Comprehensive Planning for Technological Emergencies

NARRATOR: Welcome to the training on comprehensive planning for technological emergencies. This training was developed with experts who plan response actions to very toxic chemical agents and radioactive material releases, whether accidental or in a terrorist attack.

It is important that emergency planners and first responders, public officials, health-care workers, and others who work to protect the public understand the unique risks and protective actions associated with these technological hazards.

It's also critical, especially in fast-moving and unusual situations, that everyone understands the appropriate response actions and how to communicate that information to affected people.

The goals of the training are to ensure that emergency responders have the most current knowledge about response to chemical or radiological events, both accidental or intentional.

Using a risk based response approach; first responders should have knowledge of personal protective equipment... or PPE, and decontamination procedures for each of these agents.

To enhance this training we have incorporated vetted training materials produced for the Federal Emergency Management Agency... (FEMA's), Chemical Stockpile Emergency Preparedness Program or CSEPP and the Radiological Emergency Preparedness, or REP program and from the fact sheets on radiation, produced by the Centers for Disease Control and Prevention - the CDC.

In addition, the training includes materials prepared by other scientific institutions such as the Center for BioSecurity located in Baltimore, Maryland, and the Department of Energy's (DOE) national laboratories, including Oak Ridge National Laboratory, Sandia, Livermore, and Los Alamos.

The topics covered in the training on technological hazards include: Appropriate emergency worker response and PPE; Radiation characteristics, including how it is measured, human health effects, signs and symptoms of exposure, and protective actions including the taking of potassium iodide (K-I) after a release of radiological materials from a nuclear power plant or thermonuclear bomb;

Chemical agent characteristics, their toxicology, human health effects, signs and symptoms of exposure and contamination, and protective actions for airborne releases of those agents; and Issues related to personal and animal decontamination for chemical agents and radiological hazards.

The training is divided into modules that reflect the topics.

This allows the viewers to pause for discussion, review the previous module, or to take the training in separate increments.

While you may likely not face exposure to all, or perhaps any, of the scenarios covered in this training video during your career, in the event you are, an understanding of the appropriate response could save your life or that of others.

Your response may be to simply help with an evacuation, call for shelter-in-place, or to help communicate a community response but what ever it is - doing it safely is paramount.

One response event could be the release of, and potential exposure to a radiological release as was the case at the fictitious Blue Water Nuclear Power Plant in the state of Columbia where things took an unexpected turn.

PLANT MANAGER GREG:

Okay, Attention crew update. Let's do the morning brief.

This is the Blue Water Power Plant Unit One Pressurized Water Reactor.

We are at one hundred percent power. We've been online for 240 days. RCS boron currently at 1038 PPM, pressurizer borons at 1036 PPM.

Bravo train's currently in service, Bravo train is also protected train.

All major equipment is in operation with the following exceptions today: nuclear estimate 32 source range detector, we have a bad preamp cable on that and maintenance is schedule to replace that cable at 16:00 hours today,

Alpha boric acid transfer pump is out of service, we have to repair that motor today.

That is scheduled for 08:00 hours. OWPECW-01 essential services chilled water is in effect, we're keeping a portable ventilation unit in location at the door of the alpha charging pump to make sure that alpha charging pump remains available throughout the day.

Any questions on plant status?

Okay.

Stacy, let's make sure we have a safe shift today, focus on human error reduction and let's have a great day.

End of brief.

CREW MEMBER IRENA:

Stacy, we have a loose parts alarm. This could indicate possible mechanical damage to some of the control rods and cladding on the some of the fuel rods.

CREW MEMBER STACY: Irene, I understand we have a loose parts alarm.

IRENA: That is correct.

STACY: Irene, I'll call mechanical maintenance and have them respond to the control room for investigation.

IRENA: Thank you.

CREW MEMBER TYE: Stacy, we have a Turbine Runback alarm.

STACY: Understand, Turbine Runback.

TYE: That's correct.

STACY: We've met entry conditions for AOP10.

We're entering AOP10 at this time.

Crew update.

We've got manual reactor trip conditions met. Tye, manual trip the reactor.

TYE: Stacy, I'm tripping the reactor.

STACY: That's correct, trip the reactor.

IRENA: Stacy, controls indicate there is a tube rupture on the Number 1 steam generator unit indicating that there is a loss of 650 gallons per minute.

STACY: I understand we've got a tube rupture on steam generator 1 of approximately 650 gallons per minute.

IRENA: That's is correct.

Also Stacy, the pressure and water levels in the number 1 steam generator are still increasing. This is indicating that the coolant is flowing into the secondary steam generator.

STACY: I understand we have a primary to secondary leak.

TYE: Two rods are sticking without full insertion.

STACY: Tye, I understand we have two rods stuck out of the core.

TYE: I'm injecting additional boron to act as a neutron absorber to compensate for the lack of shutdown margins.

STACY: I understand, Tye, you're adding boron to the core.

TYE: That's correct.

IRENA: Stacy, we appear to have a tube rupture below the water line in the secondary side of the steam generator.

However, monitoring systems indicate an intermittent cycling radioactive iodine release presumably from the number 1 main steam valve relieving pressure build-up from the number one steam generator.

STACY: Irene, I understand we have a radioactive release coming from the number one steam generator safety valve.

IRENA: That is correct.

STACY: Greg, evaluate the EIL Matrix.

GREG: Understand, evaluate EIL Matrix.

STACY: That is correct.

NARRATOR: The US nuclear power industry is heavily regulated with a long history of engaging in radiological emergency preparedness.

On December 7, 1979, following the Three Mile Island nuclear power plant accident in Pennsylvania, President Carter transferred the Federal lead role in offsite radiological emergency planning and preparedness activities from the U.S. Nuclear Regulatory Commission or NRC to FEMA.

In response, FEMA established the Radiological Emergency Preparedness or REPP - Program whose mission is:

To ensure that the health and safety of citizens living around commercial nuclear power plants are adequately protected in the event of a nuclear power plant accident; and to inform and educate the public about radiological emergency preparedness.

The REPP Program responsibilities encompass only offsite activities, that is, the State, tribal and local government emergency planning and preparedness activities that take place beyond the border of a nuclear power plant.

Onsite plant activities regarding emergency planning continue to be the responsibility of the NRC. Radiological preparedness requires close and ongoing coordination and communication between FEMA, the NRC, nuclear power plant personnel, and officials from the state, tribal and local jurisdictions.

As a result of the Three Mile Island accident, FEMA and the NRC collaborated to create NUREG 0654/ FEMA REPP 1 REV 1 which provides major planning standards for state, tribal, and local governments including:

Development of coordinated emergency plans and agreements as well as appropriate updates,

Arrangements for and provision of emergency support resources, Coordination of emergency actions,Notification procedures,

Provision of prompt public warning or alert and notification procedures for people in the emergency planning zones, Emergency communications, Public education and information, Emergency facilities and equipment, Accident assessment including field-monitoring procedures, Protective actions and response protocols,

Radiological exposure controls, Medical and public health support, Recovery and reentry planning, Periodic exercises and drills, and Radiological emergency response training procedures and protocols.

This document specifies the roles and responsibilities of the plant licensee and that of the state and local governments.

Two major issues discussed in the document are the concepts of accident classification levels and emergency planning zones.

GREG: Crew update.

Based on plant conditions at time 09:29 I am declaring a general emergency based on EAL Foxtrot Golf 1 dot 1 loss of three fission product barriers.

End of update.

Emergency Communicator, report to the control room. I say again, Emergency Communicator, report to the control room.

NARRATOR: What you have witnessed is the rapid escalation of the four event categories that took us from an Unusual Event, Alert, Site Area Emergency, to a General Emergency.

An Unusual Event is signified by a potential degradation of the safety of the plant, but no radioactive materials have been released.

An Alert means that events are occurring that involve an actual or potential degradation of the plant.

Any radiation release is expected to be small.

A Site Area Emergency means that events involve processes that could lead to a potential failure of plant functions that are needed for protection of the public.

A General Emergency is where processes are occurring that involve actual or imminent core degradation with a possible meltdown and loss of containment, and with possible offsite releases of radiation that could be hazardous to nearby residents.

Emergency planning zones include the plume exposure pathway zone, or EPZ, and the ingestion pathway zone, or IPZ, both of which are the result of scientific risk analysis to an accidental release.

