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GENII Updates – Environmental Radiation Dosimetry Software

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PNNL-SA-148100

U.S. DEPARTMENT OF ENERGY

What is the Assessment Question?

- Are we compliant?
  - Often, regulatory requirements of facility operations are posed in terms of radiation dose limits
- Design requirements
  - How much material may be released and still meet the criteria?
- Safety Analyses
  - How much redundancy is necessary to prevent this event?
- Accident Planning
  - How bad could this event be?

Scenario Analyses

- All of these questions can be answered through the analysis of a *scenario* that considers
  - Radionuclide inventories,
  - Radionuclide releases,
  - Environmental transport,
  - Environmental accumulation and dilution,
  - Subsequent human exposure.

Scenarios

- A *scenario* is a conceptual model that describes patterns of human activity, events, and processes that result in radiation exposure to people.

- GENII is designed to allow flexible application to most scenarios of interest in a regulatory setting at an appropriate level of detail.

Types of Scenarios

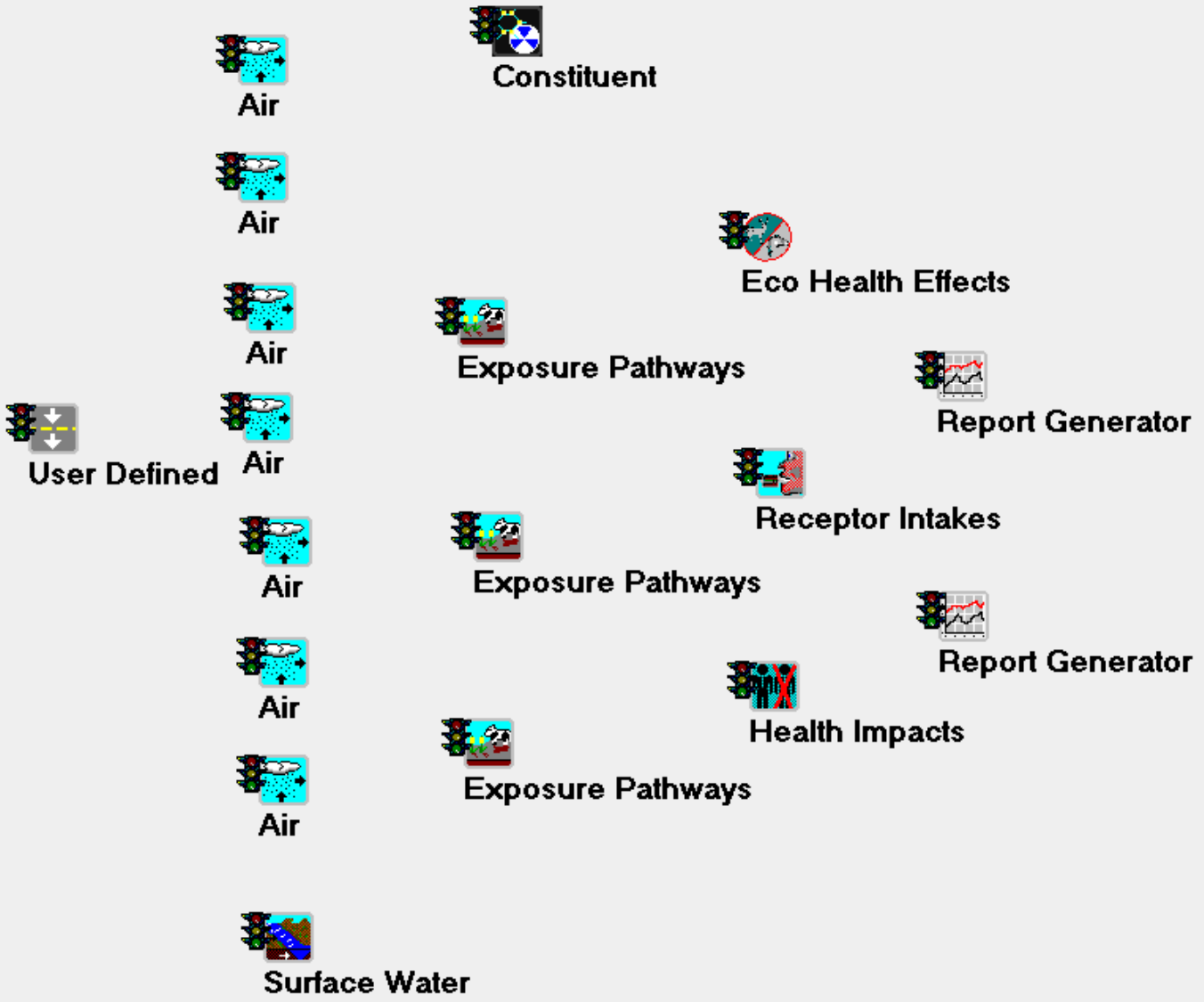
- Far-Field scenarios
  - Atmospheric transport (Acute or chronic)
  - Surface water transport (Acute or chronic)
- Near-Field scenarios
  - Spills
  - Buried waste
  - (Groundwater use - GW transport modeling is NOT an explicit part of GENII)

