Nuclear Plant Emergency Response

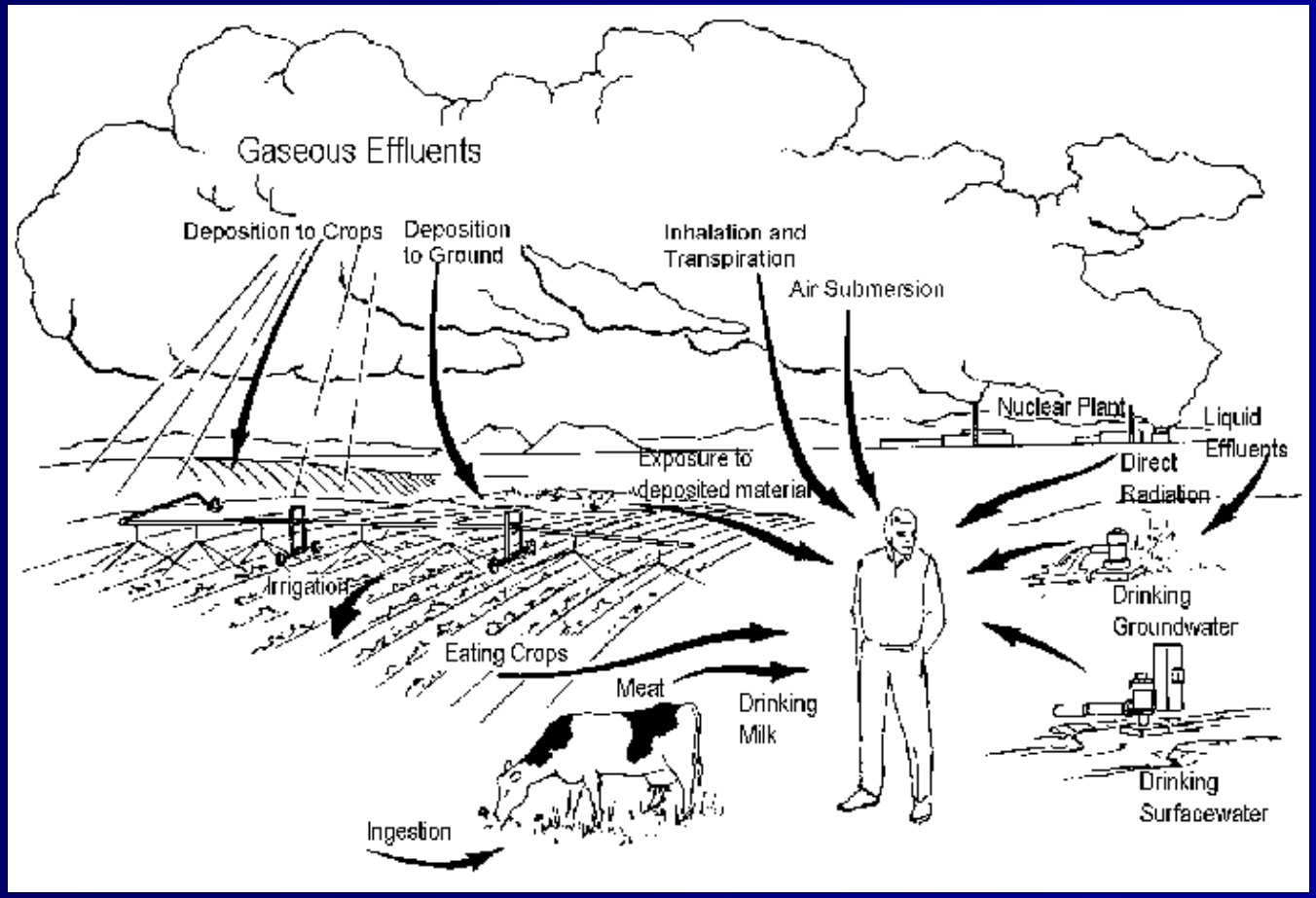
Protective Action Measures

Module 3

Objectives

- Discuss protective action measures including:
  - Shelter in place vs. evacuation
  - Use of potassium iodide
- Review importance of communication
- Discuss long term actions
- Describe agricultural restrictions
- Describe federal assistance

Pathways of Exposure



What is a Protective Action Measure?

- Any action that mitigates or decreases the absorption or effect of radiation.
  - Time
  - Distance
  - Shielding

EPA Recommended Actions

Exposure Pathways and Protective Actions

These are examples of exposure routes and various protective actions. The phases are not set timeframes and protective actions may overlap more than one phase.

POTENTIAL EXPOSURE PATHWAYS	INCIDENT PHASES	PROTECTIVE ACTIONS
1. External radiation from facility	EARLY	1. Sheltering, evacuation, control of access
2. External radiation from plume	EARLY	2. Sheltering, evacuation, control of access
3. Inhalation of activity in plume	EARLY	3. Sheltering, administration of stable iodine, evacuation, control of access
4. Contamination of skin and clothes	EARLY, INTERMEDIATE	4. Sheltering, evacuation, decontamination of persons
5. External radiation from ground deposition of activity	EARLY, INTERMEDIATE, LATE	5. Evacuation, relocation, decontamination of land and property
6. Ingestion of contaminated food, water	INTERMEDIATE, LATE	6. Food and water controls
7. Inhalation of re-suspended activity	INTERMEDIATE, LATE	7. Relocation, decontamination of land and property