The EPZ is primarily where human exposure to radiation may occur and extends roughly 10 miles from the plant location.

A 50-mile IPZ is where radiation may contaminate the environment including agricultural products and could lead to the ingestion of radioactively contaminated items.

These also include possible naturally occurring events that could cause a plant accident without warning.

STATE EOC REP: Dave, POC.

EMERGENCY COMMUNICATOR:

This is the Blue Water Power Plant in Bright County. We've declared a general emergency based on current plant operating conditions.

Repeat, this is the Blue Water Power Plant in Bright County.

We've declared a general emergency based on current plant operating conditions. Our operators conducted a dose projection assessment and are issuing a Protective Action Recommendation or PAR.

The PAR is to evacuate all residents within 5 miles 360 degrees around the plant and 10 miles in downwind sectors F, G and H (ESE, SE, and SSE sectors) and to advise emergency officials in the affected counties to administer potassium iodide to the general public in the evacuated areas in accordance with the state plan.

STATE EOC REP: OK, I'll put it out.

EMERGENCY COMMUNICATOR: Blue Water Power Plant out.

EMERGENCY MANAGER: Emergency Manager Jamison.

STATE EOC REP: Yea James, this is Ed at State. We've got an issue here, this is a notification of an emergency in Bright County.

EMERGENCY MANAGER: Is this a drill?

STATE EOC REP: This is not a drill, this is the real thing.

We have received word that Blue Water Power Plant they have issued a General Emergency, that's a

General Emergency, due to an accidental release from the plant's fuel system.

We do not have all th e information right now, on their recommendation, we are issuing a general evacuation recommendation to people living in a 5 mile radius adjacent to the plant 360 degrees for five miles, also in the downwind sectors, that's sector F, G and H. The east-southeast,

the southeast and the south-southeast

sectors for ten miles they are

to evacuate.

We are also advising all emergency

personnel and the general public

to administer potassium iodide -

or the K-i pills.

EMERGENCY MANAGER:

Okay. Hey listen,

is there a chance that this thing is

gonna get any worse, or?

STATE EOC REP:I have very little

information right now, I will get more

information and pass it on to

you as soon as I have it.

EMERGENCY MANAGER: Alright,

we'll get on this right now, thanks.

STATE EOC REP: Yup.

EMERGENCY MANAGER: Attention!

All emergency personnel in Bright County.

This is the Bright County

Emergency operations center.

We have been notified by the State that

a General Emergency has

been issued because of a incident at
the Blue Water power plant to

evacuate residents within a 5-mile radius
of the plant and for people living within a

10 miles of the plant in downwind
sectors F, G and H.

That's east-southeast, the southeast
and the south-southeast sectors.

AND to advise the emergency personnel
and the general public

in the evacuated areas to administer
potassium iodide - or K-i pills.

Activate at the intersections of State
highway 95 and the following roads -

Hightower, Lakeshore, and Mills Valley.

Notify all off-site emergency workers to don appropriate PPE for the tasks they

are performing.

We will give you more information as

soon as we are updated, thank you.

Okay, we are activating the EOC.

I need you to get on this right away.

I need you to help her with anything

that she needs help with.

This right now is serious,

but it could get worse, so we need

to stay on top of this. Alright.

NARRATOR: Because of a possible

radioactive release, an order has been

given to distribute potassium iodide

pills and for responders to don

appropriate PPE.

But to understand what is appropriate PPE, we need to understand something

about radiation and follow all local and state procedures.

Radiation is simply a term that describes a form of energy that travels

through space either as electromagnetic waves or as charged particles.

We are all exposed to radiation on a daily basis - but not all radiation is the same.

Radioactivity is the spontaneous emission of radiation - either directly

from unstable atomic nuclei or as a consequence of a nuclear reaction.

Radioactive materials could be released into the environment and affect humans and animals in several ways.

There could be:

an accident at a nuclear power plant,

an explosion of an atomic bomb by
a rogue nation

an Improvised Nuclear Device or IND

used by terrorists that would result
in a thermonuclear explosion similar

to a nuclear bomb

an accidental release from, or exposure
to, a medical or industrial device,

or a radiological dispersion device, an
RDD or a "dirty bomb," where radioactive

materials packaged around a conventional
explosive device are released in an

explosion and widely dispersed.

In addition to power plant accidents or

terrorist events, radiological releases can

occur at any stage of the nuclear fuel cycle.

These include accidents during

uranium enrichment,

the production of fissionable material,

assembly of nuclear weapons,

transport of radioactive material

or exposure during spent fuel storage.Ê

Additionally, there can be mishaps

with medical and industrial

uses of radioactive sources or isotopes.

Scientists divide radiation into two

categories:

ionizing; and non-ionizing.

Non-ionizing radiation - such as visible light, microwaves, lasers, radio waves, and heat generally is not harmful to humans or the environment when properly used or controlled.

Ionizing radiation, on the other hand, has enough energy to actually remove an electron from an atom.

This structurally changed atom is called an ion – hence the term “ionizing radiation."

Ionizing radiation occurs naturally from exposure to cosmic rays from the sun and stars, radon gas from earth's crust, and naturally occurring radioactive particles,

or radionuclides, and even
from some foods.

Ionizing radiation may also be human-
produced with exposure coming from

medical or industrial diagnostic
procedures, coal-fired power plants,

even tobacco products, or, in our
scenario, an accidental release from

a nuclear power reactor.

Ionizing radiation is divided into
four main types:

alpha particles,

beta particles,

X-rays or gamma rays

and neutrons.

Even though ionizing radiation is
generally considered dangerous,

some forms are much more
dangerous than others.

Alpha particles, for example,
are non-penetrating

they only travel an inch or two in the
air and cannot penetrate the skin.

If alpha-emitting radioactive particles,
(radionuclides), are ingested or

inhaled however, they continue to emit
energy even after being absorbed into

cells and tissues including bone.

Beta particles are slightly more
penetrating

they can travel a few yards and,

in sufficient quantities,

may cause skin damage.

Beta-emitting radionuclides,
especially long-lived ones,

create internal hazards if ingested or
inhaled and, like alpha emitters,

can cause significant damage if they
are absorbed into body tissues,

such as bone, where they may be
retained for long periods of time.

Some types of radiation - such as
X-rays, gamma rays, and neutrons

are highly penetrating and can pass
through air, clothing, paper,

and even the body.

In passing through the body, these

forms of radiation may hit cells and

produce forms of oxygen that are highly
reactive and can be very damaging.

Usually the cell can repair itself, but
sometimes - especially during cell

division in rapidly dividing tissues -
the repair may be incorrect or faulty

and result in cell death, or cancer.

Exposure to X-rays, gamma rays, or
neutrons during pregnancy,

may result in abnormalities in the
unborn child.

There is a common misconception
that items - or people -

exposed to radiation become
contaminated or radioactive.

People receiving X-rays or CT scans do not become radioactive because the radiation passes through the body and there are no particles, or radionuclides, left on or in the body.

Food is irradiated to preserve it but it does not become radioactive.

If, however, radioactive particles, land on, or are inhaled or ingested, that person actually is contaminated.

How radioactive materials act on the body has been a subject of intense study and the risks and consequences of radiation exposure are well understood.

Radiation monitoring has its own vocabulary.

Determining how much of a dose a person

receives is measured in very specific terms.

The risk that a person will suffer health
effects from an exposure to radiation is

measured using the conventional unit rem.

Countries that use metric measures
measure exposure by Sieverts

one sievert equals 100 rem.

Because a rem is a rather large quantity,
radiation dose is often expressed

in units of milirems, or
one-thousandth of a rem.

A chest x-ray is roughly equal to
10 millirem.

On average, an individual in the US
receives an annual natural background

dose of radiation of about a third

of a rem, or 300 millirem.

Human-made sources, mostly medical
procedures, contribute an extra

320 millirem for a non-smoker for
a total average annual background

radiation dose of 620 millirem.

At these doses scientists can't
detect any harmful effects on humans.

Some individuals may get higher
doses because of their lifestyle,

their occupation, or where they live.

For example, cigarette smokers receive
an additional average

annual dose of 1300 millirem.

Airline flight crews receive an
additional 1000 millirem because

of the altitude at which they fly.

Nuclear power plant workers receive
an additional 560 millirem simply

by working near a nuclear source,
and medical personnel who work near

machines or instruments using radiation
receive an extra 70 millirem annually.