Framework for Risk Analysis in Multimedia Environmental Systems

File Site Customize GO... Help

GENII VERSION 2.10

- Eco Health Effects
- Fate & Transport
  - Air
  - Aquifer
  - Overland Flow
  - Source
  - Surface Water
  - Vadose Zone
- Human Exposure & Ris
  - Exposure Pathways
  - Health Impacts
  - Receptor Intakes
- Reports
  - RAGS
  - Report Generator
- System
  - Sensitivity



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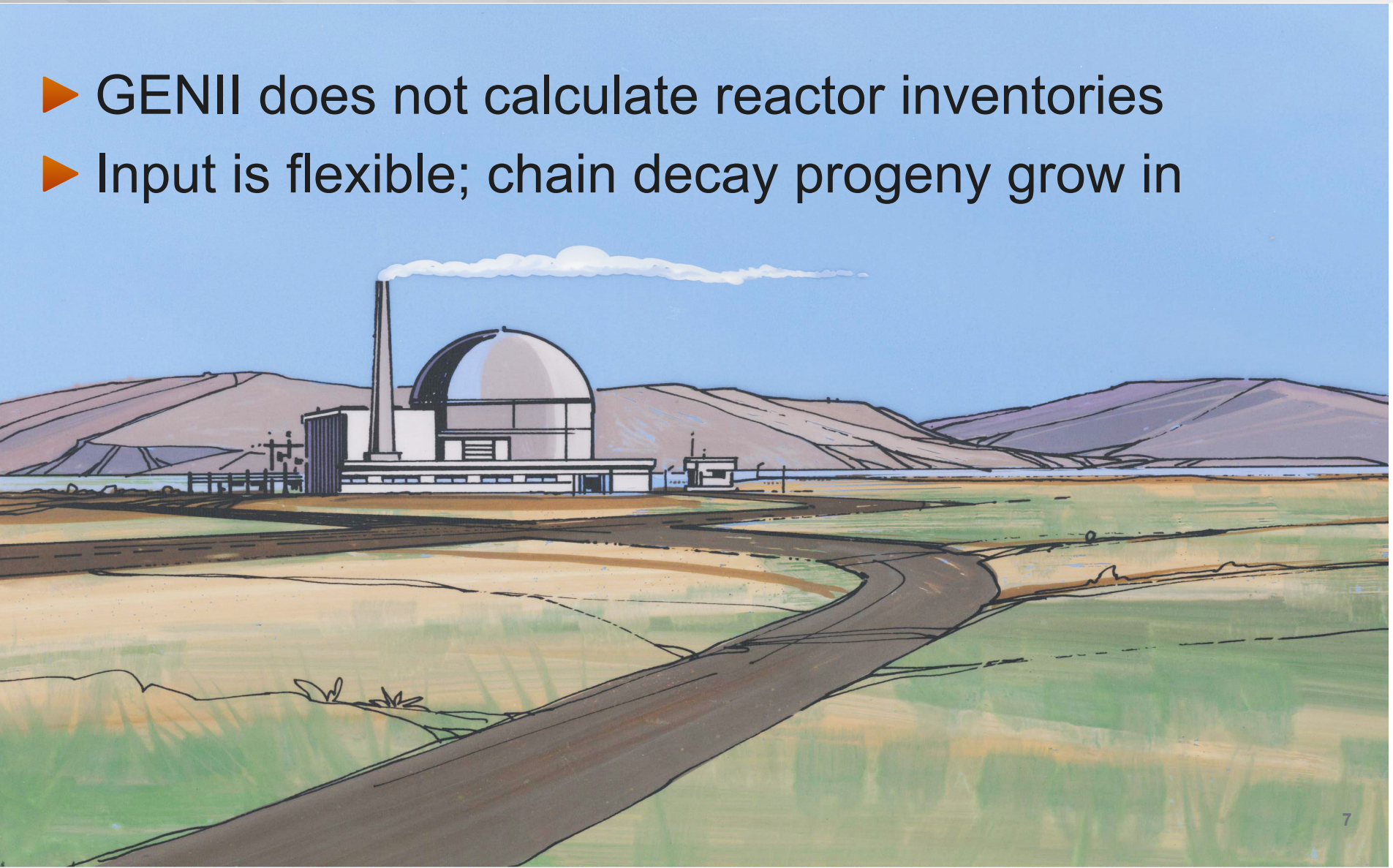
Radionuclide Source Terms