Evacuation/Sheltering Model

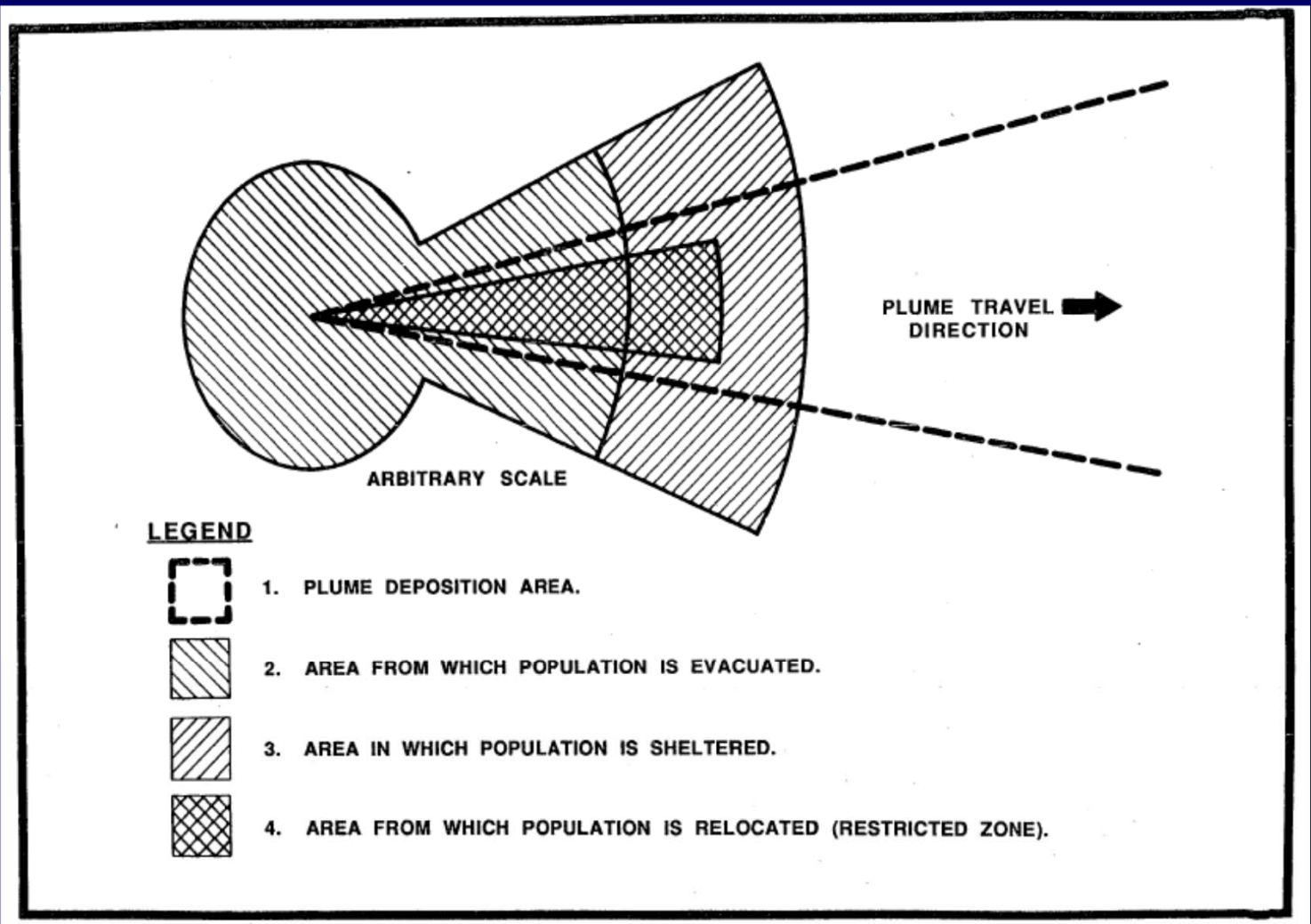
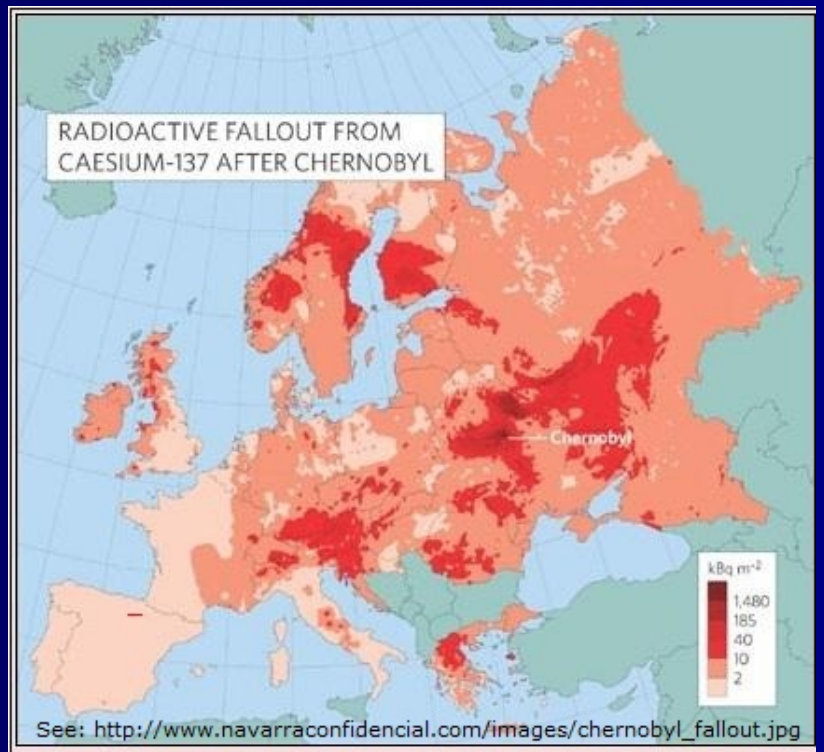
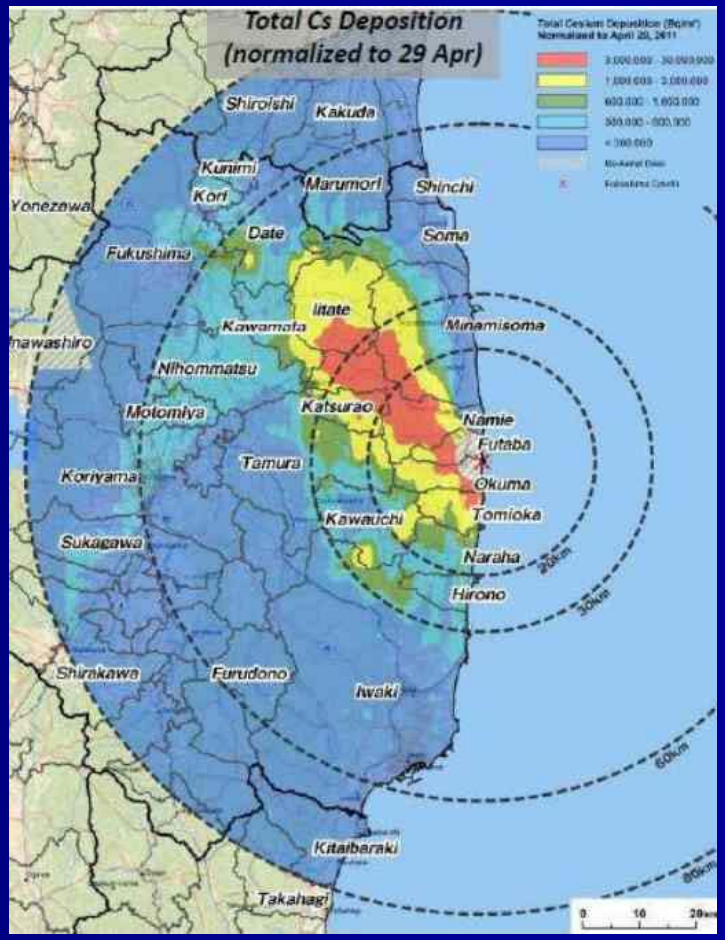


FIGURE E-1. RESPONSE AREAS.

Which way is the wind blowing?



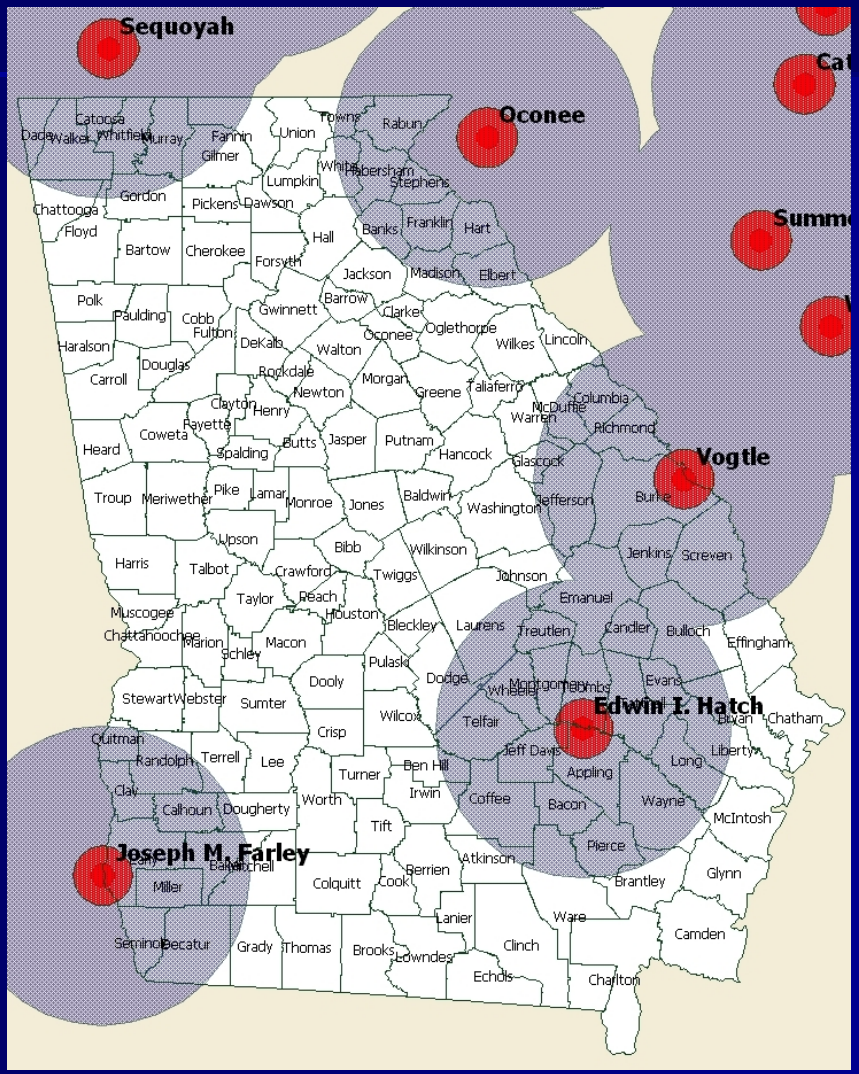
J. SMITH & N. A. BERESFORD CHERNOBYL: CATASTROPHE AND CONSEQUENCES (PRAXIS, CHICHESTER, 2005)