Just living at a higher altitude, such as
in Denver, increases ones annual dose

by about 100 millirem due to
increased exposure to cosmic rays.

How much radiation a person is exposed
to is considered the dose.

Evacuation of the general public normally
will be initiated if projected doses are

greater than or equal to 1 rem whole

body or 5 rem to the thyroid gland.

The EPA recommends that the public be evacuated if doses are projected that are

greater than or equal to 5 rem to the whole body, or 25 rem or above to the thyroid.

Evacuation is the primary protective action for the general public,

unless there are circumstances where the evacuation would involve a

greater risk than from the radiation exposure - such as might occur during

a major winter storm or other disaster that would compromise vehicle safety.

In-place sheltering to the general public can be recommended if

projected doses are not anticipated to exceed EPA guidelines.

Since our first responders are working
within an area surrounding

the nuclear plant, they would be
required to wear a recording

dosimeter that would monitor their
cumulative exposure.

These dosimeters are designed to be
sent to designated

laboratories for reading and
documentation purposes.

So, back to our scenario, our first
responders have been ordered to

don the appropriate PPE.

But what is appropriate PPE
for this situation?

PPE typically consists of a combination

of protective clothing and respiratory

protective equipment.

Let’s start with respiratory protection.

Two basic types of respirators guard against
inhalation of hazardous substances:

atmosphere-supplying respirators
or air-purifying respirators.

Atmosphere- supplying respirators provide
air from a source other than the

surrounding atmosphere and provide the
highest level of respiratory protection.

These include the Self-Contained
Breathing Apparatus or SCBA,

and the Supplied-Air Respirator.

The self-contained SCBA provides
increased maneuverability

and more independence than a
Supplied-Air Respirator.

These advantages however, must be
balanced against the increased

weight of an SCBA, the limited
air-supply duration, limited vision

if the face-piece fogs, and limited
communications capabilities

(unless equipped with microphone).

The principal advantage of the
Supplied-Air-Respirator is that it

provides an unlimited clean air supply
through a hose - although it

is necessary to monitor the air-supply
end and to carefully

manage the hose in an effort to

avoid mechanical or heat damage.

The length of the hose will also limit the
distance responders can travel and is

therefore restricted to 300 feet.

Heat stress, dehydration and fatigue will
limit the time a

responder can work in any PPE.

There is no standard for setting
work times - and individual medical

monitoring will be the only means of
determining when a worker needs to rest.

Air-Purifying Respirators - or APRs -
use an air-purifying filter

or cartridge to remove specific
contaminants from ambient air.

Some APRs may contain a blower,

at which point they are referred to

as a Powered Air-Purifying Respirator

or PAPR, where a motor-powered

fan pulls air through filters to make

breathing easier.

PAPRs come in both tight-fitting and

loose fitting versions.

The tight-fitting units require fit testing

and an ongoing commitment by the user

to remove facial hair; the loose-fitting

version does not.

In addition to respiratory protective

equipment, several types of protective

clothing are available depending on the

nature of the hazard.

The National Fire Protection

Association - or NFPA

divides these into three general categories:

structural fire-fighting protective clothing

high-temperature protective clothing

and chemical protective clothing,

which consists of either -

liquid-splash protective clothing or

vapor-protective clothing.

Because no single protective clothing
material or respirator filter

can protect the wearer from every hazardous
substance, the NFPA has

established four levels of protective clothing

A, B, C, and D.

Level A ensembles should be worn when the highest level of

respiratory, skin, eye, and mucous membrane protection is needed.

Level A protection consists of chemical-resistant boots with steel toe and shank,

coveralls, and a SCBA or self-contained breathing apparatus.

Hard hat, chemical resistant inner/outer gloves and fully encapsulated, vapor-tight

chemical resistant suit.

Level B ensembles should be selected when the highest level of respiratory

protection is needed but a lesser degree of skin and eye protection is required.

Level B differs from Level A only in that it provides splash protection through the use of

chemical-resistant clothing,

which includes overalls and long-sleeved

jacket, a two-piece chemical splash suit,

a disposable chemical-resistant coverall,

or a fully encapsulated,

“non-vapor-tight suit” and SCBA.

Level C protection provides the same

level of skin protection as Level B,

but a lower level of respiratory protection

and includes a full-face piece,

air-purifying canister-equipped respirator,

and chemical-resistant clothing.

Level C ensembles can be used when the

type of airborne substance is known,

the concentration can be measured,

all the criteria for using

air-purifying respirators are met, and
skin and eye exposures are unlikely.

This is the protection recommended
for civilian responders in the

Chemical Stockpile Emergency
Preparedness Program or CSEPP

who may come in contact with nerve
or blister chemical agents.

Level C ensembles will require air
monitoring and escape routes

if the concentration of hazardous
materials exceeds the threshold limit.

And finally, a Level D ensemble is
primarily a normal

work uniform with hard-hat, gloves,
and eye protection.

Level D protection provides no respiratory protection and

minimal skin protection, and should not be worn on any site where

respiratory or skin hazards exist.

Structural fire-fighting clothing, even with an SCBA, provides

limited protection against some chemical hazards and is generally

considered Level D.

NIOSH notes that Level D full-body suits will protect the skin

against alpha and beta radiation sources but the wearer should be

aware that unprotected skin and the respiratory tract will still be vulnerable to alpha and beta radiation

in Level D if a respirator

and face and hand coverings

are not worn.

None of these suits, nor any other PPE,

protect against neutrons or gamma radiation.

Neutrons however, are only released

from a reactor, a nuclear bomb,

or an improvised nuclear device.

Additionally, there are special over

garments that have been designed

to provide specialized protection

against extreme temperatures.

They include an entry suit, and a

proximity suit.

In our scenario, since there has been an actual release of radioactive particles,

or radionuclides, some level of
protection is necessary.

The level of PPE would be
established by the state

and local jurisdiction following
federal guidelines.

Since our responders are located
outside the evacuation radius they

should not have any exposure but,
as a precaution, they have been

instructed by the EOC to take
potassium iodide pills and wear dosimeters.

As alluded to earlier, the thyroid gland is
particularly susceptible to absorption

of radioactive iodine.

In an incident where exposure is
expected to exceed 5 rem to the thyroid,

potassium iodide, or K-I, is
routinely issued to all

emergency workers and may be
recommended for the public.

K-I can be an effective protective
measure to reduce the risk of

radiation dose to the thyroid if taken
just prior to, or within the

first few hours of exposure to
radioactive airborne iodine.

Because the protective effect of
potassium iodide lasts for only

about 24 hours, it must be taken daily
until a risk of significant

exposure to radioiodine by inhalation

or ingestion no longer exists.

Potassium iodide is not a substitute
for other protective actions,

nor is it protective against
any radionuclides

other than radioiodines.

According to the FDA, K-I is
recommended for all responders

but because dosage of K-I varies by
age, gender, and other considerations,

dosage to the general public will be
dictated by public health officials.

Remember, K-I only protects the thyroid
not other tissues or organs.

Following these simple procedures, our
first responders are adequately protected.

There are no reliable antidotes

once radionuclides are in the body

but some compounds taken under

medical supervision can help cleanse

the body of specific radioactive materials.

If exposure and absorption of

radioactive fallout have occurred,

medical treatment called chelation

may be used to bind the

radioactive elements and enhance

their flushing out of the body.

STATE POC: This is the State POC.

We have received your declaration of a

General Emergency at the

Blue Water Power Plant.

Based on your declaration we have

activated the State and Bright county

EOCs and the State Joint Information
Center and have recommended to

the county officials to initiate off-site
protective actions.

Can you give us more information
about the cause of the declaration?"

EMERGENCY COMMUNICATOR:
Yes.

At 10:45 the Number 1 main steam
safety relief valve designed to

relieve pressure build up in the secondary
side of the Number 1 steam generator

became lodged in the open position and
it is anticipated that there will

be a monitored, unfiltered airborne
release of some radiological materials.

We are assuming that 12% of the fuel

rods have experienced cladding damage.

At 10:46 the Number 1 main steam line

radiation monitor reading increased

to 450 millirem per hour.

Subsequent dose projections by the

Blue Water operators,

that concurs with the State Dept.

of Health's projections,

indicate that EPA's Protective Action

Guidelines have

been exceeded outside the

Blue Water site boundary.

NARRATOR: Obviously a response

that requires the evacuation of a

surrounding population is not uniform

but depends on wind direction,

terrain, and the amount and type
of radiation released.