- GENII does not calculate reactor inventories
- Input is flexible; chain decay progeny grow in



7 Atmospheric Transport Models

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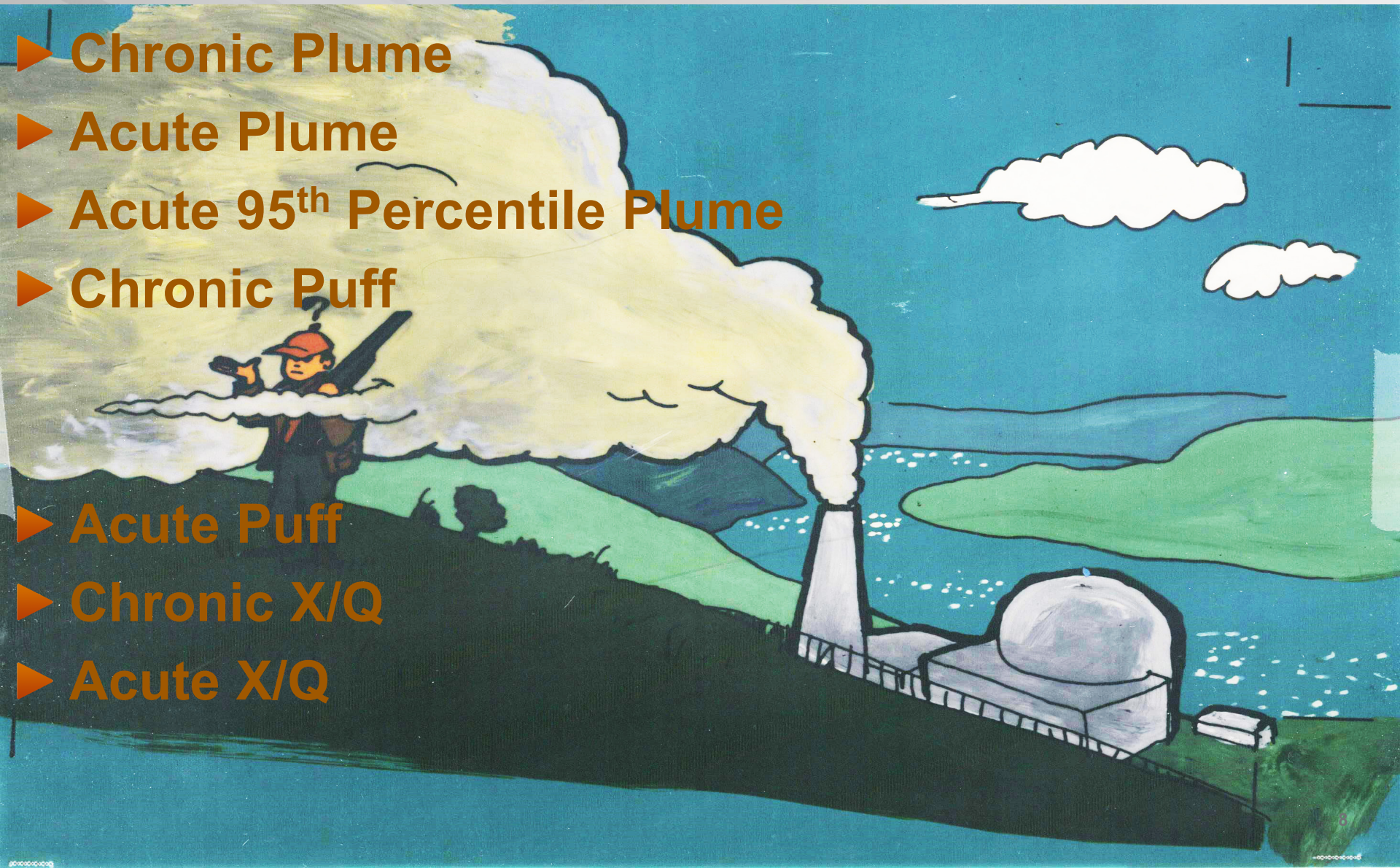


- Chronic Plume
- Acute Plume
- Acute 95th Percentile Plume
- Chronic Puff
- Acute Puff
- Chronic X/Q
- Acute X/Q