Emergency Planning Zones

- 10-mile EPZ
  - Area of potential exposure to radioactive plume
  - Detailed plans mandated by law
- 50-mile EPZ
  - "Ingestion pathway" area
  - Contamination of food, water, soil

10- and 50-mile EPZs in Georgia



Time Phase	Protective Action	Limit (mSv)	Comments
Early	Evacuation or Sheltering	TED 10-50 Thyroid 50 – 250 Skin 500 – 2500	Evacuation should normally be initiated at 10 mSv. Sheltering may be the preferred protective action when it provides protection equal to or greater than evacuation.
	Administration of KI	250	Equivalent Dose to the thyroid from radioiodine. Requires approval of state medical officials.

Source FRMAC Assessment Manual, Volume 1 Appendix C – Table 2-2, April 2010

Evacuation

Population Monitoring

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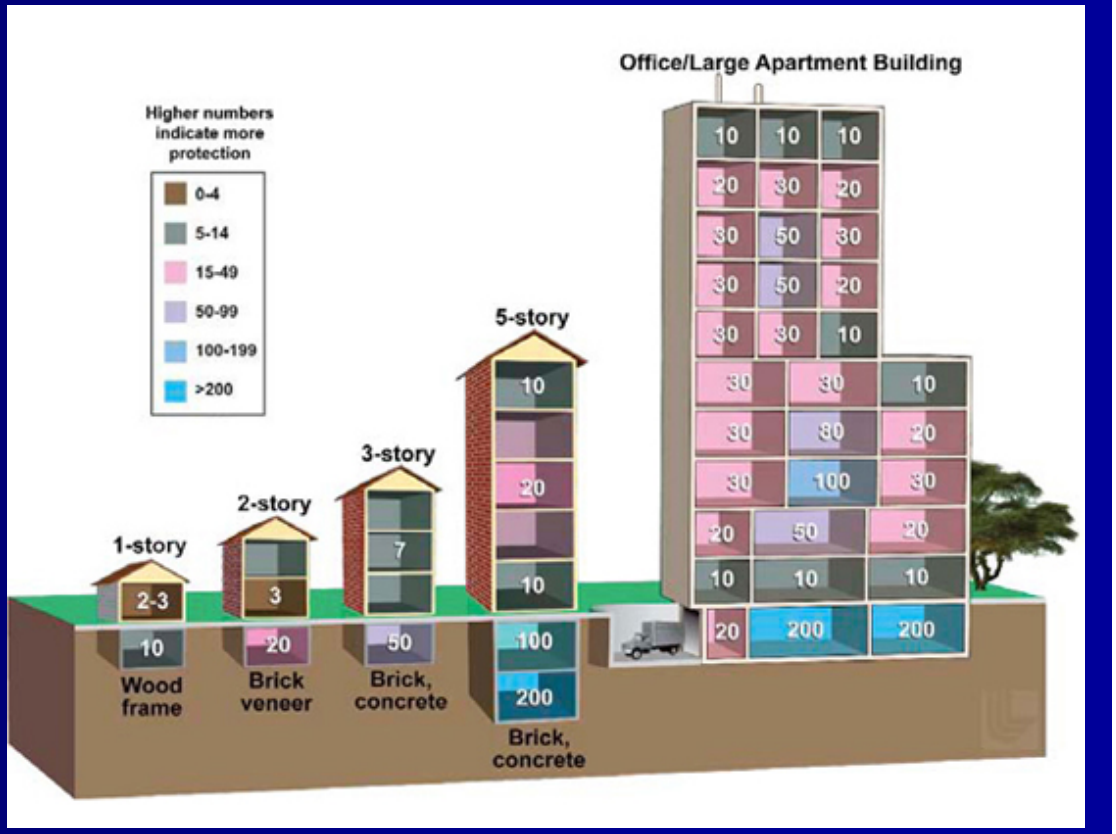
Sheltering in Place

- Stay inside, close windows and vents
- Provides shielding from radiation
- Decreases inhalation of particles



How to Shelter in Place?

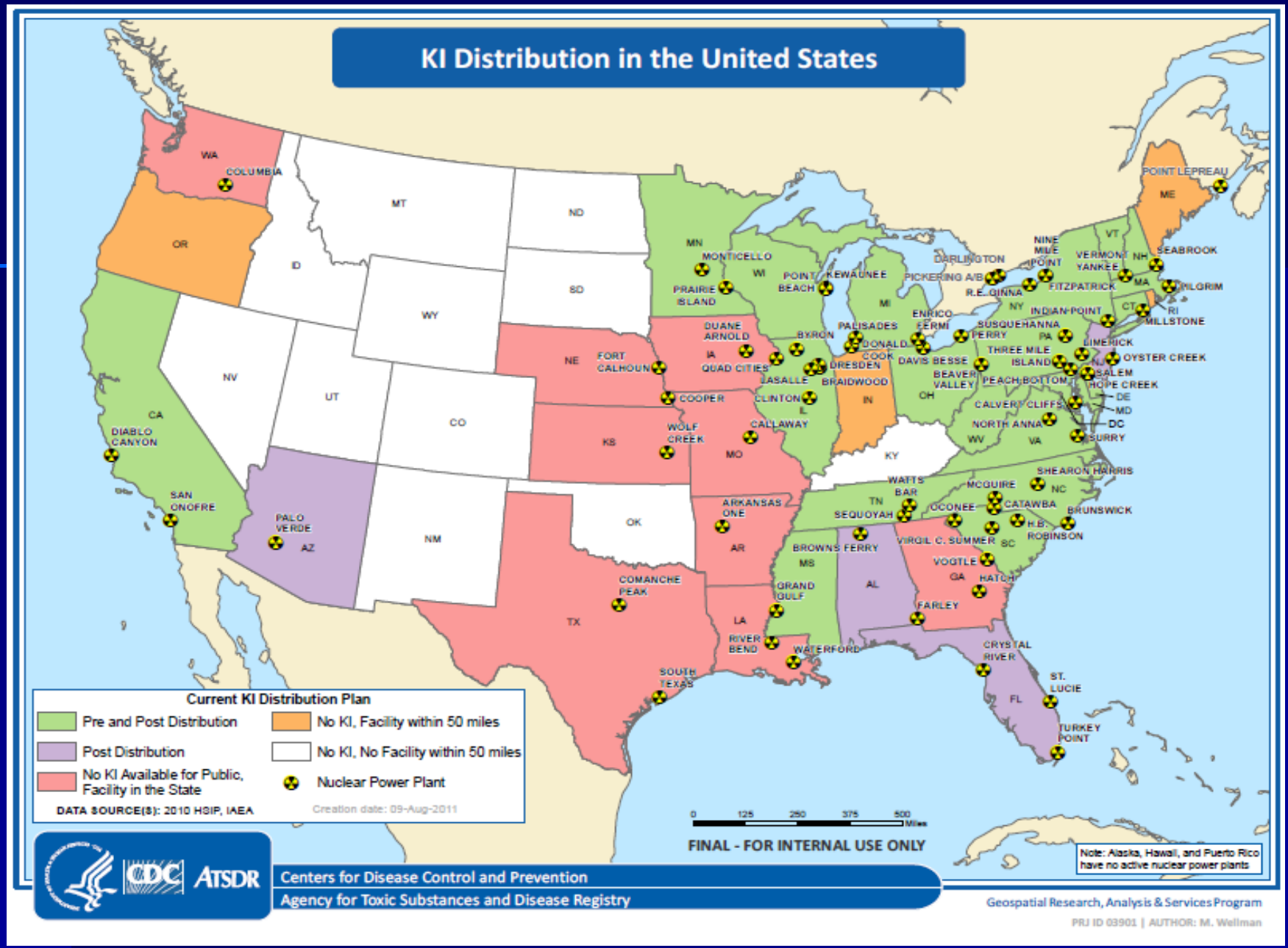
- Get inside and stay inside a stable building
  - If you are outside, get inside.
  - If you are inside, stay inside.
  - If you are in a car, get inside the nearest stable building.
  - You will be safest in a basement or inside (interior) rooms with few or no windows.
  - Turn off any fans, air conditioners, and heating systems that bring in air from the outside.

