes Resp
Health hazards	irritent ,burns Pulmonary edema	SAME	SAME
Incompatible with	fuel gas,ammonia Metals	none	alcohols, molten aluminum
VP	6.8 atm	not given	7600mmhg @86F
VD	MW 70.9	not given	2.49
LEL	NA	NA	NA
UEL	NA	NA	NA
PEL	1ppm	1ppm	not given
TLV	not given	0.5ppm	0.5ppm
AEGL	not given	not given	1ppm

Small group exercise

Using flip charts write down these chemicals in groups for report back on question # 8

As the students match the health effects meanings have them pick witch category of chemicals would fall under each meaning

Sodium hydroxide
Nitric acid
Chlorine
Hydrochloric acid

wood dust
Carbon tet
asbestos
perchloroethylene

Carbon tet
Arsenic
Benzene
Mercury

argon
helium
nitrogen
carbon dioxide

Carbon tet
Benzene
Toluene
Perchloroethylene

Thalidomide
Ionizing radiation
Arsenic
Ethylene oxide

Objectives

Using & Comparing Resources

Upon completion of this class participants will be able to:

- Identify strengths and weaknesses of the NIOSH Pocket Guide (electronic version) in researching chemical hazards.
- Identify strengths and weaknesses in the Agency for Toxic and Disease Registry (ASTDR) information sheets in researching chemical hazards.
- Identify strengths and weaknesses in the CAMEO Response Information Data Sheets (RIDS) in researching chemical hazards.

Objectives

Toxicology

Upon completion of this class participants will be able to:

- Recognize chemicals that are present at their worksite.
- Recognize what form chemicals are usually found in.
- Recognize the health problems that can be caused by those chemicals.
- State why it is important to know what form a chemical is in.
- Identify which chemicals at their worksite have the potential of causing pulmonary edema.
- Identify which chemicals at their worksite are corrosive.
- Recognize which chemicals at their worksite might cause reproductive health problems.
- Recognize which chemicals at their worksite might cause cancer

(All questions are highlighted. Points that should be brought out in the answers are included but this text is not designed to be read verbatim)

A. Introduction

ASK: "What is toxicology?"

Study of toxic effects hazardous chemicals have on the body.

B. Small Group Activity

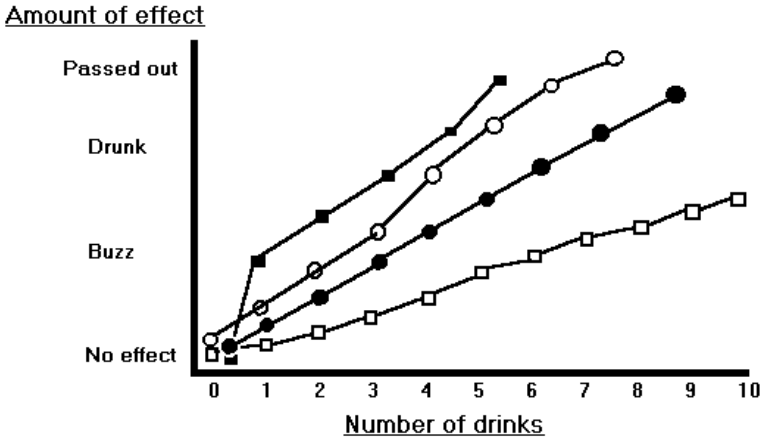
C. Anything can be harmful, if enough of it is taken into the body.

ASK: "Can a person die by drinking too much water?"

Yes. Too much water throws off the body's salts (electrolytes) which must be in balance. If they are not balanced, it can be deadly.

D. Dose-Response Curve

The amount of the effect, depends on the dose. This is called a "dose-response" curve. In other words, a certain dose causes an effect. For example if we all went out drinking after class, some of us might start feeling the effects of the alcohol after just one drink (dose). Other people may not feel any effect until after three drinks (chart this on flip chart with "dose" along the bottom and "response" or effect on the vertical axis). The more we would drink (dose), the greater the effect (response). So let's draw some examples of the response that different people may have to this exposure to drinking alcohol:



ASK: "Why are these curves different?"

Because, not all people react the same way when they are exposed to chemicals. There are individual differences - some people are more susceptible than others. Age, sex, genetic factors, and health status all also affect how a person reacts to chemical exposure.

E. Other Factors Which Influence The Dose-Response Curve:

Concentration of the Chemical

There are also other factors which may influence these dose-response curves such as concentration and toxicity of the chemical. For example if you drank 12 ounces of whiskey, you would have a greater effect or feel more drunk than if you drank one can (12 ounces) of beer. It is very important to know what the concentration is of the chemical you are working with in the workplace. Many chemicals in the workplace are often much stronger than that same chemical found in the home. For example, hydrogen peroxide found in industrial settings can cause severe burns if it gets on your skin but in the home it is diluted to the point that some use hydrogen peroxide as a mouthwash.

ASK: **"Where in your workplace might you find out the strength of a chemical?"**

On Material Safety Data Sheets

ASK: "Where in your workplace would you find MSDSs?"

Frequency or Duration of Exposure

The toxicity of many chemicals depends not only on the dose but also on the length of exposure (number of days, weeks, or years). This is especially true for chemicals which can produce irreversible injuries to cells or tissues. So a brief exposure to a low dose of certain chemicals may produce so little damage that no immediate injury occurs. However, continued exposure to this same chemical may accumulate in the body tissues or damage cells until there is significant injury or illness.

Additive effects of chemicals

The effect of some chemicals are additive in the body. For example, if a worker breathes in a solvent all day that acts on the body just like drinking alcohol, it may have the equivalency of three drinks. Then if the worker has a couple of beers after work, the body acts as if the worker has had 5 drinks. This is an additive effect.

Synergistic effect of chemicals

ASK: "Has anyone ever heard of synergism? What is it?"

Synergism is when the effects of two or more chemicals gives a much worse health effect than what would be expected. For example, one of the most common workplace examples of the effects of synergism is with smoking and asbestos. Cigarette smoke and asbestos react synergistically on the lungs so the risk of getting lung cancer are multiplied - not just added. For example out of 100,000 people, 10 non-smokers who are not exposed to asbestos get lung cancer. Fifty non-smokers who are exposed to asbestos will get lung cancer. But if a worker smokes and is exposed to asbestos, then these odds are multiplied so 500 out of 100,000 will get lung cancer.