Technological advances have made it
possible for federal authorities

to immediately monitor the radioactive
plume and describe to the public

where deposition of radioactive debris
may occur and how to avoid those areas.

Generally, such information would
be immediately broadcast

to help people protect themselves.

With accurate information, the EOC can
determine an appropriate evacuation plan.

As real time variables change,
such as wind direction,

response actions must be modified

to reflect changes.

Response could be problematic if

private vehicles, public roads

or highways are contaminated.

EMERGENCY COMMUNICATOR:

This is Blue Water Power Plant.

Good news!

At 12:00 the stuck Number 1 main steam

line steam regulator valve

was shut by the plant damage control

team which means no more steam

is coming from the valve and the

release is terminated.

STATE EOC: Is everyone there on the line?

This is to be recorded for immediate release.

This is an EAS message from the office
of Emergency Management for the

State of Columbia.

At 12:30 pm the Blue Water Power Plant
announced the valve release

problem was fixed and that the
Blue Water plant has returned to

normal operations.

The State Health Department in
conjunction with the state EOC and

local emergency officials will be
sending in monitoring teams to

assess the situation by measuring the
deposition and distribution of the radiation.

We will keep the public informed as
the monitoring continues

but until the information becomes
available, the evacuation order

remains in effect.

You got that?

Okay.

Thank you very much.

NARRATOR: You can see from this
scenario that one of the critical

responses to such an event is having
consistent and informed communications.

Even though the problem at the Blue
Water plant has been resolved,

there was still a serious release that will
require considerable

measurements to determine if,

and where, radionuclide

deposition has occurred and what
decon and remediation is necessary.

Until remediation is complete, the
evacuation order will likely remain in effect.

NARRATOR: Device The possibility
of exposure to a radiological

release is not confined to a nuclear
power facility.

A terrorist event could occur anywhere
or at any time and

a response appropriate to the event
would be necessary….

Yeah...

I just finished putting the frosting
on our cake.

In about an hour from now,

we're gonna be providing quite a party

for the good folks in the city….

alright, good.

Yup, we’ll connect up later….

[[[BIG EXPLOSION]]]

911 OPERATOR: 911, what's the

address of your emergency?

CITIZEN: Yeah, sure...

2020 Sandy Drive

911 OPERATOR: What's the

emergency you are reporting?

Hey I heard a loud noise and

lthere's a car on fire.

911 OPERATOR: You are reporting

a vehicle fire?

CITIZEN: Yeah I guess so, there's
smoke all over the place.

911 OPERATOR:
Are there any injuries?

CITIZEN: I don’t know...

there's smoke all over the place,
but there's a guy who lives there…

But a, he's kind of a loner.

911 OPERATOR: I'll get the
fire department on the way.

[[[SIRENS]]]

ENGINEER: Captain, we’ve got to
check for extension in the trailer.

CAPTAIN: Alright, alright,
yeah, let’s do that

and the we'll wrap up a primary

search and finish it up.

ENGINEER: Looks like we’ve got

bomb making equipment

CAPTAIN: Okay, let’s go,

everybody back 300 feet!

LET'S GO!

CAPTAIN: “Yeah, dispatch, this is

company B responding to car fire.

With a need to request HazMat and

Bomb Squad backup,

we have what looks like might

be a dirty bomb….

Yeah...

thanks.

NARRATOR: As we have seen here, upon putting out the fire, our

seasoned first responders recognized something wasn't quite right.

The fire seems to have started in the back seat area,

and where was the owner?

Retreating from the source and calling in HAZMAT and the Bomb Squad

after seeing the suspicious materials was an appropriate response.

Not knowing if there was a bomb or an additional device, standing back

for a clearance by the Bomb Squad protects them from exposure.

Working under the assumption that the responding crew was

potentially exposed to radiological
materials, HAZMAT would not want

to enter that area - a potential hot zone -
but would communicate remotely via radio.

HAZMAT CAPTAIN: So John, what’s up?

CAPTAIN: Yeah, well we responded to
what we thought was a routine

car fire but then it seemed like the fire
started in the back seat instead of

the engine compartment or back by
the gas tank… which is strange,

and ah, then when we tried
to contact the owner,

who I assume lives in that trailer right
there, we came across a lot

of radioactive labels, boxes and a pig

with a powdery substance …

that’s when we called you guys in…

we have the Bomb Squad en route.

HAZMAT CAPTAIN: Roger that, let’s
see what the bomb squad has to say…

they’re just a few minutes behind me.

You may want to advise your people to
put on N-95 masks just to be safe.

CAPTAIN: Why don’t you get those
and pass ‘em out.

BOMB SQUAD CAPTAIN: Hey captain,
what do we have?

HAZMAT CAPTAIN: Well, John responded
to what he thought was just a normal

fire call but they found that a device
had gone off in the back seat.

Whatever it was, it was different than a
gas tank or an engine so they ah,

on further inspection in the trailer,
they found boxes with

what they thought was radioactive
material and stickers and so forth

and they found a pig with a white
substance on it… so anyway they

figured a dirty bomb or something…
so anyway, that’s why we called you

BOMB SQUAD CAPTAIN: Okay, we’ll
suit up and go in and check it out.

HAZMAT CAPTAIN: Great

NARRATOR: Response to a Radiological
Dispersion Device, or RDD,

sometimes referred to as a “dirty bomb,” is quite different from a

release from a power plant.

A dirty bomb is usually some type of explosive or incendiary device in

which radioactive material is placed.

Upon detonation, the intent is to have the radioactive particles

become widely dispersed or carried by smoke to the surrounding area.

Since it would typically be a homemade device, the radiological material would

be whatever could be found, likely medical or industrial waste.

Since most radiological isotopes including medical and industrial grade

products are made up of very heavy

elements, they are unlikely

to be carried far with the much lighter
products of combustion and

would likely precipitate out and be
near or on the surface areas

around the immediate scene.

Even though the area of direct effect
would be small, the disruption

and psychological effect on the
population at large would likely be

significant, so excluding unnecessary
personnel, media representatives,

and converging spectators from the
hazard area would be wise.

Although a dirty bomb would be a
very localized event, there would

be a release of dangerous radionuclides
that could be deposited on skin,

clothing, structures, and vegetation,
or could be inhaled or ingested.

Simply moving a short distance
upwind from the scene of a dirty

bomb could provide significant
protection since dose rate and dose

decrease dramatically with distance
from the source of the explosion.

Normal turnout gear, as we mentioned
earlier, provides protection from Alpha

and Beta particles but provides no
protection from X-ray, Gamma rays,

or neutrons.

From our “dirty bomb,”
radionuclides would certainly

have been deposited on our
first responders’ turnout gear.

Being protected from any exposure is
always the first and best response.

In some circumstances though,
responders may have to enter

a contaminated area.

In that event, the underlying
radiation protection principle is

to limit their exposure to
“As Low As Reasonably Achievable,”

the ALARA principal, to within the whole
body limit prescribed for radiation

workers, which is a 5-REM total
effective dose equivalent per hour.

That means that a first responder

could safely enter an

area of say,100 rem for example,

for a 3-minute period.

In an emergency situation, these

guidelines may not provide the

flexibility required for essential

operations.

In these cases, all possible measures

will be taken to limit radiation exposure

of emergency workers to an effective

dose of 10 rem when protecting

valuable property or up to 25 rem when

performing life-saving activities.

Doses greater than 25 rem may be

allowed for life-saving activities

but only if the emergency workers

participate on a voluntary basis and

are fully aware of the risks involved.

When a person is exposed to radiation,
energy is deposited in the

tissues of the body.

The amount of energy deposited is
called the absorbed dose.

Absorbed dose is measured using the
conventional Radiation Absorbed Dose,

or RAD.

As we discussed earlier, the term
“REM,” is a measurement of radiation

exposure that has biological effects.

But we use another unit of measurement
to indicate the actual amount

of radiation absorbed.

The idea is that just because one

is exposed to radiation,

that exposure can be different than

the amount of absorbed radiation.

Absorbed radiation is measured in RADs

one RAD is generally equal to one

REM of radiation – but again,

exposure to one REM doesn’t mean

absorption of one RAD radiation.

A high radiation-absorbed dose greater

than 100 RAD from a single

whole-body exposure, usually external,

can cause various degrees of

radiation sickness or even death.