KI – Role in a NPP Accident

- Supplement to other protective measures
  - Shelter in place
  - Evacuation
  - Food, milk, and water restrictions
- Sole purpose is to reduce dose to the thyroid gland from radioiodine (primarily I-131)
- Administration needs to be guided by local health authorities.

State KI Distribution

- Varies by state
  - Pre-event distribution
  - Post-event distribution
  - Pre- and post-event distribution
  - Distribution to emergency workers
  - Not provided


KI Distribution in the United States
Current KI Distribution Plan
Pre and Post Distribution
Post Distribution
No KI Available for Public, Facility in the State
No KI, Facility within 50 miles
No KI, No Facility within 50 miles
Nuclear Power Plant
DATA SOURCE(S): 2010 HSIP, IAEA
Creation date: 09-Aug-2011
0 125 250 375 500 Miles
FINAL - FOR INTERNAL USE ONLY
Note: Alaska, Hawaii, and Puerto Rico have no active nuclear power plants
CDC ATSDR
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Geospatial Research, Analysis & Services Program
PRJ ID 03901 | AUTHOR: M. Wellman
WA
COLUMBIA
OR
CA
DIABLO CANYON
SAN ONOFRE
PALO VERDE
AZ
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PRAIRIE ISLAND
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QUAD CITIES
DUANE ARNOLD
FORT CALHOUN
COOPER
WOLF CREEK
MO
ARKANSAS ONE
AR
COMANCHE PEAK
SOUTH TEXAS
LA
RIVER BEND
GRAND GULF
MS
WATERFORD
BROWNS FERRY
AL
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SEQUOYAH
WATTS BAR
KY
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LASALLE
CLINTON
CALLAWAY
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POINT BEACH
KEWAUNEE
IN
DONALD C. COOK
PALISADES
BYRON
DRESDEN
BRAIDWOOD
OH
ENRICO FERMI
DAVIS BESSE
BEAVER VALLEY
WV
DARLINGTON
PICKERING A/B
R.E. GINNA
NY
NINE MILE POINT
FITZPATRICK
INDIAN POINT
SUSQUEHANNA
PERRY
PA
THREE MILE ISLAND
PEACH BOTTOM
CALVERT CLIFFS
NORTH ANNA
VA
VT
VERMONT YANKEE
NH
MA
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MILLSTONE
POINT LEPREAU
ME
SEABROOK
PILGRIM
LIMERICK
OYSTER CREEK
SALEM
HOPE CREEK
DE
MD
DC
SURRY
SHEARON HARRIS
NC
MCGUIRE
CATAWBA
OCONEE
BRUNSWICK
H.B. ROBINSON
SC
VIRGIL C. SUMMER
VOGTLE
GA
HATCH
FARLEY
CRYSTAL RIVER
FL
ST. LUCIE
TURKEY POINT

Fukushima and KI

- Population wanted to feel safe and empowered
- Much time and energy was spent on messaging to discourage use of KI
- Some <u>in the US</u> wanted KI!

Time Phase	Protective Action	Limit (mSv)	Comments
1st Year	Relocation	TED 20	Or 1000 mSv skin dose
	Apply dose reduction techniques	<20	Should be taken to reduce doses to ALARA. (Scrubbing and/or flushing hard surfaces, soaking or plowing soil, minor removal of soil from areas of concentration, limiting outdoor time, etc.)
2nd Year	Relocation	5	Any single year after the 1st.
50 years	Relocation	50	Total for 50 years (including the first and second years).

Ingestion Protective Actions

Animals	Move to shelter and/or corral, provide protected feed and water.
All foods	Isolate by temporary embargo until survey and initial sampling is completed. Determine whether condemnation or other disposition is appropriate.
Milk	Hold for decay or divert to other products involving adequate decay during processing (e.g. cheese, butter, dry milk solids, or evaporated milk).
Fruits and Vegetables	Wash, brush, scrub, or peel to remove surface contamination. Preserve by canning, freezing, dehydration, or storage to permit decay.
Grains	Process by milling and polishing to remove surface contamination.

Source FRMAC Assessment Manual, Volume 1 Appendix C – Table 2-3, April 2010

Recovery

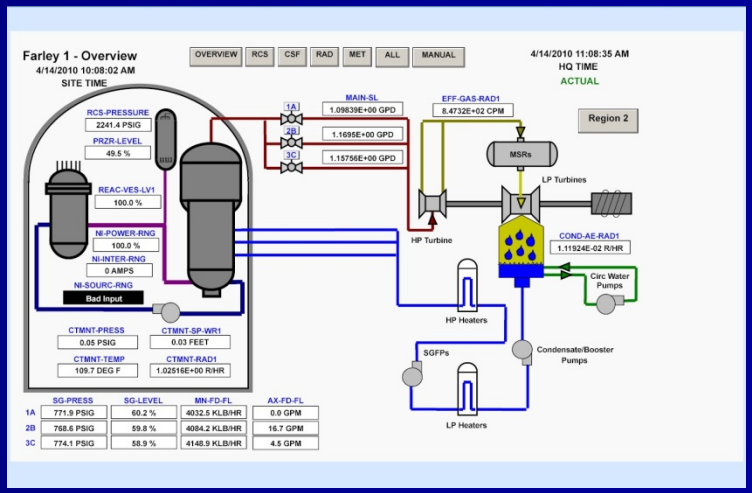
?