F. Acute & chronic health effects

(Questions #1 & #2 on the Toxicology Exercise)

1. If you have worked with a chemical for eight years and have not had any health problems as a result, that means that chemical is not toxic to you.

   TRUE __ FALSE X

   There are individual differences in people. So, it is possible that you may never be hurt by that chemical. But, but some health effects from chemicals, like some cancers, don't appear for as long as 20 or 30 years.

2. Chemicals that cause acute health effects are more dangerous than those that cause chronic health effects.

   TRUE __ FALSE X

   The key word here is "more". Both acute health effects and chronic effects can be deadly.

ASK: "What is the difference between acute and chronic (dose) exposure and acute and chronic effect."

Acute (dose) exposure means usually a large (dose) exposure in a short period of time. Acute exposures may produce acute health effects that may appear hours or days later, but they usually appear within 24 hours. Acute doses may immediately kill somebody, but they also cause long-term effects.

ASK: **"Many people do not consider skin rashes to be a major problem. Are all acute health effects considered minor?"**

No - just because it is an acute exposure to a chemical that does not mean it is mild. For example, death can be an acute effect. Acute effects of a chemical exposure means the health effect occurs right away that is especially true for strong acids and bases (alkalies) because they burn the skin and eyes. For example, an acute exposure to chlorine gas causes immediate eye irritation and bronchoconstriction (restriction of the airways), but a worker may develop chemical pneumonia or liver/kidney failure in the next 1-7 days.

ASK: **"What is a CHRONIC exposure?"**

Chronic effects are those usually due to small doses over a long period of time and may take years for adverse effects to appear. But, sometimes a brief exposure can also result in chronic effects. For example, some people who were exposed to large amounts of asbestos later developed lung cancer (a chronic effect) due to asbestos exposure (this can be an acute exposure). Asbestos is one of a few examples in which an acute exposure can result in cancer.

G. Routes of Entry

(Question #3 on the Toxicology Exercise)

3. Check the ways through which chemicals can enter the body:

Through cuts in the skin _X_ Breathing in _X_

Eating or drinking in the work area _X_

Through unbroken skin _X_

ASK: "How do chemicals get into the body?" (write answers on the flip chart)

Inhalation, ingestion, absorption, contact - Emphasize these four answers and make sure that each of these is defined including the difference between absorption and contact. Another answer that may come up during this brainstorm is injection - but do not list this unless someone mentions it.

So to understand how chemicals can affect us, we need to know **how they get into the body.**

ASK: "How do chemicals get swallowed in the workplace?"

The most common way is if someone eats or drinks in a work area where hazardous chemicals are used, and the chemicals get in the air and land on the food or in the drink. For example, some companies had policies where workers were not allowed to leave their machines to go eat. They had to eat at their work station. This increased the chances they would ingest the chemicals that got in the air. Ingestion can also occur if a worker does not wash his or her hands before eating. Another way chemicals are ingested is by improperly labeled containers such as storing a hazardous chemical in a food container such as a milk jug or soda pop bottle.

ASK: "Can you tell if something is hazardous just by smelling?"

No, because sometimes hazardous chemicals do not have a smell (like carbon monoxide, asbestos, silica) and some "non-hazardous" chemicals (like skunk smell) have a very bad smell. Also, noses can sometimes get used to a smell (like hydrogen sulfide) so that you can't smell it anymore.

ASK: "Has anyone here ever been in an area that smelled bad at first; but the longer you were there, the less you noticed it?" This is called nasal fatigue.

Some resources will give you an odor threshold number. This is the lowest concentration of a chemical that can be detected by smell. This only gives a clue on the amount of chemical in the air. But, you

should not rely on it because sometimes if you are exposed to a chemical with a high odor threshold, you may be overexposed before you even smell it. For example, the New Jersey Hazardous Substance Fact Sheet (1992) gives a minimum odor threshold for carbon tetrachloride of 140 ppm. These means that average people with no sinus problems will first begin smelling carbon tet when the concentration has reached 140 ppm in the air. Carbon Tetrachloride is considered a carcinogen by NIOSH & ACGIH and has a vacated OSHA PEL of 10 ppm. So if a person smells carbon tet, they may have been overexposed.

H. Target organs:

(Question #4 on the Toxicology Exercise)

4. The main target organs for many industrial solvents are: (check all that apply)

Stomach ___ Liver _X_ Central Nervous System _X

Teeth ___ Skin _X_ Pancreas

ASK: "What are target organs?"

Many chemicals target a specific body organ. For example, in the example just given between smoking and asbestos, the lungs are the target organ for both asbestos and cigarette smoke. Alcohols, including drinking alcohol & degreasing agents (organic solvents), target the liver. That is why exposure to solvents can cause cirrhosis of the liver.

ASK: **"How do chemicals get to organs like the liver or kidney**?"

The chemicals are usually inhaled (but occasionally absorbed through the skin or ingested) and get into the bloodstream. The blood then carries that chemical throughout the body in minutes.

ASK: **"Why are the LIVER and KIDNEYS common target organs?"**

The liver changes chemicals that are insoluble in water to soluble in water so the kidney can filter them into the urine (examples include methylene chloride and stoddard solvent)

Notice that industrial solvents affect the same organs as drinking alcohol. That is because drinking alcohol is an organic solvent. There have been cases of workers who have been pulled over for DUI who have been working with solvents all day. Drinking alcohol has an additive effect with solvents. That means that if a worker works with solvents all day, the body treats that solvent just like drinking alcohol so the body may react as if it has already had several drinks. So if a worker is exposed to solvents in the workplace and get a beer on the way home, they may not pass the sobriety test.

ASK: **"Is skin considered to be an organ?"**

Yes, the skin is the largest organ of the body.

I. Forms of substances

(Question #5 on the Toxicology Exercise)

5. Almost all hazardous substances are found in three main states of matter: solids, liquids, & gases. Name the four additional forms that they can be broken down into.