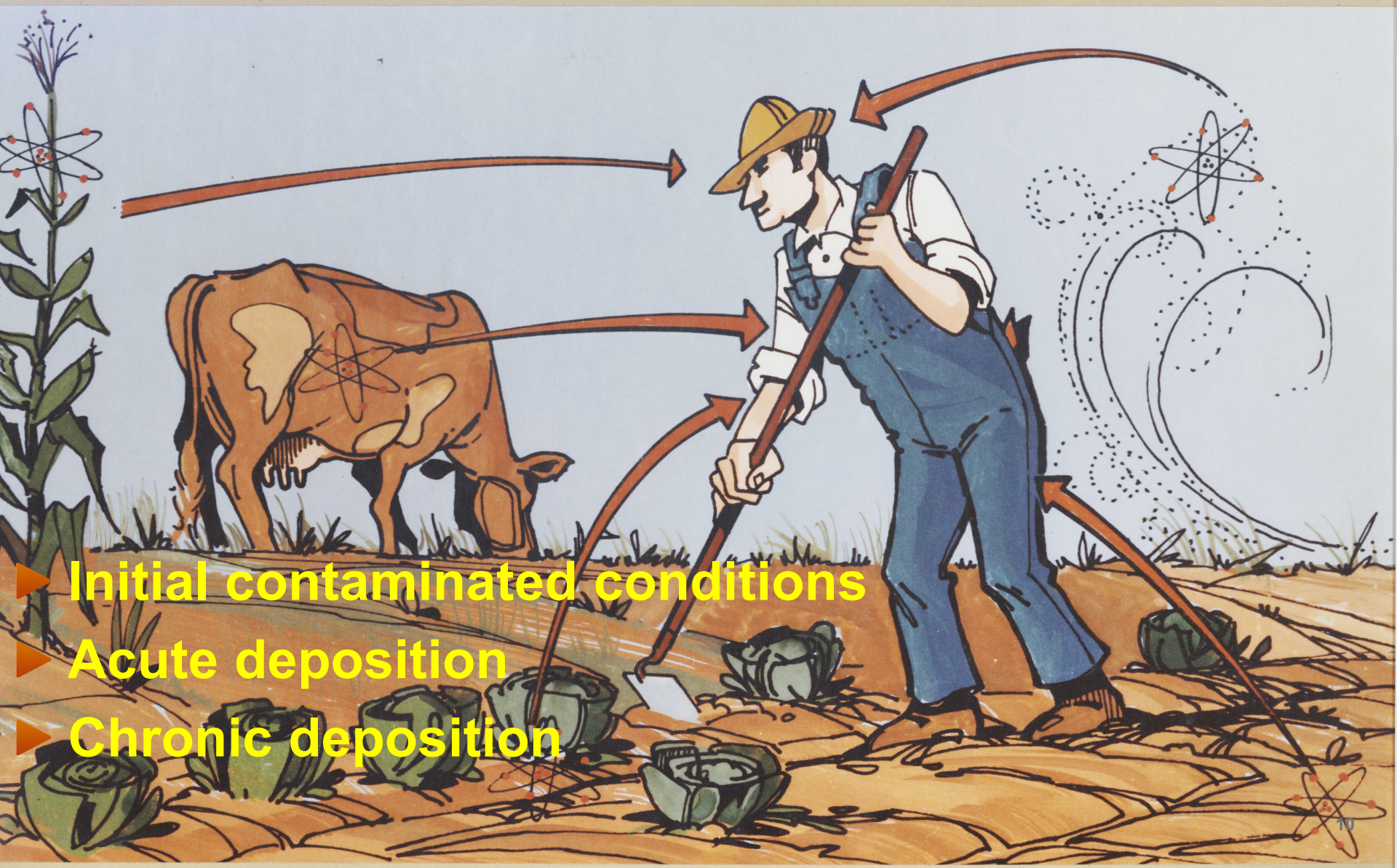
4 Surface Water Models

- Chronic River
- Chronic Flow Dilution
- Acute River
- Near-shore Lake / Ocean

Options for types of initial impoundments:

- Once-through pond
- Fully-mixed pond
- Partially-mixed pond

3 Accumulation / Exposure Models



- Initial contaminated conditions
- Acute deposition
- Chronic deposition

Biotic Transport and Exposure

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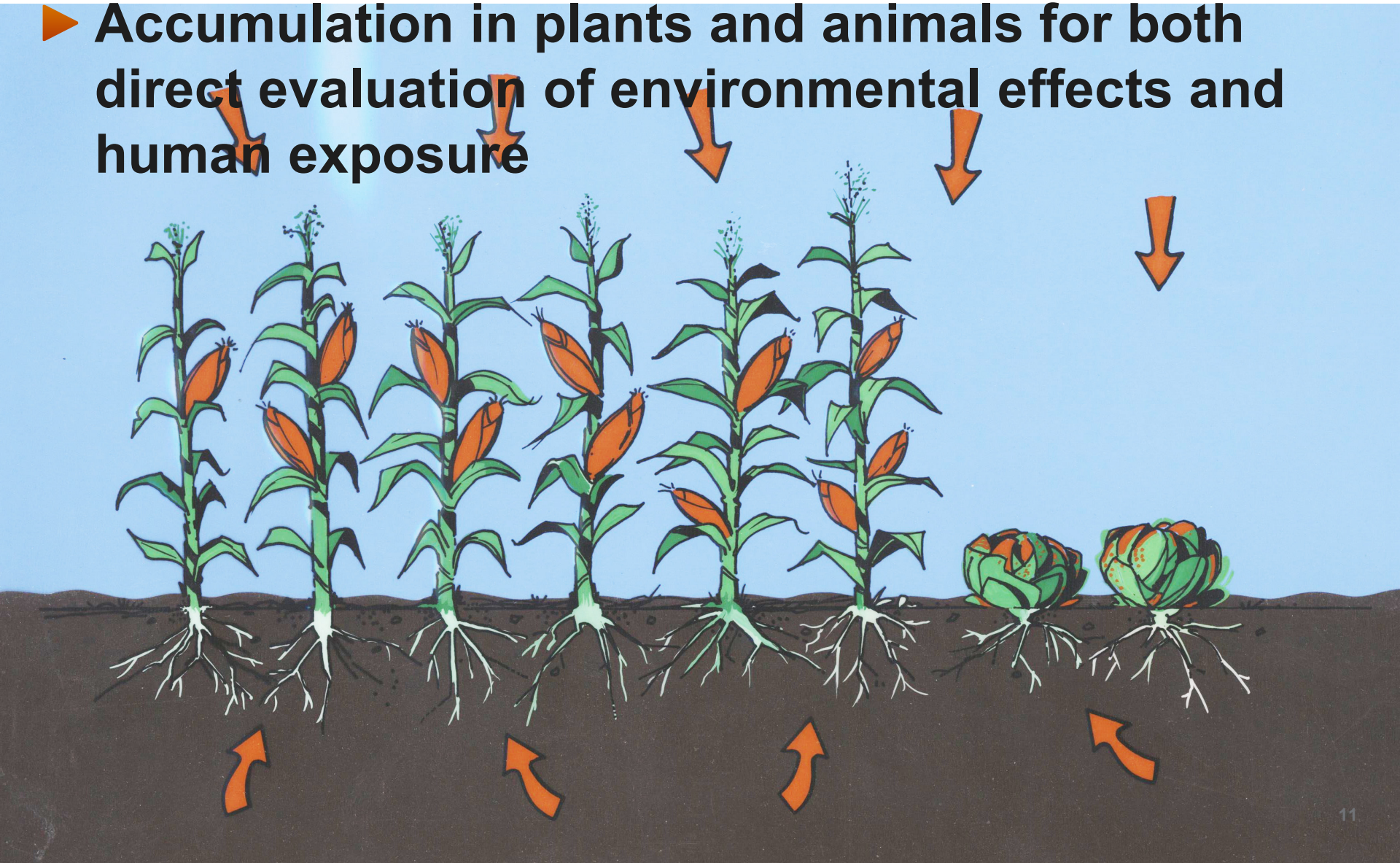
- **Accumulation in plants and animals for both direct evaluation of environmental effects and human exposure**



Human Intrusion

- Models for evaluating transfer of buried waste to soil surface; resuspension; etc.

Human Exposure Pathways

- External
  - Transported air
  - Soil
  - Swimming
  - Shoreline
- Inhalation
  - Transported air
  - Resuspended soil
  - Volatilized indoor air pollutants from water

Human Exposure Pathways

- Ingestion
  - Leafy vegetables
  - Other vegetables
  - Fruit
  - Grain
  - Meat
  - Milk
  - Poultry
  - Eggs
  - Fish
  - Crustaceans
  - Molluscs
  - Aquatic plants
  - Drinking water
  - Shower water
  - Swimming water
  - Soil

GENII V.2 Acute-Deposition Food Pathways

- GENII V.2 Results presented for 4 seasons (Winter/spring/summer/autumn)
- "Seasons" are surrogates for complex sets of underlying assumptions about plant growth, weathering, uptake, and time-to-harvest
- Selection of season depends on meteorological input (this is related to the uncertainty capability)
- *Seasons below the equator are reversed! A minor change in an external file to adjust…*