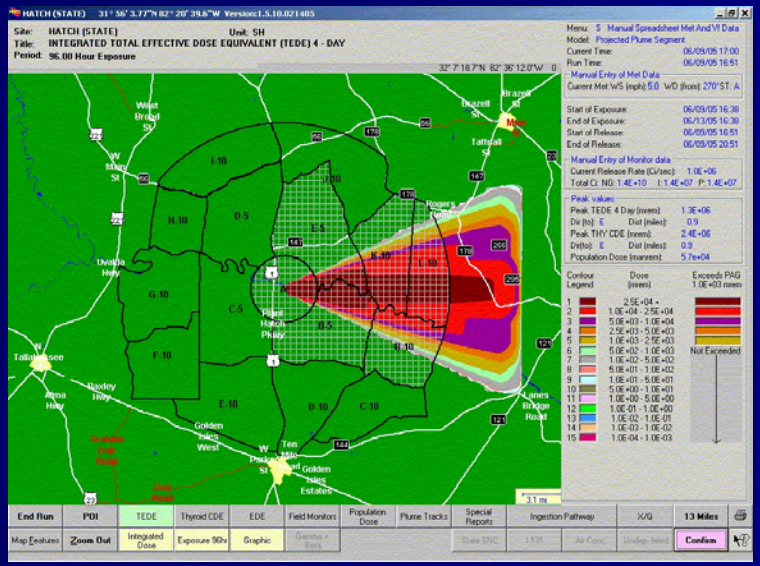
Consequence Assessment

- What radioactive material(s) is/are present?
- Where is the radioactive material?
- How much is there?
- What are the pathways to humans?
- What are the likely doses?
- What can be done to minimize doses (i.e. protective actions)?

Consequence Assessment (Emergency Phase)

- Plant status
- Field monitoring
  - direct radiation
  - air samples





- Atmospheric dispersion estimates
- Utility liaison
- Recommendations to Governor, local officials

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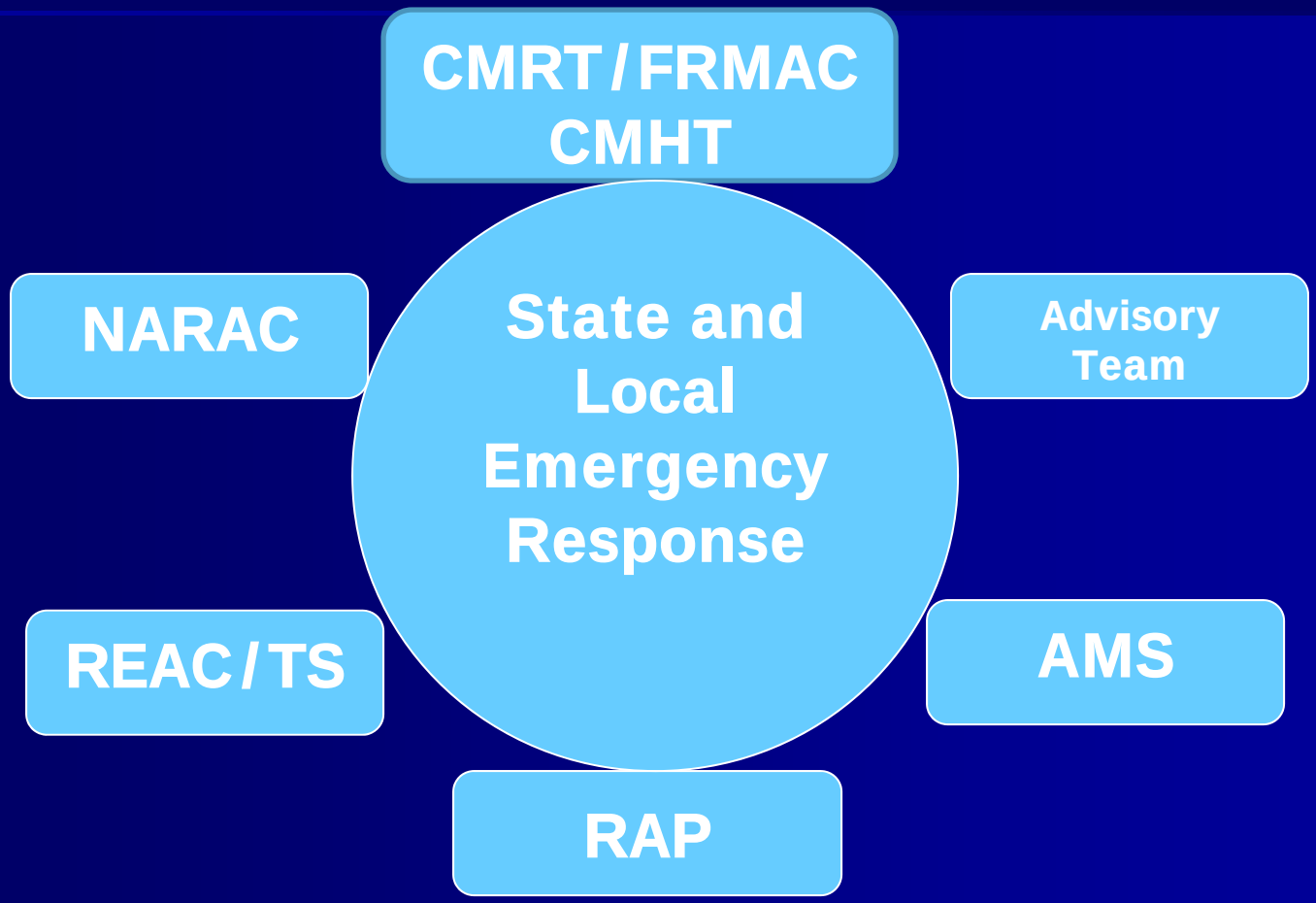
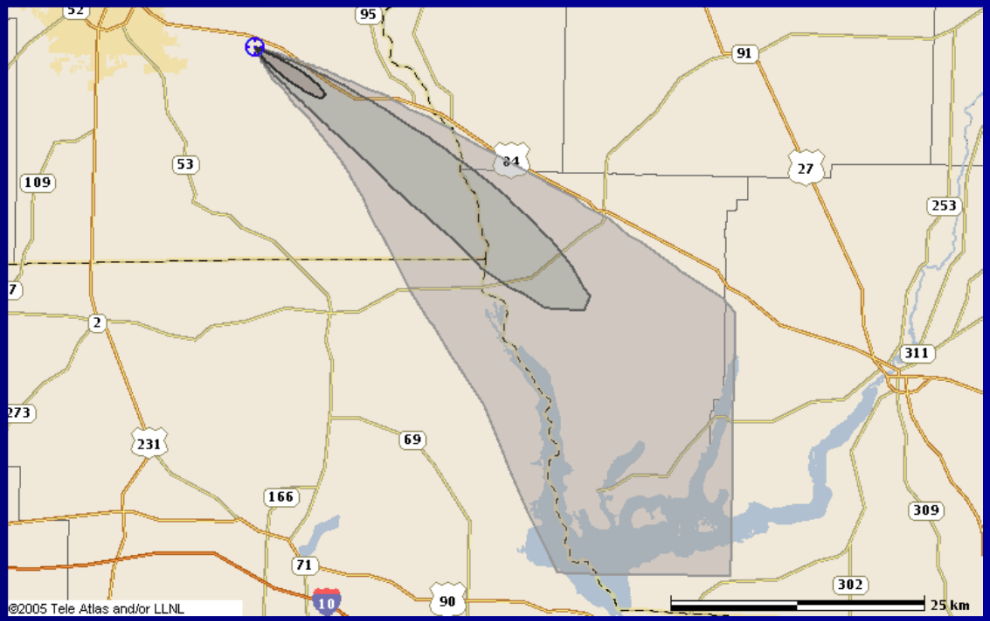
Federal Assistance