Signs and symptoms may not be seen

for days or weeks with a moderate dose.

If the exposure is sufficiently great, either from an acute

(that is, one-time) exposure or low doses over long periods - that is,

chronic exposure – it can cause cancer, premature aging,

or genetic effects that may be passed onto future generations.

Severe exposure, over an extended period of time, can cause death.

Radiation sickness signs and symptoms usually begin with loss of appetite,

nausea, vomiting, fatigue, and diarrhea, and after high doses,

may progress to anemia, skin burns, dehydration, hair loss, bleeding and bruising, and

reduced blood cell counts.

The symptoms occur in a

predictable sequence.

The greater the radiation dose, the more

rapid the onset of signs and symptoms.

Again the severity of illness depends on:

the dose

the dose rate and

the type and amount of radiation.

The effects also depend in part on a

persons individual characteristics

and whether the person receives

whole-body exposure, or if not,

what areas of the body are exposed.

The best indicators of the extent

of the radiation sickness are:

time from exposure to the start of

signs and symptoms,

the severity of symptoms, and

the severity of changes in white

blood cells 48 hours after exposure.

In a radiation event with a high risk

of contamination,

such as our “dirty bomb,”

OSHA recommends that respiratory

PPE include at a minimum,

a full-face-piece air purifying

respirator with a P-100 or

High Efficiency Particulate Air filter

- commonly called a HEPA filter.

If you need further guidance refer to

OSHA/NIOSH Interim Guidance

August 30, 2004.

Chemical - Biological - Radiological

- Nuclear (CBRN)

Personal Protective Equipment Selection

Matrix for Emergency Responders:

Radiological Dispersal Device (RDD).

In low risk situations, such as those

faced by EMTs or first receivers

at medical facilities, or low risk

responder operations,

Level D PPE may be adequate.

Appropriate respiratory protection

will be determined

by incident commanders and

jurisdictional authorities.

Several manufactures sell
radiation protective suits based

on European standards.

According to OSHA's Technical Manual
TED 1-0.15A,

these suits protect against alpha
and beta particles but not against

penetrating x-ray or gamma
radiation or neutrons.

They are designed to prevent skin
contamination from radioactive

particulates and should be used with
appropriate respirator masks to

prevent inhalation and ingestion hazards.

Ultimately the choice of PPE for a

radiation event depends on the risk of contamination and exposure and the decision made by the incident commander about what to use.

States and local jurisdictions may have more specific regulations regarding PPE for such events.

Because of the possibility of adverse health effects in a radiological incident, all emergency workers going into the hot zone must wear and monitor a personal dosimeter.

Every emergency worker is personally responsible for:

1. Recording the direct-read dosimeter reading every 30 minutes

or as otherwise directed according to state, tribal, and local guidelines;

2. Reporting the exposure readings to their supervisor every 15 to 30 minutes;

3. Reporting to their supervisor when direct-read dosimeter readings reach 100 millirem and 500 millirem; and

4. Returning all dosimetry and the radiation exposure record forms to their supervisor at the end of the emergency.

Any individual that has received exposure to radiation would also have their exposure documented and that information would remain on file for 30 years after retirement or as directed.

In this scenario, HazMat would isolate the radiation source, and establish

perimeter boundaries with HOT, WARM, and COLD zones.

The zone boundaries, as well as the evacuation zone, would be

established based on dispersion of the radionuclides as determined

by wind speed, wind direction, etc.

As mentioned earlier, a person contaminated by radioactive materials

will continue to be irradiated until the material is removed

either washed off, if external, or flushed out of the body in urine and feces, if internal.

Therefore, they, and any public in the area, would be required to

go through decon procedures on-site between the WARM and COLD zones

involving, at a minimum, discarding of clothing, lightly brushing

exposed skin, and showering prior to seeking immediate medical attention.

If preliminary tests indicate the presence of a radiological agent,

the FBI will initiate a forensic investigation and secure the area

to preserve the scene, control access, confirm the agent type,

and determine its specific properties.

All FBI Hazmat teams have access to an isotope identifier, as do most state

RAD response groups, which would greatly enhance the response.

The FBI will also search for other types of evidence to establish where the

agent was obtained or manufactured and the responsible parties.

After securing the site, especially if it may later be considered a

crime scene, it's important to set up perimeter control according to

the Emergency Planning Guide, or EPG, establish a chain of command

based on the incident command system, gather information, call for

additional resources if necessary,
relay information to oncoming units,

and designate approach routes and
staging areas.

Incident commanders should also
determine what agencies need to be

notified regarding the incident.

For example, a radiological emergency
on a highway requires the U.S.

Department of Transportation to be
notified but an on-site emergency

at a nuclear power plant requires
plant operators to notify the

Nuclear Regulatory Commission or NRC.

Other individuals or organizations that
require notification for an

on-site radiological event will vary
depending on State guidelines.

More information can be found in the
National Response Framework (NRF)

Nuclear Radiological Incident Annex
and the NRF Terrorism Annex.

NARRATOR: Emergency preparedness
for a thermonuclear device

such as a nuclear bomb or an
improvised nuclear device or IND

is quite different than from a
fixed-site nuclear power plant accident

or an RDD or Dirty Bomb incident.

With the design of US plants and
planned safety upgrades,

a power plant can't explode like a
nuclear bomb and off-site releases

would likely be minimal, if at all.

A dirty bomb also cannot produce a
nuclear explosion.

The effects of a “thermonuclear
detonation” are usually discussed

in two categories.

Effects that occur within the first
minute are called "prompt effects."

The initial explosion would produce
an intense flash of radiation

that includes light and heat waves that
move outward in all

directions from the source of the
explosion but that would

generally dissipate within a few miles
of the detonation site.

However, the blast wave and fires
ignited by the intense heat,

could devastate structures and seriously
affect people to at least a mile from

the explosion site, or further, depending
on the size of the nuclear device.

People up to a mile away who may
be outdoors at the time of a

nuclear detonation would likely be
severely injured or killed by radiation

exposure or the blast effects from the
pressure wave itself, debris or fires.

People further out - perhaps as much
as 10 miles away

who observed the flash of intense
light energy are likely to experience

a temporary "flash blindness" lasting

from a few seconds to minutes or longer.

The blindness may even be permanent

depending on the light intensity.

A second category, called "delayed

effects," is related to fallout

from the nuclear detonation and occurs

when radioactive particulates

generated by the blast, and irradiated

earth and debris that would be drawn

up into the atmosphere by the fireball's

heat, drop back to earth.

This cloud could rise up to five miles

into the atmosphere

and would typically take the familiar

"mushroom" shape.

As the cloud cools, radioactive

particulates fall back to the earth.

Where they would be deposited
depends on the existing weather

conditions such as wind
direction, precipitation, etc.

but most would fall on the ground,
roofs, or other exposed surfaces.

An IND device detonated on or near
ground level would produce far

more fallout than the same size
device detonated high in the air,

so seeking immediate shelter from the
fallout would be even more imperative

in such an event.

The bombs used at Hiroshima
and Nagasaki were detonated at

2,000 feet above the earth to

maximize blast effects, not fallout.

Harmful radiation levels from fallout

drops rapidly to about

half in the first hour and by 80% within

the first 24 hours.

Even with this decrease, radiation

levels near the blast site

could be highly dangerous for as

much as two weeks or more,

possibly requiring extended sheltering,

especially for those in the plume path.

As with any radiological incident,

the consequences of each of

these threats differ in terms of:

the doses that individuals would

likely experience,

the types of radiation sickness
symptoms that would result,

and the ensuing health effects.

The main ways to protect oneself are
through time, distance, and shielding.

This means people should be told to:

minimize the duration or time
of exposure to the radiation sources,

maximize the distance from the
source of radiation,

and have as much shielding as
possible between themselves

and the source of radiation.

When responding to any radiological
event, remember dense materials

such as brick, cement, and earth
provide better protection than

wood, drywall, and thin sheet metal.

But the underlying principle will be
ALARA, as low as reasonably achievable.

Technological advances have made it
possible for federal authorities

to immediately monitor the radioactive
plume and describe to the public

where deposition of radioactive debris
may occur and how to avoid those areas.

Generally, such information would be
immediately broadcast to help people

protect themselves.

Radiological contamination can be
determined using available

radiation detection equipment.

Before an incident occurs, local jurisdictions should contact relevant

federal partners to help with developing nuclear response plans.