GENII V.2 Human Exposure

- Up to 6 age groups allowed, following ICRP-56,67,69

3 months	0-1 year
1 year	1-2 year
5 year	2-7 year
10 year	8-12 year
15 year	13-17 year
20 + year	17- 110 year

External Exposure - Doses

- Dose rate conversion factors from Federal Guidance Report 12, provided by Keith Eckerman, ORNL
  - Air Submersion
  - Water Immersion
  - Soil Plane
  - Soil Volume

Internal Exposure - Doses

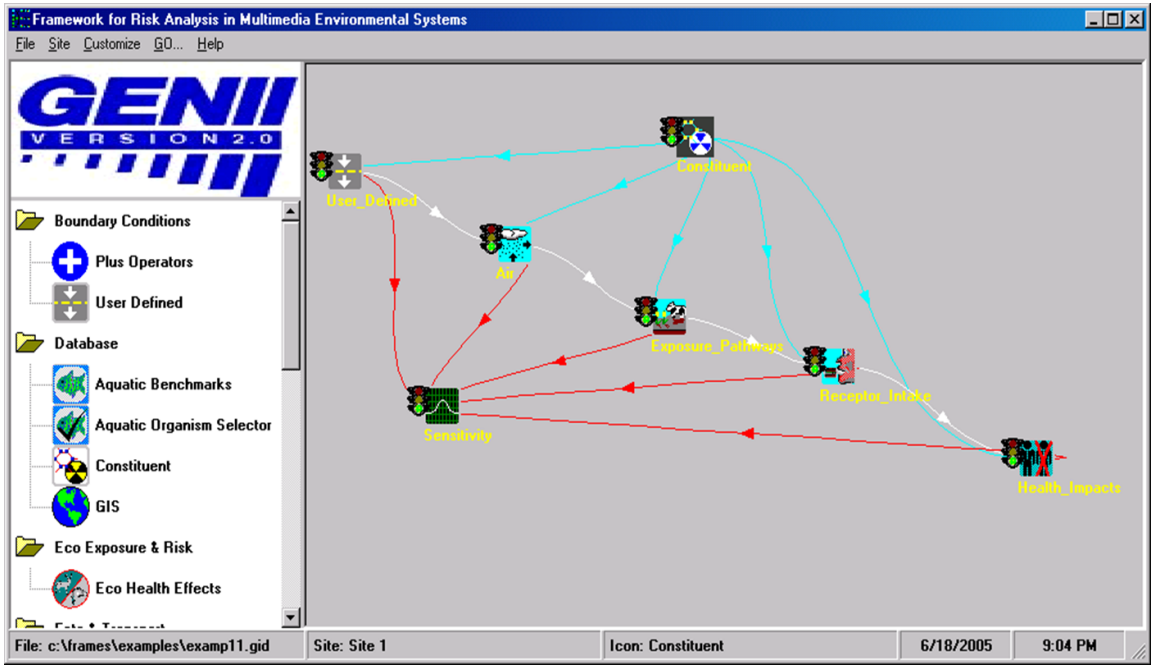
- Effective dose equivalent: ICRP-30
  - Adult only
- Effective dose: ICRP-72
  - 6 age groups
  - 24 organs/tissues
  - Inhalation classes F, M, S

Risk Calculations - FGR 13

- US Federal Guidance Report 13 provides coefficients for 15 cancer sites
  - Inhalation (risk/Bq)
    - Inhalation classes F, M, S
  - Ingestion (risk/Bq)
    - Accounts for different consumption patterns with age
      - Drinking water
      - Food crops

GENII V.2 Uncertainty Analysis

- Parameter uncertainty and sensitivity may be addressed using the SUM^3 processor in FRAMES.
- All non-control parameters are allowed to be varied, using description files to define 'available' parameters
- Acute atmospheric releases are an important subset. SUM^3 is used to vary start times, creating distribution functions of dose.