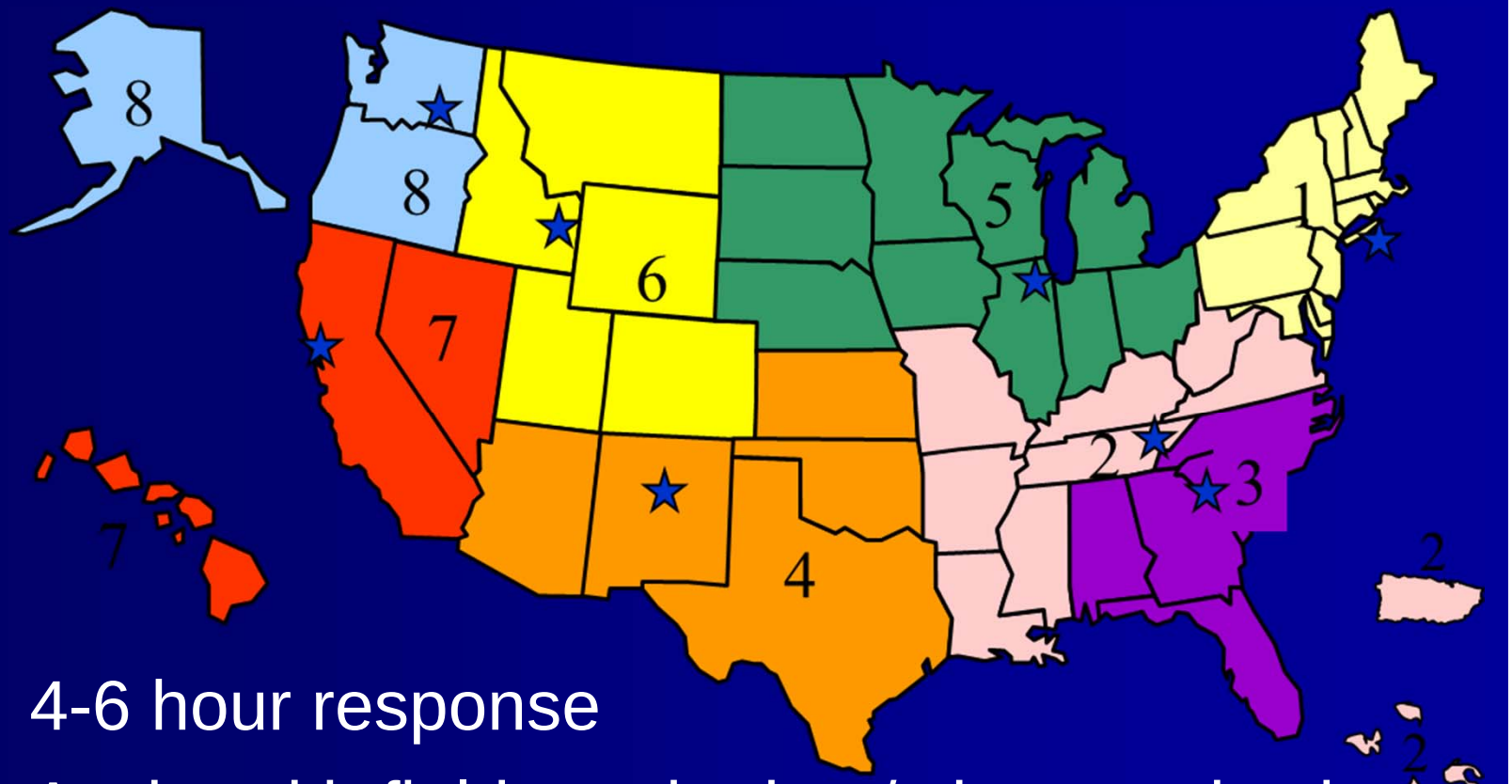


National Atmospheric Release Advisory Center (NARAC)

- Predictive plots
  - What?
  - Where?
  - How much?
- General guidance

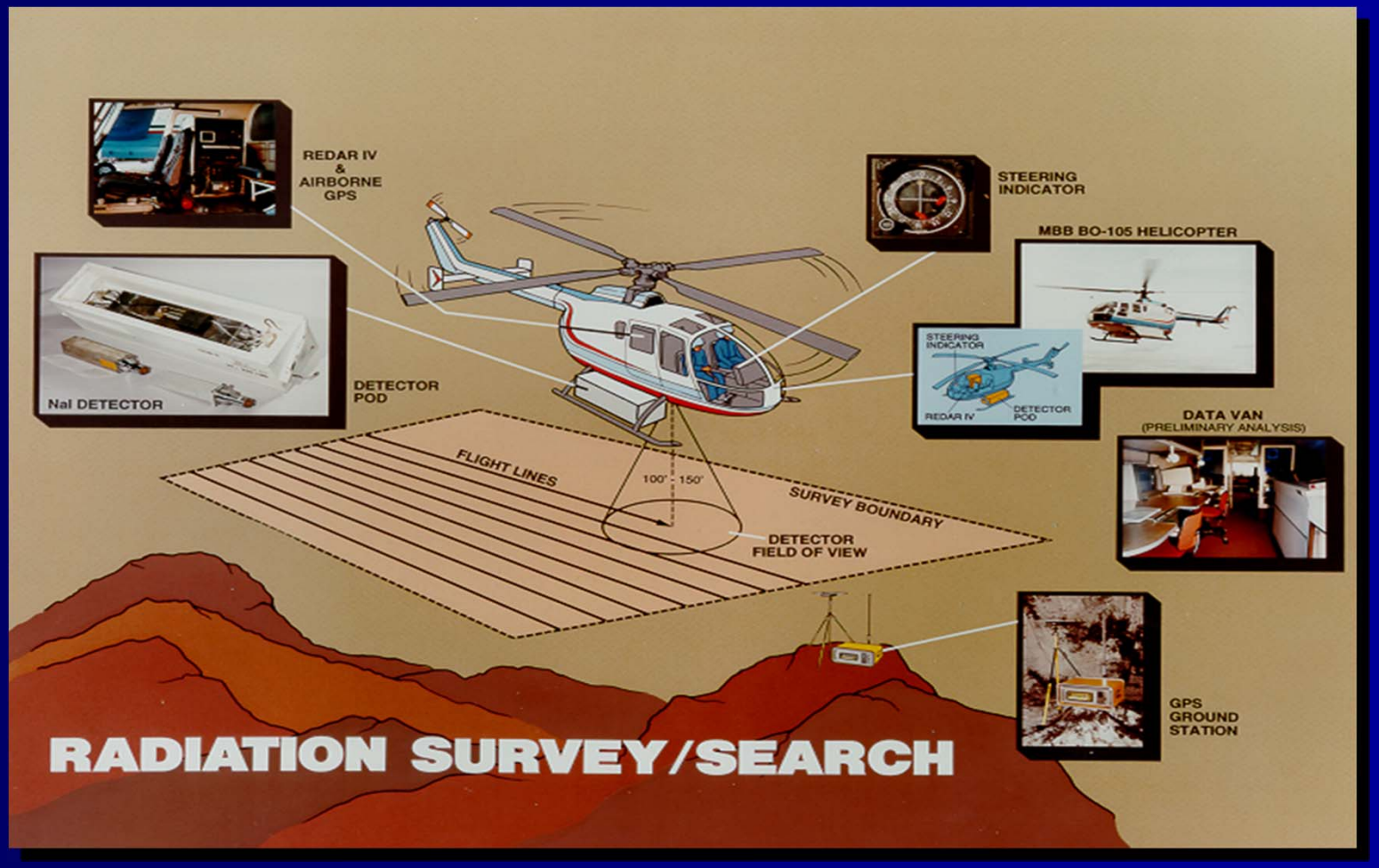


Radiological Assistance Program (RAP)