DUST

⇗

SOLID

⇘

FUMES

MIST

⇗

LIQUID

⇘

VAPOR

GAS

ASK: "Why is it important to know what form a particular chemical is in?"

So you know how it gets into the body.

Substances are found in three major states of matter - solids, liquids, and gas. Solids can then be broken down into fumes and dusts. Liquids can break into mists or evaporate into vapor. Vapor basically enters the body and acts the same as a gas, but it comes from liquids.

Define these terms:

SOLIDS

dusts: small particles of solids. Usually found with "-ing" activities such as grinding, sweeping, sanding.

fumes: This is a commonly misused word. Fumes are extremely small particles of metals which are released by heating, welding, & smelting. These particles are so small that they go all the way to the air sacs of the lungs and pass into the bloodstream.

LIQUIDS

vapors: this is what comes off of liquids when they get in the air or evaporate. For example, vapors come out of most liquid solvents easily. One of the most important ways to control this exposure to hazardous vapors is to make sure that vats are covered and processes are properly enclosed and ventilated. Also lids should be kept on smaller containers when not in use in order to keep vapors from escaping into the air.

mists: small particles of liquids that get in the air.

GASES

These are molecules of matter that move freely and swiftly in all directions. So a gas not only takes the shape of the vessel, but expands and fills the vessel.

J. Examples of forms of common chemicals

For example, here are some hazards associated with these forms of chemicals if exposures are uncontrolled:

(Do not go into every example given. Ask the class for examples of each form of chemicals that they work with. These examples are only given to give the facilitator additional background information)

GASES: These are health hazards because they either have a direct toxic effect on the body or they take up space in the atmosphere and keep the body from getting the oxygen it needs to survive (common in confined spaces)

Examples:

Sulfur dioxide (produced in smelting of sulfide ores and in the process of sulfur-containing fuels like coal. Magnesium workers may be exposed to large amounts since sulfur dioxide is used to prevent oxidation of metal.); **hydrogen sulfide** (smell of rotten eggs and seen in industries where sulfide ores are used and in the manufacture of chemicals, dyes & pigments, and in the refining of petroleum)[one deep breath of pure hydrogen sulfide can kill you. It tells the respiratory center in the brain to stop breathing]; **halogens** (set of similar chemical elements [**fluorine**, **chlorine**, **bromine**, and **iodine]**); **phosgene** (nerve gas used during WWI and is useful in many chemical reactions, produced whenever a compound containing chlorine comes in contact with a flame or hot metal - like in welding); **ammonia**, these are all highly irritating to the skin, eyes, and linings of the respiratory tract and may cause pulmonary edema. Chemical burns may also occur.

Carbon monoxide (CO) - (colorless, odorless gas that accompanies incomplete combustion is often found near furnaces, ovens, stoves, forges, and kilns). Carbon monoxide has an affinity for hemoglobin in the red blood cells that is 210 times that of oxygen. So CO replaces oxygen by attaching chemically to hemoglobin in the red blood cells which carries oxygen in the blood. If tissues do not receive enough oxygen, they stop working. The brain and heart are the most sensitive organs. Death occurs because there is not enough oxygen for the heart muscle and brain.

DUSTS: These usually cause disease only in the lungs. Particle size affects the toxicity of dusts - the smaller the particle, the farther down into the lungs it can go and the greater the amount of dust that will be retained by the body. The more dust retained in the body, the more severe the resulting illness. In the nose, larynx, and in the airways there is a way of clearing out large particles such as dust. It is called the muco-ciliary escalator. Dust and other large particles are trapped by the mucus and the cilia (tiny hairs in the airway) "sweep" the contaminant to the larynx where it is swallowed into the esophagus. However, these cilia are paralyzed by cigarette smoke which results in what people know as a "smoker's cough" to bring up the mucus.

Examples:

Beryllium dust: This disease results from the inhalation of beryllium dusts which is a non-radioactive lightweight metal used in the defense, energy, telecommunications, and computer industries. It can take 15 to 30 years after exposure to beryllium dusts for symptoms to develop. In chronic berylliosis, the lungs become stiff and unable to transfer oxygen to the bloodstream. The heart is affected by years of straining to pump blood through the stiff lungs. The final stage of the disease is similar to asbestosis. (**FYI** - There have been more than 30 cases of chronic berylliosis diagnosed in workers at the DOE Rocky Flats nuclear weapons plant near Denver)

Asbestos: A fibrous, inorganic (no carbon) mineral similar to cotton (which is organic - contains carbon) but with fibers as strong as piano strings. In the past it has been used in over 3000 products ranging from potholders to childrens' toys. These fibers are extremely small and almost indestructible. Since they are so small, they reach the air sacs in the lungs. Since the body cannot destroy asbestos fibers, it walls these fibers off with tissue in the gas exchange area (alveoli = air sacs) which make the lungs inelastic. Also, this takes up room in the air sacs so the lungs do not hold as much air. Low blood oxygen levels and decreased lung volume are often seen in workers with asbestosis. Another serious effect of asbestos dust is that it can cause body cells to turn cancerous. The cancer often associated with asbestos is lung cancer. Another type of cancer specific to asbestos is mesothelioma. Prior to the introduction of asbestos into our society at

the turn of the century, mesothelioma was so rare that it was unheard of by most doctors. Then the only cases appeared to result from exposure to natural deposits of asbestos or to asbestos-rich soil in farming country. There are cases of mesothelioma resulting from only one day of work in a shipyard, or developing in asbestos workers' wives who were exposed when washing their husbands' work clothes.

FUMES: The main hazards of metals are when they are in the forms of dusts or fumes. Metals affect the nervous system and cause nervous disorders. Some of the metals cause metal fume fever which is an illness with symptoms very similar to the flu: muscular aches and pains, fever, chills, weakness, nausea, burning throat, and a cough. This illness is brief and complete recovery usually occurs in 12 to 24 hours. Examples of metal that can cause metal fume fever include copper oxide, iron oxide, magnesium oxide, titanium dioxide (released from electric furnaces or during machining), and zinc oxide.