Such plans should establish a two-directional flow of mapping

and monitoring information.

Fifteen minutes to an hour after a nuclear detonation, for example,

the Interagency Modeling and Atmospheric Assessment Center

or IMAAC led by DHS and supported by DOE is expected to initiate

provision of plume and fallout projections to federal, state, and local authorities.

This action will help guide local
radiation monitoring

and to identify at-risk populations.

IMAAC maps and predictions will be
refined as local readings become available.

NARRATOR: Although unrelated to a
radiological release, a chemical release

has the potential to create a dangerous
situation - dangerous to the public

and first responders...

The U.S. Army,

as part of the Chemical Stockpile
Emergency Preparedness Program,

CSEPP, has been involved in the
protection of civilian

communities near the U.S. Army

chemical weapon storage facilities.

[[[Explosion]]]

CREW MEMBER 1: [Yelling] Gas, gas...

EVERYONE: [Yelling} Gas, gas, gas...

CREW MEMBER 2: George...

You okay George?

CREW MEMBER 3: [Yelling] George,

george... hey, can you hear me?

George...

NARRATOR: Whether exposure to this

family of chemicals comes from

an accidental source or a terrorist

event, a proper response must follow….

[[[Coughing]]]

MOTHER: Johnny,

Johnny... you okay?

FATHER: [Yelling} Someone help,
call 911...

COUNTER PERSON 1: Chris,
did you see that?

Somethings not right here,
I'm calling airport control.

...requestion help here at the
baggage claim terminal 1

Yes, I don't know what's going on, we
have people falling to the ground,

choking... right, right...

no, no... an outside security
person tried to help,

but no, they're choking too.

SECURITY PERSON: [Yelling} I
need everyone to stand back...

step away NOW.

OVERHEAD ANNOUNCER: Attention,
this is an airport security alert.

We have just been informed about
an emergency situtation at the

baggage claim area, we advise
everyone in the baggage area to

immediately move to an area outside
the terminal doors

and remain there till further notification.

Please do not leave the area or airport
at this time as you may have to be

medically evaluated for possible contamination.

At this time, we are closing the terminal and putting everyone on standby emergency alert.

We repeat: everyone in the baggage claim area should exit the building to the street side and remain their until further notification.

NARRATOR: In this scenario a number of passengers in an airport have unexplainably collapsed in a public area.

Based on the reaction of the passengers and the first responder to the event, airport security has deduced that a chemical agent of some type has been released.

No mechanical alerting devices are in
place to detect chemical

or biological agents in the terminal
HVAC system and no threat was

received by airport authorities about
a possible terrorist attack.

INCIDENT COMMANDER: Looks like
we got the real thing here

chief, what can you tell me so far?

FIRE CHIEF: Well, we've got three
passangers and an officer down

in the baggage claim area.

They're showing symptoms of
what looks a lot like

exposure to toxic gas.

I've got a Hazmat crew in there an a

positive reading on a roller bag,

and it's either a organo

phosphate insecticide

or a chemical warfare nerve agent.

Either way, I've got medical on the way.

INCIDENT COMMANDER: This is

unbelievable, thanks chief.

FIRE CHIEF: You bet.

INCIDENT COMMANDER: Has everyone

been notified?

PIO: “Yes, Sir. Our command center

is being staffed even as we speak

In fact, we’re about ready to begin

emergency operations.

Could you provide a brief summary

to staff?

I’ll tape you so people outside can

see what’s happening.

INCIDENT COMMANDER: Will do.

Yes, medical is on the way,

5 minutes tops.

Don’t let anyone, and I mean

anyone near that roller bag.

If it is a chemical agent we need to

keep a parameter around that bag of

at least 1500 feet.

I think we need to assume a worse case

scenario and there has been a release

of a chemical warfare nerve agent.

If that is the case, we’re going to need at least four in Level A PPE

Regular turn-out gear will not protect
from toxic chemicals.

Okay, right.

Good, medical’s arrived!

SAFETY OFFICER: “Sir, we need to
get the HVAC shut down

so this thing doesn’t jeopardize the
whole building.

This your head of engineering, go ahead
and give him the order

to shut the HVAC down.

INCIDENT COMMANDER: Paul,
did you hear that?

We've got to get the HVAC shut down
as soon as possible.

And put the other terminal buildings on

alert too for a possible HVAC shutdown.

SAFETY OFFICER: “We’re going to need

air samples.

I heard you say four hazmat folks

are suiting up.

So they could get some air samples

and swabs?.

INCIDENT COMMANDER: Absoulutely.

SAFETY OFFICER: Right away!

INCIDENT COMMANDER: We'll

take care of it.

Listen up people. You know that

exercise we had last fall on a

possible chemical release here?

Well, we think this one is for real.

Can’t tell what it is now but we do
know 3 people and one security

officer were overcome by something,
probably a gas

contained in a roller bag near
baggage claim B about 20 minutes ago.

Airport medical and security have
responded and

we’re waiting on the hazmat and EMT
folks from town.

At this time please remain in this
room until further notice.

Sorry I can’t give you more,

but I’ll let you know something as soon
as we find out what’s going on.

Thanks for coming so promptly.

PIO: Scott, it's for you.

INCIDENT COMMANDER: Scott here.

Who’s down there now?

Good – make sure the area is kept clear
for at least a 1500 foot radius that

and no one enters the area without
appropriate level PPE.

We’ll likely have the FBI forensics
folks down there soon.

Listen, we need to call the state folks,
can you do that for me?”

PIO: Yes

INCIDENT COMMANDER: Alright,
that sounds good, got it.

NARRATOR: It is important that emergency planners and first

responders, public officials, health-care workers, and others who work

to protect the public, understand the unique risks and

protective actions associated with toxic chemicals and chemical

warfare agents whether due to an accidental release or a terrorist attack.

Remember, it is critical to have knowledge of appropriate PPE,

de-contamination procedures, and that everyone understands the

appropriate response actions and how to communicate that information

to affected people.

Like our “dirty bomb” event, if there is a hazardous release,

especially if there is a suggestion that a chemical warfare agent is

involved, anyone in the area of the release needs to be screened,

potentially de-contaminated at the site, and receive medical

evaluation as soon as possible.

In addition to first responders who are at the scene

in this case, airport security personnel,

local hazmat and law enforcement agencies, and emergency medical

technicians, it is likely regional, state, or Federal resources may respond quickly to provide field sampling and analytical capabilities.

Such entities include public health agencies, the FBI,

National Guard Civil Support Teams, and EPA regional resources.

The incident would be classified as a crime scene and as such all

evidence would be collected and sent to an appropriate laboratory

for analysis.

The first action for security or law enforcement is to move people

away from the general source location to a place where they can be

contained and receive appropriate

medical attention, including

decontamination if necessary.

The next task is to stabilize the
number of casualties,

usually facilitated by an emergency
medical unit followed by the

separation of exposed individuals
from unexposed individuals.

In general, those located close
to the chemical release

will likely exhibit increasingly
severe toxic effects.

If there is a potential downwind hazard,
the next step is to start

the process of evacuation or issuing
shelter-in-place recommendations.

Environmental sampling by HazMat

responders trained to technician

level is typically done using a hand-held

Ion Mobility Spectrometer,

or IMS, to identify the contaminant

promptly and to help locate

the release point if it is not already known.

Such information is useful to identify

the appropriate medical treatment

for victims and to establish the

HazMat exclusion area (the hot zone),

as well as the contamination reduction zone,

(warm zone), and the support,

or cold zone.

Unless emergency responders quickly

identify the chemical threat

and don appropriate PPE to provide
respiratory and skin protection,

some responders may also exhibit
agent-specific health effects.

Operations level personnel are not
allowed in a Hot zone,

but may staff a DECON line located
in the warm zone.

How much harm a chemical agent can
cause depends on the unique

characteristics of the compound’s
make-up, how and where it is released,

the amount of contamination that occurs,

and the length of time a person is exposed.

Other conditions that affect the potential
degree of harm include

the existing environmental conditions at
the time of the release,

route of exposure, sensitivity of the
individual's system,

and what, if any, protective measures
were taken prior to exposure

or immediately afterward, such as
when decontamination occurred.

Response to a HazMat incident is
situation specific and should be

an area of concern when any
responder arrives or is dispatched

to the incident site.

At fixed sites - such as a facility in
an industrial park

the type of business and location are
good initial clues as is information

provided by managers and owners.