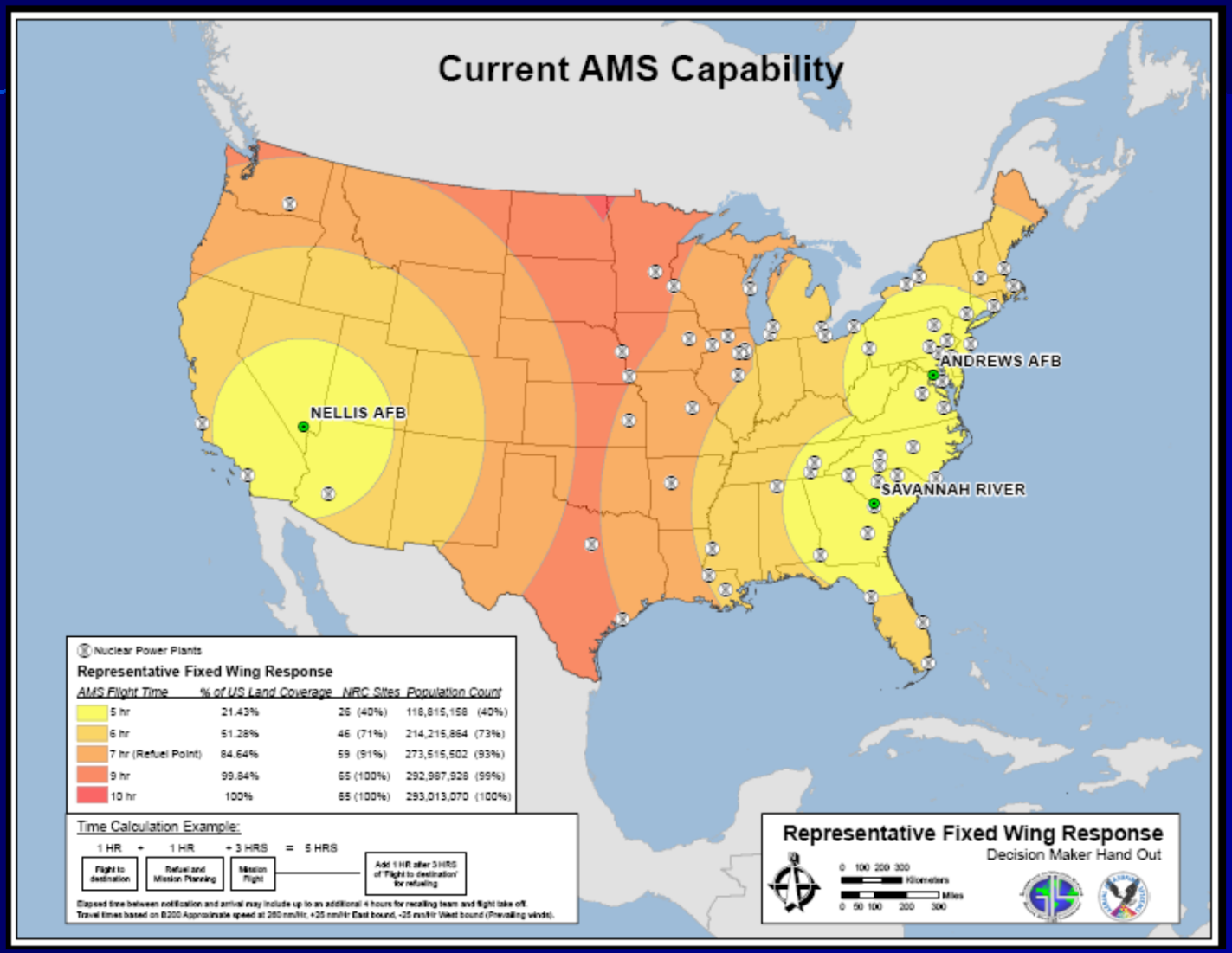


- 4-6 hour response
- Assist with field monitoring / characterization

Aerial Measuring System (AMS)



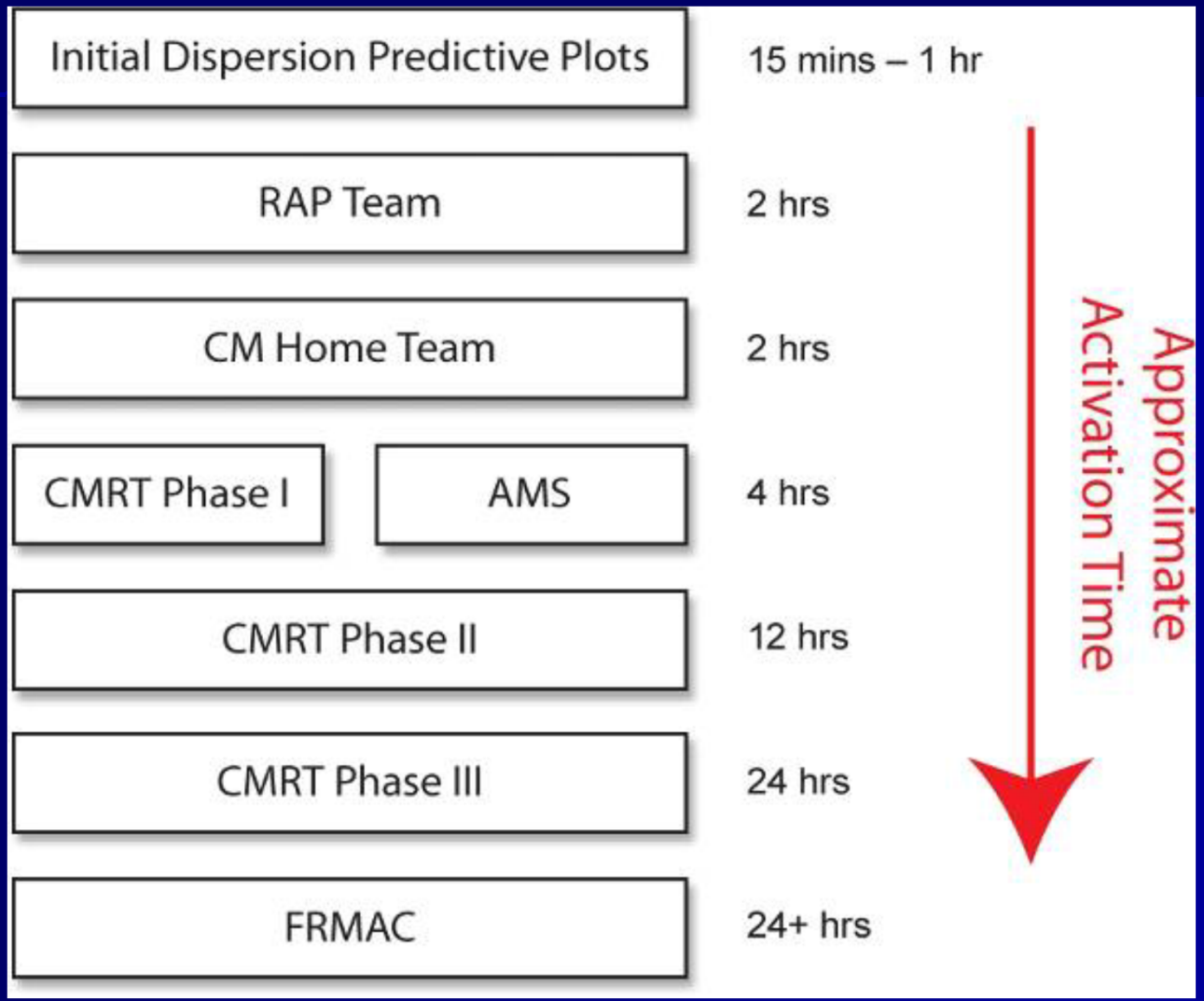
Aerial Measuring System (AMS)



Federal Radiological Monitoring and Assessment Center (FRMAC)

- Phased deployment
  - CMRT Phase I (25 technical and management personnel)
  - CMRT Phase II (38 support personnel)
  - Augmentation / FRMAC (42+ personnel)
- Initially DOE-only, later inter-agency
- CMHT coordinates while assets in route