Examples:

Cadmium: earliest symptoms of acute cadmium poisoning are similar to those of metal fume fever but pulmonary edema (fluid in the lungs) may develop. There may be severe shortness of breath. Recovery from acute poisoning may take 1 to 2 weeks, but chronic emphysema often results. Chronic effects results in severe lung problems such as chronic bronchitis, emphysema, or lung scarring. The kidneys are also damaged by repeated exposure. There may also be bone-marrow damage resulting in anemia.

Manganese: these fumes are often released near reduction furnaces and from manganese-coated welding rods. These fumes can cause metal fume fever and also pneumonia. There is also a severely crippling, permanently disabling disease of the nervous system similar to Parkinson's disease called *manganism*. It has been found in workers involved in the arc-cutting of manganese steel - especially in unventilated areas. Early symptoms include headache, weight loss, & lack of appetite. Later there may be inability to sleep followed by overpowering sleepiness, leg cramps, and changes in speech patterns. In the final stage the face is rigid and the use of the hands and arms are restricted by extreme muscle rigidity.

Inorganic Lead: (found in paint or grinding operations) Early symptoms of inorganic lead poisoning are inability to sleep, fatigue, and constipation. Later anemia, colic, and neuritis will develop. Involvement of the brain causes headache and sometimes double vision. The nerves that extend to arms, legs, and all other parts of the body become inflamed and painful and a fine tremor may develop. Finally, a person may lose his or her teeth and have sore gums. The anemia results from the lead affecting the blood-forming tissues in the bone marrow. After many years of lead poisoning, a worker may develop kidney complications that can lead to high blood pressure and even to complete kidney failure.

LIQUIDS:

Though it is possible to ingest liquids if they are stored improperly, the main concern with liquids is the skin. Some liquids may cause irritation or burns on contact with the skin and others may get into the bloodstream by being absorbed through the skin which is the largest organ of the body.

Examples: **Phenol:** This is a component of coal tar. Extensive absorption of phenol can affect both the central nervous system and the circulatory system. Depression of the nervous system may be so great that the nerve signals sent out by the brain to the body are very weak such as those nervous impulses that control breathing. As a result, many victims die from respiratory failure. Phenol is also very corrosive to the skin and can cause skin burns or irritation. Long term exposure to phenol may result in nervous system disorders and there may be liver and kidney damage.

Pyridine: (obtained from distillation of coal tar - widely used solvent) Workers exposed to high concentration of this vapor in the air may have digestive disturbances such as diarrhea, stomach pain, nausea, and weakness. Even if the exposure is not high enough to produce these signs, there can still be damage to the liver. Pyridine is also irritating to the membranes of the breathing passages.

Toluene: Toluene can impair workers' judgment and reflexes so that they are much more prone to industrial accidents.

MISTS: Mists are small particles of liquid that get into the air which can be inhaled or land on the skin.

Example:

Oil mists: These can be thrown off by moving machinery and can cause a skin rash and possible skin cancer if the oil lands on the skin. If these mists are inhaled, they can cause a chemical pneumonia (called lipoid pneumonia) which is an inflammation of the lungs. Repeated exposures to oil mists can lead to lung scarring and a disability similar to asbestosis. Cancer has also been found in the scarred lungs of workers exposed to mineral oils.

VAPORS: Vapors come off of liquids as they evaporate. As they get in the air, they can easily be breathed in and enter the bloodstream through the air sacs in the lungs.

ASK: **"Does anyone remember how you can tell how easily vapors come off of a liquid?"**

From **vapor pressure** - Give an example of a vapor pressure from one of the solvents in the chemical of concern from NIOSH Pocket Guide and ask if it is a high or low vapor pressure. (**High** is greater than 10 mmHg at room temperature, **Moderate** is between 1 - 10 mmHg, and **Low** is a vapor pressure less than 1 mmHg at room temperature.

Examples:

Mercury: This is the only metal that is a liquid at room temperature. Mercury vapors get into the air easily so mercury vessels or spills must never be left uncovered. Mercury is toxic to the kidneys, but its most striking effects are on the nervous system. A person with mercury poisoning may develop a slight tremor of the hands and no longer be able to write properly. Mercury poisoning can lead to speech disorders and loss of coordination. The victim may develop a staggering gain and there may be serious changes in mental ability. The expression "mad as a hatter" refers to the fact that most hatters used to become crazy after several years because most hatters used mercury to soften the felt in the hats which poisoned them and eventually drove them mad.

Naphthalene: This gets into the air easily and has a familiar "moth ball" smell. High concentrations of the vapor irritate the skin and eyes and can cause a worker to develop a chronic allergy. It can also affect the blood and cause anemia. Exposure may lead to liver and kidney damage, as well as damage to the optic nerve resulting in blindness.

Carbon disulfide: This chemical can be absorbed through the skin as well as inhaled. High concentrations in the air can affect the brain causing loss of consciousness and even death. Lower concentrations may cause headache and irritation of the lungs and stomach. Prolonged, repeated exposures to moderately high levels of carbon disulfide can result in brain damage, blindness (if the optic nerve is damaged), weakness of a leg or arm when peripheral nerves are inflamed and also stomach ulcers, heart, kidney, and liver damage. Though levels of carbon disulfide in most factories have been low enough to prevent most of these illnesses, prolonged exposure (5-15 years) to low levels of the vapors seem to contribute to a higher incidence of heart attacks and high blood pressure compared to workers who do not work with this chemical.

HEALTH EFFECTS OF CHEMICALS

Now we are going to discuss some of the health effects seen with many chemicals if exposures are not controlled:

K. Irritants: (Write on the flip chart, "irritants")

ASK: **"What do you think of when you think of irritants? (no names, please)"**

Usually think of skin rashes, watery eyes, itching, sore throat.

ASK: **"Do you usually think of irritants as a major or minor health problem?"**

Most may be considered minor health problems, but watch out for lung irritants. These can be life-threatening. Lung irritants can cause pulmonary edema which means fluid in the lungs (write this on the flip chart).