Information relayed to a dispatcher
may directly or indirectly

indicate that hazardous materials are
present, as may the signs and

symptoms exhibited by victims at the
scene or arriving at an emergency room.

Visible clues on containers such as
marking and labeling,

as well as information from witnesses
and documentation found at the scene

may confirm the presence of
hazardous materials, as may

the physical and chemical properties
of the released chemical itself.

Until the contents are identified,

assume that the release is dangerous

and airborne and therefore always
follow the HazMat adage

“uphill, upstream and upwind.”

In this training we concentrate on
health impacts from exposure to nerve,

blister, and other Chemical
Warfare, or CW, agents.

We will cover the nerve agents GB and
VX, the blister agent sulfur mustard,

and three dual-use toxic industrial
chemicals, or TICs.

Most CW agents are stored as
liquids or solids.

Exposure to a nerve or blister agent
would occur as with other toxic chemicals

through inhalation, direct contact to

the skin or eyes,

or by ingestion - injection is highly unlikely.

In an accidental event or terrorist scenario,

the release mechanism

how the agent gets into the environment

will determine if the

agent would remain liquid, becomes

suspended as an aerosol, or be volatilized

or evaporated as a toxic vapor.

For example, an agent could be placed

in a canister such as a spray

can and vaporized or it could be spilled

as a liquid puddle and evaporate.

Blister agents can enter the body more

readily through breaks in the skin

or if the skin is sunburned.

The delivery method would also affect the symptoms exhibited.

For example, vapor exposure of a nerve agent to the eyes would have direct effects on vision while inhaled nerve agent would first affect the nasal passages and after being absorbed through lung tissue would go into the bloodstream and be carried throughout the body.

Although the key to determining the potential health effects of CW aerosols or vapors is knowing the amount or concentration of the agent, testing for air concentrations is usually done only with specialized instruments by trained personnel.

When swallowed as a contaminated liquid or as a contaminant on food

sources, the body can absorb the chemical from the digestive tract.

Once absorbed, the chemical may be transported to other parts of the body.

Health effects can occur rapidly or be delayed, according to the type

of agent and dosage.

Sulfur mustard blister agents have delayed effects that can

occur 2 to 36 hours after exposure depending on the dose.

Since nerve agents are extremely

toxic and act quickly on the body,

it would be critical to decon
and seek immediate medical help.

In cases of high exposure to nerve
agents, prompt administration of an

antidote may be necessary to avert
potential life-threatening health effects.

Sulfur mustard blister agents can
remain stable and potent

for very long periods at cold
temperatures and in deep water.

An example is fishermen who have
been contaminated and injured

when the liquid sulfur mustard agent
leaked onto clothing and deck

surfaces after they pulled up corroded
containers of old World War One

sulfur mustard agent munitions in
their nets or dredges.

Explosive ordinance disposal, or
EOD personnel, have experienced

similar situations.

Sulfur mustard agent usually has an
odor like garlic, horseradish

or mustard and is different than
nerve agents in its effects.

Skin blisters are estimated to develop
after exposure to a whole-body dose

of 600 milligrams of sulfur mustard
while the dose that would be lethal

to 50% of the exposed adult population
is 100 milligrams of liquid on the skin

per kilogram of body weight.

This would translate to 7 grams -

about one teaspoon

of liquid agent on the skin of a healthy

155-pound man.

Much less would be lethal for infants and

children, the elderly, or debilitated individuals.

While health effects may be delayed,

often the first sign of mustard agent

exposure is irritation of the eyes -

reddening, itching, tearing,

sensitivity to light or the sensation

of having grit in the eye similar

to the signs and symptoms of hay fever.

Difficulty breathing occurs only

when exposure is severe.

Since there is no antidote, immediate

decontamination with soap and water,

especially of the warm moist areas of
the body, such as underarms

and the groin area is critical.

Eyes should be thoroughly flushed
with large quantities of plain water.

Respiratory support may be needed
if exposure was severe,

with oxygen administered as needed.

Regardless of the time between exposure
and subsequent medical treatment,

emergency responders and medical
staff should be aware that

agent contamination may still be
present on the patient's body,

hair, or clothing and take appropriate

precautions to protect themselves

from secondary contamination.

If not decontaminated, and sufficient
exposure has occurred,

the skin may redden and then develop
fluid-filled blisters within 12 to 24 hours

in severe exposure within 4 to 6 hours.

If blisters are broken, they can become
infected but the fluid within the blister

does not contain sulfur mustard and
cannot cause cross-contamination

to individuals or clothing.

As for any biological fluid, cautions
should be taken to prevent contact.

If sulfur mustard, at sufficient
concentration, is inhaled,

it can injure the lining of the nose,

throat, and bronchial tubes.

Prolonged exposure can damage the

mucous lining of those organs

just as blisters damage the outer layer

of skin, and is similar to "burns"

caused by exposure to corrosive

industrial chemicals.

Such tissue injury causes internal

inflammation and hemorrhaging

and makes airways and lungs

susceptible to infection.

In severe cases, the resulting

airway damage can be fatal.

Nerve agents react differently -

and very quickly - on the human body.

Nerve agents are odorless,
colorless, and tasteless

and therefore more difficult to detect,
especially if casualties

human or animal - are
not already present.

They are chemically similar to
organophosphate pesticides,

such as the commercial insecticide
Malathion, but can be up to a

thousand times more potent.

The nerve agent VX is considered the
most potent.

The liquid-to-skin dose estimated to be
lethal to 50% of adults exposed

would be 5 milligrams of liquid VX on
the whole-body skin of a

155-pound adult.

That's about the same size as a tiny
droplet on Lincoln's head of a penny.

VX is persistent, unlike GB or sarin.

The major signs and symptoms that
may indicate a nerve agent exposure

has occurred include reduction in
pupil size, runny nose,

shortness of breath and headache.

With greater exposure, these signs
and symptoms may progress to

localized sweating, salivation, and
muscular twitching as well as, coughing,

runny eyes, and lots of foamy secretions
and drooling from the mouth.

Confusion and inability to follow
directions may be present.

If the nerve agent were released
in high concentrations,

there would also be vomiting, diarrhea,
loss of muscle and/or respiratory

control and or consciousness that
could quickly lead to death

if medical treatment is not received
immediately.

For nerve agents there are antidote-filled
injectors similar to Epi-pens

but the antidote must be given very
quickly after exposure.

Severity of signs and symptoms can
also be reduced by removing the victim

from the source of exposure and

through decontamination.

When the source is unknown or unclear, problems with both nerve

and blister agent releases are the ability to quickly identify the agent,

determine how much was released and where, and assess the resulting

contaminated areas, if any.

Problems can also arise because instruments often give false-positive

or false-negative results and sampling tests must be scientifically validated,

often in special laboratories located far from the site of the release.

As a consequence, this makes it difficult for first responders to

identify contaminated areas, employ
appropriate decontamination procedures,

and determine appropriate PPE.

This true for most chemical warfare agents
as well as for toxic industrial chemicals.

Toxic industrial chemicals, or TICs
can pose risks during their intended

industrial use or, if deliberately
released by terrorists.

The three chemicals considered to
pose significant threats are

Hydrogen Cyanide, Cyanogen Chloride
and Phosgene.

At ambient temperature and pressure,
hydrogen cyanide - HCN

is a colorless gas to pale blue/white or
liquid and has a bitter-almond odor.

Hydrogen cyanide is currently employed in various industrial applications, including

fumigation, the production of certain resin monomers,

and in liquid form in certain metal-mining operations.

Cyanogen chloride - CK - is a colorless gas with a highly irritating odor.

Cyanogen chloride is used in various industrial processes and was historically

deployed as a military chemical warfare agent by several countries.

Inhalation is the most common route of exposure causing major damage to

the lungs; although ocular exposure can cause eye injuries and it can be lethal.

Phosgene - CG - is a colorless,

reactive gas.

In the United States, phosgene has

wide industrial use in the synthesis

of other chemicals or products.

Phosgene also has a history of military

use as a chemical warfare agent

during WWI and is described as having

an odor resembling new-mown hay.

Inhalation of phosgene vapor is the

primary exposure route for

this agent and lungs are the principal

organs that are at risk.

Eye, nose, throat, and bronchial

irritation can also occur.

Many other TICS, such as Chlorine,

can pose significant hazards to first

responders and the public.