Timing

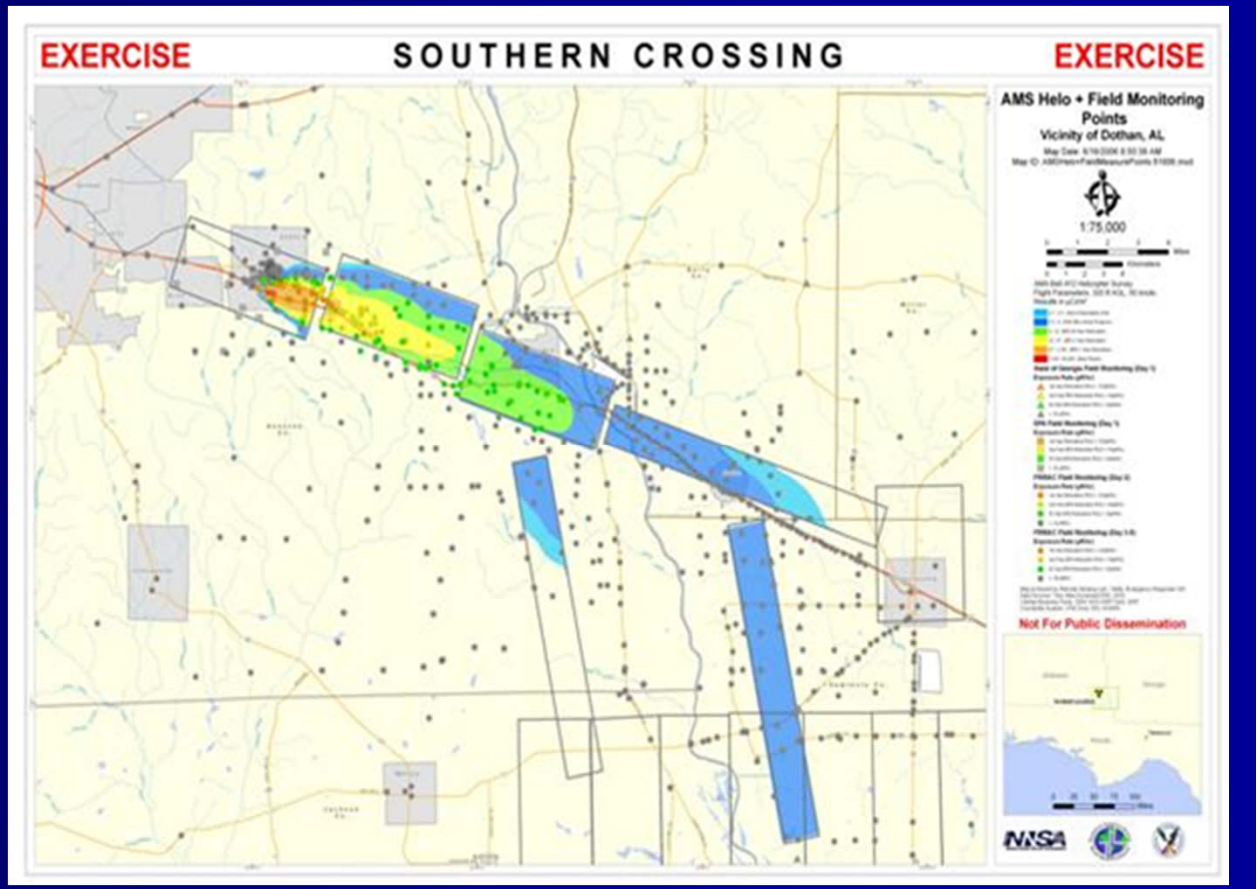

Initial Dispersion Predictive Plots
15 mins – 1 hr
RAP Team
2 hrs
CM Home Team
2 hrs
CMRT Phase I
AMS
4 hrs
CMRT Phase II
12 hrs
CMRT Phase III
24 hrs
FRMAC
24+ hrs
Approximate Activation Time

Federal Radiological Monitoring and Assessment Center (FRMAC)

- Field measurements and AMS data
- Field samples and laboratory analysis

Common Operating Picture

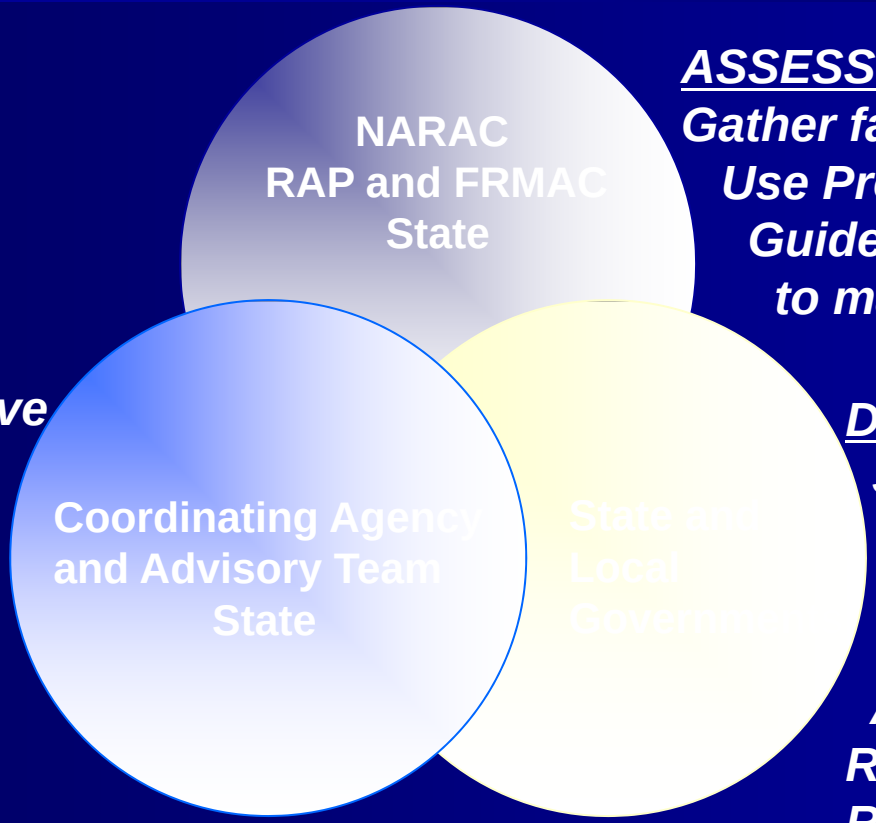
- What?
- Where?
- How much?



Advisory Team for Environment, Food and Health (Advisory Team)

- Multi-agency
- Provide guidance to state and local ERO
  - Health and safety advice
  - Application of PAGs
  - Minimization of agricultural losses
  - Disposition of contaminated items

Different Roles - One Team



ASSESS
Gather facts
Use Protective Action Guidelines and facts to make projections

RECOMMEND
Data-based protective actions to minimize radiation dose to public

DECIDE & IMPLEMENT
Shelter-in-Place
Evacuate
Population monitoring
Relocate
Agriculture restrictions
Return
Recovery

How Would the Public Respond?

- *"The first thing I would want to do is grab my kids."*
- *"As a mother, your first thought is, 'I've got to go get my kids'."*
- *"[I'd] gather my family."*

CDC Radiation Emergency Communications Research
http://www.emergency.cdc.gov/radiation/audience.asp

Effective Communication Can:

- Decrease illness, injury, and death
- Facilitate response and recovery efforts
- Avoid misallocation of limited resources
- Reduce rumors
- Minimize medically unnecessary self-referrals to hospitals and other critical facilities

Questions or Comments?

Summary Points

- Protective action measures depend on situation, may change over time
- Sheltering in place excellent protection for some situations, but may prove to be impractical for reactor accidents
- KI availability varies by state
- Many agencies (federal, state, and local) will be involved – coordination is key to success
- Proper public messaging is vital