The way this happens is that somebody may get a big whiff of one of these chemicals. At first, they may feel some burning or just discomfort or rawness in their throat. But a few hours later, often when the person is sleeping, they will wake up unable to breathe because of all the fluid in their lungs. Pink froth may come out of their mouth and nose. This is a medical emergency. If not treated immediately, they will die because there is no way for the oxygen to get into the blood because it can't get through all the fluid in the lungs. Examples of chemicals that can cause pulmonary edema include acute exposures to **hydrochloric acid, titanium tetrachloride, hydrogen fluoride, methyl bromide, nitric acid, sulfur dioxide, and chlorine**.

L. **Corrosives:** Write "corrosives" on the flip chart.

ASK: "What are corrosives? What health problems do they cause?"

Corrosives are usually strong acids or bases which eat away whatever they come in contact with. Corrosives usually cause severe burns - usually to the skin or eyes. **Sodium hydroxide** and **potassium hydroxide** (found in several forms including solids, liquids, dusts, and mists) are more corrosive to tissue than most acids because they combine with tissue proteins and fats to form burns that are very deep and painful. Even dilute solutions are very irritating. Caustics which cause similar damage include **sodium carbonate**, **sodium peroxide**, and **trisodium phosphate**.

M. **Solvents:** Write "solvents" on the flip chart.

ASK: "What are solvents? What health problems do they cause?"

Solvents are chemicals that are degreasing agents. The solvents that cause most of the health problems are "organic solvents" or ones that contain carbon. The reason we bring this up is because water is a solvent - but it isn't an organic solvent. Organic solvents vaporize easily and can be easily breathed in, enter the bloodstream, and damage other parts of the body. Many may also be absorbed through the skin. For example, **carbon tetrachloride** and **perchloroethylene** have extremely toxic effects on the liver. Workers who work with these chemicals and then drink alcoholic beverages, especially after work when the solvents are still in the body, greatly increase their risk of permanent liver damage.

Solvents also affect the central nervous system (brain and spinal cord) and the liver. They act on the body just like drinking alcohol since drinking alcohol is also an organic solvent. Organic solvents are also usually flammable & explosive and many evaporate easily so proper controls should be in place to prevent breathing these vapors. Chlorinated solvents are not explosive, but they have the same health effects as organic solvents.

Many solvents, such as aromatic hydrocarbons, have distinctive odors however there are problems with using smell as a warning against excessive exposure.

Solvents can dissolve fats and oils (including those in the skin) so exposure may lead to a dry, scaly, painful dermatitis. Since chemicals such as toluene or benzene have the ability to go right through the skin's protective barrier

and enter the bloodstream by direct absorption, this makes it even easier for these chemicals to get in the body. This is why workers should not wash their hands in gasoline or other solvents. Has anybody seen someone do this?

N. **Sensitizers/allergens:** Write "sensitizers/allergens" on the flip chart.

ASK: "What are sensitizers and allergens? What health problems do they cause?"

Sensitizers and allergens are substances that don't cause any problem the first time somebody works with them; but in the future, they may cause allergic reactions such as rashes, hives, itching, tearing, and wheezing. One common example are bee stings. The first time somebody gets stung by a bee, there is only the discomfort from the sting. But if that person then gets sensitive to bee venom or develops an allergy to it, then the next time they are stung, it can turn into a life-threatening problem if the throat begins to close up and get tight.

One common allergic response to chemicals in the workplace is contact dermatitis. This results from substances that are not normally irritating to the skin but may cause dermatitis or skin rash if the skin becomes allergic to them. Once the skin becomes allergic to a chemical, it can react to even very small amounts of that chemical. The most common examples of groups of chemicals that can cause contact dermatitis are **epoxy resins** and catalysts in plastics, **nickel** (such as nickel itch) and **mercury compounds**, **cobalt compounds**, and **rubber accelerators** and **antioxidants**.

Lungs can also become sensitized or allergic to chemicals such as **toluene diisocyanate (TDI)** which can result in an asthma-like reaction. This sensitization can be immediate in susceptible people or it can build up after repeated exposures. People with chronic respiratory diseases or allergies should not take the chance of exposure to a chemical like this. Once sensitized, a person cannot stand any exposure to TDI.

O. **Carcinogens:** Write "carcinogens" on the flip chart.

(Question #6, on the Toxicology Exercise)

6. In large enough doses, all chemicals will cause cancer.

TRUE __ FALSE X

Only carcinogens will cause cancer.

Examples of carcinogens include **benzidine** (used in dye production) - bladder cancer; **chromium compounds** (such as chromates found in paints, wool processing, & lithography) - lung cancer; **benzene** (very common solvent used in making adhesives, battery production, degreasing, enamel making, glass making, herbicide production, coke ovens, ink production, etc) - leukemia; **asbestos** (insulation) - lung cancer, intestinal tract cancers; **radiation** (defense industry, medicine production, medical facilities) - lung cancer, bone cancer, leukemia; **coal tar pitch** (petrochemical and steel industries) - skin cancer, lung cancer, possible esophagus & liver cancer; **coke oven emissions** (steel industry) - lung cancer, bladder cancer, skin cancer.

(Question #7, on the Toxicology Exercise)

7. Only women workers need to be protected from exposure to reproductive hazards.

   TRUE __ FALSE X

   If a chemical is harmful to women than it may also be harmful to men. Workplaces should be safe for all workers.

Write "**mutagens**" ASK: "What are mutagens?"

MUTAGENS are those chemicals that cause changes (mutations) in the genetic material of a cell. Many of these become carcinogenic. Commonly, mutagens are associated with reproductive hazards because if the mutation occurs in the reproductive cells (the egg or sperm), genetic defects can be passed on to future generations.

Mutagens affect both men and women so if that person wants to have a child in the future, there may be problems such as infertility, spontaneous abortion, or birth defects.

Examples of mutagens include **carbon disulfide, mercury, 2,4-D** (an herbicide commonly used in agriculture and forestry) & **carbon tetrachloride**. Now let us look at other reproductive hazards.

P. Reproductive hazards

Write "**teratogens**" on the flip chart.

ASK: "What are teratogens? What health problems do they cause?"