For protection from a chemical release at a fixed facility, most people will be

instructed to evacuate or shelter in place.

The proper protective action will be dictated by the situation which may include:

when no fatalities are expected, either protective action is feasible,

when people can be evacuated before plume arrival, evacuation is preferable,

when conditions make evacuation impossible, sheltering is preferable

when releases are extremely short in duration, sheltering is preferable,

when releases are extremely long, evacuation is preferable, and

when the people refuse or are unable to
take the recommended protective action,

the choice may be limited to the alternative.

It is prudent to perform those analyses
during pre-planning for potential releases.

Warning dissemination is also location
and hazard-specific.

In fast-moving events, specialized
warning technologies

such as tone-alert radios or sirens or
route alerting by first responders

may be required to get people to
take immediate protective actions.

In an emergency, initial alert and
notification may come from a variety of

sources some official, others not,

through various channels.

If authorities are sure about the
potential threat and where it will occur,

the emergency alerting system may
be activated to alert and

warn those affected.

Communication after an event will be
essential to inform the public

about where to go to determine whether
they may be contaminated

and need treatment.

With-out effective prior planning
for separate counseling stations

and communication, existing medical
facilities will likely be overwhelmed

by the large numbers of frightened

persons or “worried well”

who are desperate to know their status,
interfering with the treatment

of those who actually need it.

This phenomenon of the “worried well”
causing problems has been widely observed.

Decontamination for HazMat and
chemical warfare agents is defined as

the process of reducing or removing
hazardous substances by physical

means so contaminants are no longer
in contact with the body

or by chemical neutralization,
called detoxification,

so they are no longer hazardous.

While the major objective of

decontamination of victims is the

prevention of further harm and
optimization of full clinical recovery,

an important additional objective is to
avoid secondary contamination

of others beyond the exposure site
or hot zone.

Potential victims of secondary
contamination include both first

responders and first receivers at
health care facilities where victims

are taken or to which they self-evacuate.

It is generally argued that removal of
outer clothing reduces the majority of

contaminants -whether chemical or
radiological substances.

Most field decon efforts involve clothing removal and showering either in a special decon unit such as a trailer or in an expedient setup near the scene of the incident.

Bagging and proper disposal of clothing will prevent further spread of contaminants.

Field decontamination allows the transfer of clean victims to a health care facility without contaminating the conveying vehicle or exposing others such as EMTs en route.

It can also be used to decontaminate potentially exposed uninjured persons before they leave the incident scene.

In mass-decontamination situations with multiple victims, elements readily at hand, such as a deluge of water from firefighting hoses may be used.

When resources cannot be mobilized

quickly enough to perform

systematic and assisted decontamination,

people potentially exposed to a chemical

agent or radioactive particulates should

be told to perform self-decontamination

and then to assist others in

decontaminating.

This will likely be feasible for people in a

residential structure or an institution with

showers but rinsing in any body of water

a muddy ditch, swimming pool, etc.,

is far better than spending time

locating a shower.

For people in office buildings, stores,

or other commercial locations,

this technique may be impractical,
as most public places

have limited facilities to perform
these operations.

Victims would need to rely on emergency
response crews, use large swimming pools,

or relocate to a gym or other recreational
facility with multiple showers.

Before showering, people should remove
and bag all clothing in a plastic bag.

Personal items, such as cell phones,
watches, wallets, and jewelry

should be placed in a separate
sealable plastic bag inside another

sealable bag that people can take
with them when leaving the area.

Leather items should be bagged and

disposed of because they cannot be effectively decontaminated.

People should then thoroughly shower with copious amounts of soap and water followed by a clean water rinse.

After drying, people should dress in clean clothes and follow official instructions for taking further protective actions.

Clothes stored in drawers and closets should be free of contaminants.

To avoid irritating or breaking the skin and forcing the harmful substances into the skin, rubbing or using a stiff bristle brush is not advised for chemical or radiological exposures.

An alternative for radioactive fallout is to
lightly brush the skin to remove the material.

Decontamination is relatively simple for
ambulatory victims, but increases in

complexity with non-ambulatory victims,
people with access and functional needs,

and when treating casualties.

In some instances, when injuries are
life-threatening or victims have been

exposed to a highly toxic chemical agent
that requires an immediate antidote,

medical personnel in appropriate PPE
may treat victims

before they are decontaminated.

While flushing with a soapy water

solution is the most common method,

decontamination should never be
delayed if only water is available.

Regardless of the process used,
decontamination should be performed

as quickly as possible after exposure
and contamination.

Contaminated water used for decon
activities should be captured

and sequestered if at all possible to avoid
the further spread of contamination.

Animal decontamination is another matter
but should be planned for because

of the large number of pets that
generally accompany evacuees.

A significant number of people will
refuse to evacuate without their pets.

Owners should not attempt to decon animals unless they are certain that they will not be cross-contaminated via contact with residue on the pet’s hair or from off-gassing of residual toxic chemicals or their degradation products.

Most animals with hair can be deconned using a soap and water solution.

Responders performing decon should wear appropriate PPE, be trained to use the PPE, and be trained to handle potentially traumatized animals.

It is critical that volunteers lacking training not be allowed to decon animals because of the potential for bites or punctures or harm to the animal itself.

Emergency plans should also include
decon procedures for search and rescue

animals working in or around structures
demolished in explosions or fires.

Animals will need to be deconned before
taking breaks to ensure that debris

on their hair and feet will not result
in secondary contamination

of clean break or relief areas.

The underlying goal during the decon
process is to protect oneself, others,

essential assets, and to the extent
possible, the environment,

from further contamination.

You can't help others if you become a
victim yourself.

A coordinated decontamination process
that is fast and effective minimizes

secondary contamination and maximizes
the potential for complete victim recovery.

For further information see the
CSEPP video

"Operations Level Training -
A Refresher for Responders".

NARRATOR: The immediate phase
of the emergency is over,

but follow-up events will continue
into the future.

Temporary population relocation,
further decontamination, recovery,

re-entry criteria, and reoccupation
are issues with which planners

and policy-makers must reckon.

As part of the "incident management team", it is important to make sure the scene isn’t released prematurely because gathering evidence may require extensive periods of time.

Response officials may monitor media broadcasts and other communication channels such as social media to allow emergency personnel and first responders to correct misinformation, clarify technical information, and prevent erroneous rumors from spreading.

Officials often must respond to questions about ambiguous or highly scientific statements given by experts who assume most people

understand the science of risk assessment and hazard analysis.

It is a public communicator’s duty to make sure people understand the

elements of the public information message and to make corrections or

additions in follow-up messages.

It’s also important that all corrections be made positively

and delivered in a consistent manner.

How to monitor response will vary by event.

The sources considered most useful include law enforcement

and traffic reports, hotlines to 911

centers or dedicated call centers,

web cams along interstate highways
or critical road intersections,

traffic counters, and media
coverage and reports.

Making sure the messages given to
various segments of the

public are fitting and appropriate
is critical to obtaining

the desired emergency response.

Most people will be unprepared
for Chemical Warfare agent or

radiological releases or terrorist
events, and warning messages will

need to be carefully crafted and vetted
to ensure maximum public compliance

with recommended response actions.

Remember, in an unexpected emergency people are hungry for any and all information available and will search through various channels and media as long as the event is current.

Reentry and recovery are highly situation specific and occur only after the incident has been stabilized.

Appropriate PPE should also be worn until the area is considered safe for reentry without PPE protection.

Remember, the key to successful emergency response for technological hazards is advance planning and training, prompt decision-making and response, appropriate communication with the public to minimize exposure, taking the necessary steps to prevent secondary contamination, and insuring successful reoccupation of the affected areas.

Comprehensive prior interagency planning and coordination plus training and regular exercises are critical to achieving these goals.

Although there may be some extreme events where persistent chemical agents are widespread or where radioactive materials continue to emit radiation and pose problems, it is possible to protect most citizens

and first responders with available tools
and appropriate protective measures,

plans and procedures.

This concludes the "Comprehensive
Planning for Technological Emergencies"

training.

We have discussed how to recognize and
respond to technological emergencies,

both chemical and radiological using
a risk based response approach,

knowledge of appropriate PPE,
and decontamination procedures.

Although the scenarios are only
examples of possible hazardous

materials emergencies you may
encounter, the knowledge you have

gained will assist you in protecting

yourself and your community.