Teratogens are chemicals that may harm the developing fetus in pregnant women. Examples include **glutaraldehyde** (disinfectant), **arsenic** (by-product of copper and lead smelting), **ethylene oxide** (used in the production of ethylene glycol for automotive antifreeze, polyester fibers & films, detergents, and is used as a sterilizer), **ionizing radiation**, **ethylene thiourea** (rubber accelerator using to speed the curing process in the manufacturing of rubber), and **1,3-butadiene** (a gas, soluble in organic solvents, used in the manufacturing of rubber, latexes, and resins).

Other reproductive hazards:

Infertility (including reduced sperm count, reduced sperm mobility, sterility, altered or failed ovarian function) - **benzene, carbon tetrachloride, kepone**, and **cadmium**.

Irregular menstrual flow - carbon disulfide & xylene

Spontaneous abortion - carbon disulfide, ethylene oxide, inorganic mercury, lead, and **selenium**

Q.

Poisons: These type of chemicals actually kill the body cells. One of the most common is **cyanide** (used in electroplating, metal extraction, fumigants, steel hardening, blast furnaces, nitrile preparation, and chemical manufacturing). Other examples include **organophosphates** (pesticide) and **dinitrophenol** (used in dyestuff industry and used as a wood preservative).

R. **Asphyxiants:** These are chemicals that prevent oxygen from getting to the body's tissues.

These work in three ways:

a. simple asphyxiants - these displace the oxygen in the atmosphere so there isn't enough oxygen to breath. This is often seen in confined spaces. These include **carbon dioxide, methane, argon, and nitrogen**.

b. chemical asphyxiants - these prevent the oxygen in the blood from binding with the hemoglobin so individual cells are starved for oxygen. For example, one of these most common examples of this type of asphyxiant is **carbon monoxide**. When it is in the blood, the red blood cells prefer the carbon monoxide to oxygen so the cells starve for oxygen. Other examples of chemical asphyxiants include **hydrogen cyanide, hydrogen sulfide, & acrylonitrile**.

c. mechanical asphyxiation - (such as **ENGULFMENT**) a trench cave-in or suffocating in a material such as grain in a silo or rail car. In this type of asphyxiation, one does not necessarily have to have his/her head under the material in order to suffocate. If the worker is buried up to his/her shoulders, suffocation is possible since the chest cannot expand in order to breathe. Once the worker breathes out, the material can close in preventing inhalation. This is what causes the suffocation.

(Question #8, on the Toxicology Exercise)

8. Match these health effects with their meaning:

corrosives	**D A. These chemicals prevent oxygen from reaching the body tissues**
solvents	**C B. These chemicals harm the body's chromosomes and may lead to cancer in the future.**
asphyxiants	**A C. These chemicals dissolve fats & oils and can be inhaled easily.**
teratogens	**E D. These chemicals are usually strong acids or bases that eat away at tissue and cause severe burns.**
mutagens	**B E. These are chemicals which may harm a developing fetus in pregnant women.**

FACILITATOR'S CHECKLIST TO TOX PRESENTATION

☐ **Introduction and Small Group Activity**

☐ **Dose-Response Curve**

☐ **Factors Which Influence The Dose-Response Curve:**
- → Concentration of the Chemical
- → Frequency or Duration of Exposure
- → Additive effects of chemicals
- → Synergistic effect of chemicals

☐ **Define and differentiate acute & chronic health effects**

Go over Questions #1 & #2 on the Toxicology Exercise

☐ **Routes of exposure**
- → Go over odor threshold

Go over Question #3 on the Toxicology Exercise

☐ **Target organs:**
- → ASK: "How do chemicals get to organs like the liver or kidney?"
- → ASK: "Why are the liver and kidneys common target organs?"

Go over Question #4 on the Toxicology Exercise

☐ **Forms of substances**

☐ **Examples of forms of common chemicals**

Go over Question #5 on the Toxicology Exercise

☐ **Health effects of chemicals using site-specific example, when possible**
- → Irritants
- → Corrosives
- → Solvents
- → Sensitizers/allergens
- → Carcinogens
  Go over Question #6 on the Toxicology Exercise
- → Mutagens
- → Reproductive hazards (teratogens, infertility, irregular menstrual flow, etc.)
  Go over Question #7 on the Toxicology Exercise
- → Poisons
- → Asphyxiants (simple, chemical, mechanical)

Go over Question #8 on the Toxicology Exercise

Toxicology

(Facilitators Guide)

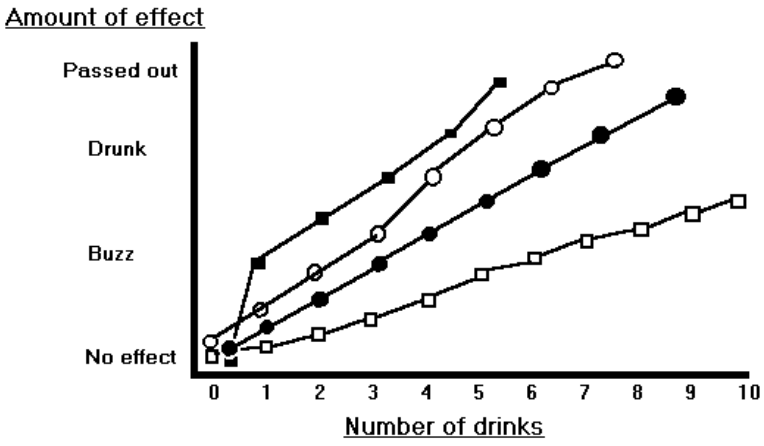
What is toxicology?

- **Study of toxins (poisons) and the adverse effects of chemical agents on biologic systems (living organisms)**
- **Toxicity rating of chemicals is based on the dosage, or amount.**

Toxicity rating	Lethal dose average adult
1- practically non toxic	more than a quart
2- slightly toxic	between pint & quart
3- moderately toxic	between ounce & pint
4- very toxic	between tspn & ounce
5- extremely toxic	between 7 drops & tspn
6- super toxic	taste < 7 drops

What changes as each toxicity rating gets higher?

- **The dose (the response is the same)**
- **Discuss the difference between dose and exposure**
- **Draw and discuss the dose response curve and how people are affected differently.**



Why are these curves different?

- **Age, genetics, general health….etc.**

- **Discuss the terms LD_{50} (DOSE other than air) & LC_{50} (AIR) Both are single doses**

How do these chemicals or agents enter the body?

- **Inhalation, to be inhaled the chemical or agent must either be a particulate, vapor, mist or gas. This is the fastest way for an exposure to enter the blood stream.**
- **Ingestion, through the mouth, hygiene, smoking**
- **Contact, generally damages the skin**
- **Absorption, through the skin on a molecular level, may not even know your being exposed.**
- **Most chemicals or agents can be broken down as follows**

SOLID ⇗ **DUST**

SOLID ⇘ **FUMES**

LIQUID ⇗ **MIST**

LIQUID ⇘ **VAPOR**

GAS

What is the most common route of entry for an agent? (INHALATION)

<u>How does this play into WMD</u>?

- **The ability of these chemicals and there effects to be used as a weapon against living organisms (people) on a large scale, with very low dosage required to inflict harm**

WMD is generally divided into the following categories

- **C- (Chemical)- get some examples from the class (chlorine, phosgene etc…nerve agents sarin, vx…etc…)**
  1. **Phosgene target organ (respiratory, skin, eyes**
  2. **Exposure takes time to manifest**
  3. **no antidote**

Chlorine

1. **Chlorine highly corrosive**
2. **Reacts explosively or forms explosive compounds with many common substances**
3. **Respiratory distress**

Mustard Gas

Blistering agent

1. **Gas or liquid**
2. **Dose relevant….more dose worse damages skin, eyes respiratory**
3. **Damages DNA**
4. **No Antidote**

Nerve agents

1. **Most toxic of the known chemical warfare agents**
2. **Chemically similar to organophosphates (insecticides)**
3. **Inhalation, contact, absorption**

B- (Biological) examples…Ricin, anthrax, smallpox

Smallpox

1. **Contagious, sometimes fatal disease**
2. **No specific treatment**
3. **Transmitted by direct contact with bodily fluids**
4. **Rarely transmitted in air**
5. **Humans are the only natural hosts**

Ricin

1. **Waste left over from castor beans**
2. **Poison…. kills cells**
3. **Stable... Not affected by temperature**
4. **Powder, mist or solid (pellet)**

Anthrax

1. **Bacterium formed from spores**
2. **3 types Skin (Cutaneous), Lungs (Inhalation), Digestive (Gastrointestinal)**
4. **Early treatment with antibiotics inhalation most**

dangerous

R & N- (Radiation/Nuclear)…(radiation dirty bomb) and (Nuclear) reactors and nuclear weapons

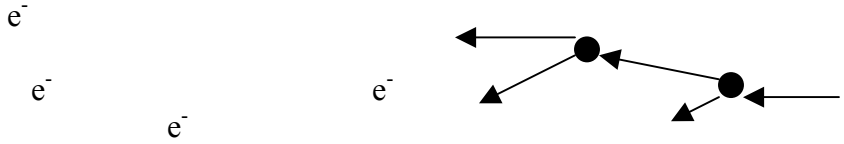
What is radiation?-Radiation is energy (particles or rays) moving through any space or medium.

1. Radiation doses internal and external

2. Radiation divided into two categories-

Define Ionization as it applies to radiation:

Radiation that has the effect of removing electrons from atoms leading to the formation of free radicals



Non ionizing-not enough energy to ionize an atom. Examples are radar waves, microwaves and visible light

Ionizing radiation: is the energy (particles or rays) emitted from radioactive atoms that can cause ionization

Four basic types of ionizing radiation

This would mostly likely occur from the dirty bomb scenario

All four would be present in a nuclear bomb blast or power reactor going super critical Alpha and Beta as fallout

1. **Alpha particles- particulate biggest particle less energy- stopped by a sheet of paper (travel 2 inches in air)**
2. **Beta particles- particulate more energy, size of an electron, stopped by plastic, rubber, metal (travel 10 feet in air)**
3. **Gamma, X-rays-rays of high energy stopped by lead, steel, concrete (travel 1100 feet in air)**
4. **Neutron particles- high energy particle stopped by water and plastic (travel 1300 feet in air)**

Th lls is what causes the biological damage.

If a bike, a car and a Mack truck are all traveling at the same speed, at hit you, which would cause your body the most damage?

The alpha particle (largest) in a typical exposure
Has the potential to cause the greatest harm. It would

Sit next to cells (ionizing them) for the longest period possibly causing damage each time the cell multiplied. A ray (gamma-x-ray) passes through and only damages the cells it contacts

This would not apply in a mega dose situation

Discuss the concepts of reducing exposure through the use of:

Time- the time you are exposed
Distance- from the source
Shielding- stopping the radiation by putting something between you and the source.

TOXICOLOGY EXERCISE

Work on these questions with the people in your group. This is not a test.

1. **If you have worked with a chemical for eight years and have not had any health problems as a result, that means that chemical is not toxic to you.**

   TRUE ___ FALSE ___

2. **Chemicals that cause acute health effects are more dangerous than those that cause chronic health effects.**

   TRUE ___ FALSE ___

3. **Check the ways through which chemicals can enter the body:**

   Through cuts in the skin ___ Breathing in ___

   Eating or drinking in the work area ___ Through unbroken skin ___

4. **The main target organs for many organic industrial solvents are: (check all that apply)**

   Stomach ___ Liver ___ Central Nervous System ___

   Teeth ___ Skin ___ Pancreas ___

5. Almost all hazardous substances are found in three main states of matter: solids, liquids, & gases. Give some other names for each thinking about how you may see them in the workplace and how they may affect your body.

6. In large enough doses, all chemicals will cause cancer.

TRUE ___ FALSE ___

7. Only women workers need to be protected from exposure to reproductive hazards.

TRUE ___ FALSE ___

8. Match these health effects with their meaning:

corrosives	___	A.	These chemicals prevent oxygen from reaching the body tissues
solvents	___	B.	These chemicals harm the body's chromosomes and may lead to cancer in the future.
asphyxiants	___	C.	These chemicals dissolve fats & oils and can be inhaled easily.
teratogens	___	D.	These chemicals are usually strong acids or bases that eat away at tissue and cause severe burns.
mutagens	___	E.	These are chemicals which may harm a developing fetus in a pregnant woman.

LARGE GROUP EXERCISE

HEALTH EFFECTS form exposure to GUNK BREAK CLEANER. (*tetrachloroethylene)*

ASK the students to look up the main chemical in your product using any resource at there table.

Using the questions for there first activity fill in the questions about your product.

ASK: is this chemical a carcinogen?

ASK: what are the ACUTE and CHRONIC health effects ?

ASK: what are the routes of entry?

ASK: what are the target organs ?

ASK: is this chemical a Mutagen or teratogen?

ASK: is this chemical a corrosive or a solvent?

October 2002

MARPLOT OBJECTIVES

Terminal Objective: At the end of this session participants will demonstrate the ability to Navigate and use the menus associated with MARPLOT

Enabling Objectives:

1. Identify the menu items
2. Download and view maps
3. Unlock and edit map layers
4. Add items and symbols to a map layer
5. Search individual or multiple map layers
6. Use geo referencing to insert aerial photos to the maps.

LOC EXERCISE

If you received the symptoms shown in the box below, what would you call the effects?

Severe burns from fire	____ Degree
Severe Sunburn	____ Degree
Minor Sunburn	____ Degree
symptoms	Effect

To receive the symptoms shown in the box below, *over a 1 hour period*, how many beers would you have to consume?

Passed out		60 Min
Dizzy		60 Min
Buzzed		60 Min
symptoms	Exposures	Time

If there was a chlorine leak in you community and you were exposed for 60 minutes, how many ppm of chlorine would it take to show the following symptoms? Choose from the choices below and place the chosen values in the correct empty boxes.

Life Threatening or Death		60 Min
Serious Health Effects		60 Min
Noticeable Discomfort		60 Min
Symptoms	Exposures	Time

A. 20 ppm
2 ppm
0.5 ppm

B. 10 ppm
1 ppm
0.5 ppm

If there was a chlorine leak in you community and you were exposed for 10 minutes, how many ppm of chlorine would it take to show the following symptoms? Choose from the choices below and place the chosen values in the correct empty boxes.

Life Threatening or Death		10 Min
Serious Health Effects		10 Min
Noticeable Discomfort		10 Min
Symptoms	Exposures	Time

A. 50 ppm
2.8 ppm
0.5 ppm

B. 10 ppm
1 ppm
0.5 ppm

LOC EXERCISE

If you received the symptoms shown in the box below, what would you call the effects?

Severe burns from fire	3RD Degree
Severe Sunburn	2ND Degree
Minor Sunburn	_1ST Degree
Symptoms	Effect

To receive the symptoms shown in the box below, *over a 1 hour period*, how many beers would you have to consume?

Passed out	?????	60 Min
Dizzy	??????	60 Min
Buzzed	??????	60 Min
Symptoms	Exposures	Time

If there was a chlorine leak in you community and you were exposed for 60 minutes, how many ppm of chlorine would it take to show the following symptoms? Choose from the choices below and place the chosen values in the correct empty boxes.

Life Threatening or Death	20 ppm	60 Min
Serious Health Effects	2 ppm	60 Min
Noticeable Discomfort	0.5 ppm	60 Min
Symptoms	Exposures	Time

A. 20 ppm
2 ppm
0.5 ppm

B. 10 ppm
1 ppm
0.5 ppm

If there was a chlorine leak in you community and you were exposed for 10 minutes, how many ppm of chlorine would it take to show the following symptoms? Choose from the choices below and place the chosen values in the correct empty boxes.

Life Threatening or Death	50 ppm	10 Min
Serious Health Effects	2.8 ppm	10 Min
Noticeable Discomfort	0.5 ppm	10 Min
Symptoms	Exposures	Time

A. 50 ppm
2.8 ppm
0.5 ppm

B. 10 ppm
1 ppm
0.5 ppm

October 2002

ALOHA OBJECTIVES

Terminal Objective: At the end of this session participants will demonstrate the ability to input data and generate a Chemical Plume on a MARPLOT map.

Enabling Objectives:

1. Identify the menus in ALOHA
2. Participants will enter site specific data
3. Participants will enter Chemical data
4. Participants will enter weather information
5. Participants will enter source data
6. Participants will use sharing menus to generate plumes

Class Scenario

Location: Loudon County Tn.

Today (use current time) an eight foot by 45 foot tanker truck overturned at the intersection of I-75 and state highway 321 overturned on the northbound exit ramp. The tanker was reportedly placarded with the following ID number 1052.
The tanker was 95% full at the time of the accident.
There is a leak from an approximately 3 inch hole located about 1 foot from the bottom of the tank.

It was not understood immediately what caused the wreck due to the following weather conditions. A clear bright sun shiny day, with little cloud cover and dry conditions. The temperature was reported at 76 degrees. The wind is a gentle breeze from 316 degrees.

There is a hospital located at the intersection of of 321 and Town Creek Road. There are also 2 schools located a half mile up Hickory Creek Road off of highway 70.

Plot the schools and hospitals on your map.

Scenario Questions

1. What is the chemical?

2. What are the signs and symptoms of exposure to this chemical?

3. Should you order the hospital evacuated or order them to shelter in place?

4. What is the LOC around the hospital 15 minutes into the accident?

5. Initally, should the schools be evacuated?

6. 40 minutes into the accident, are the school children better off inside or outside?

7. When sheltering in place, what are some actions you should take?

8. Look at other students maps and list some reasons why your footprint and map might be different from theirs.

October 2002

LAND VIEW OBJECTIVES

Terminal Objective: At the end of this session participants will demonstrate the ability to Utilize the census data that is provided with the Landview software.

Enabling Objectives:

6. Use the Menus to navigate the Landview software.
7. Identify geographic and demographic information in Landview.
8. Use marplot to access maps imbedded the Landview program.

LandView
Small Group Activity

1. What is the total population of Loudon County?

2. What is the total population affected inside your plume?

3. What is the total population affected by the AEGL 3 plume?

4. What is the total number of households affected in your scenario?

5. Looking at the demographics for your plume, which is the largest age group affected?