GENII Version 2: A General Purpose Environmental Dosimetry Tool

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New Features – Upcoming Release

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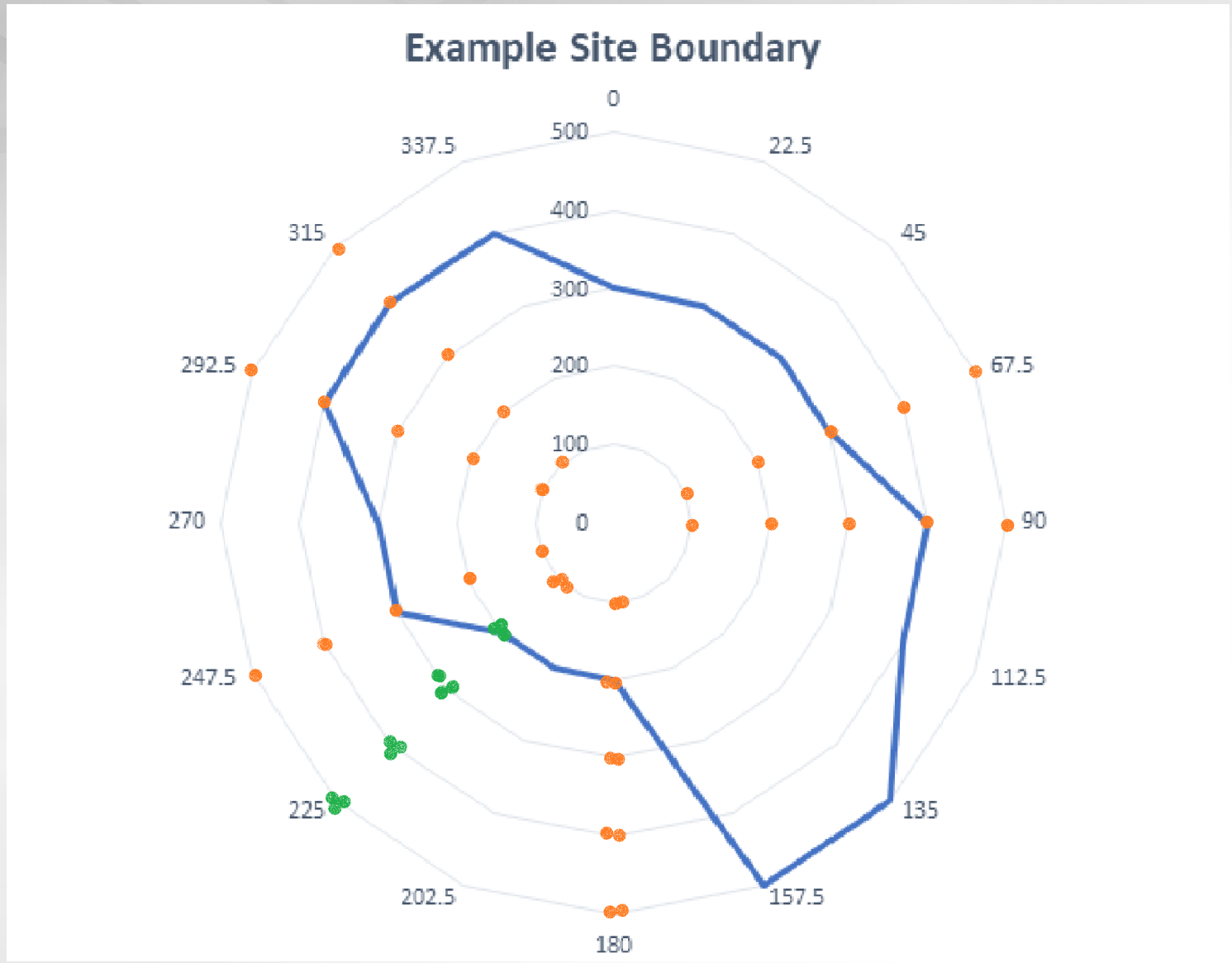
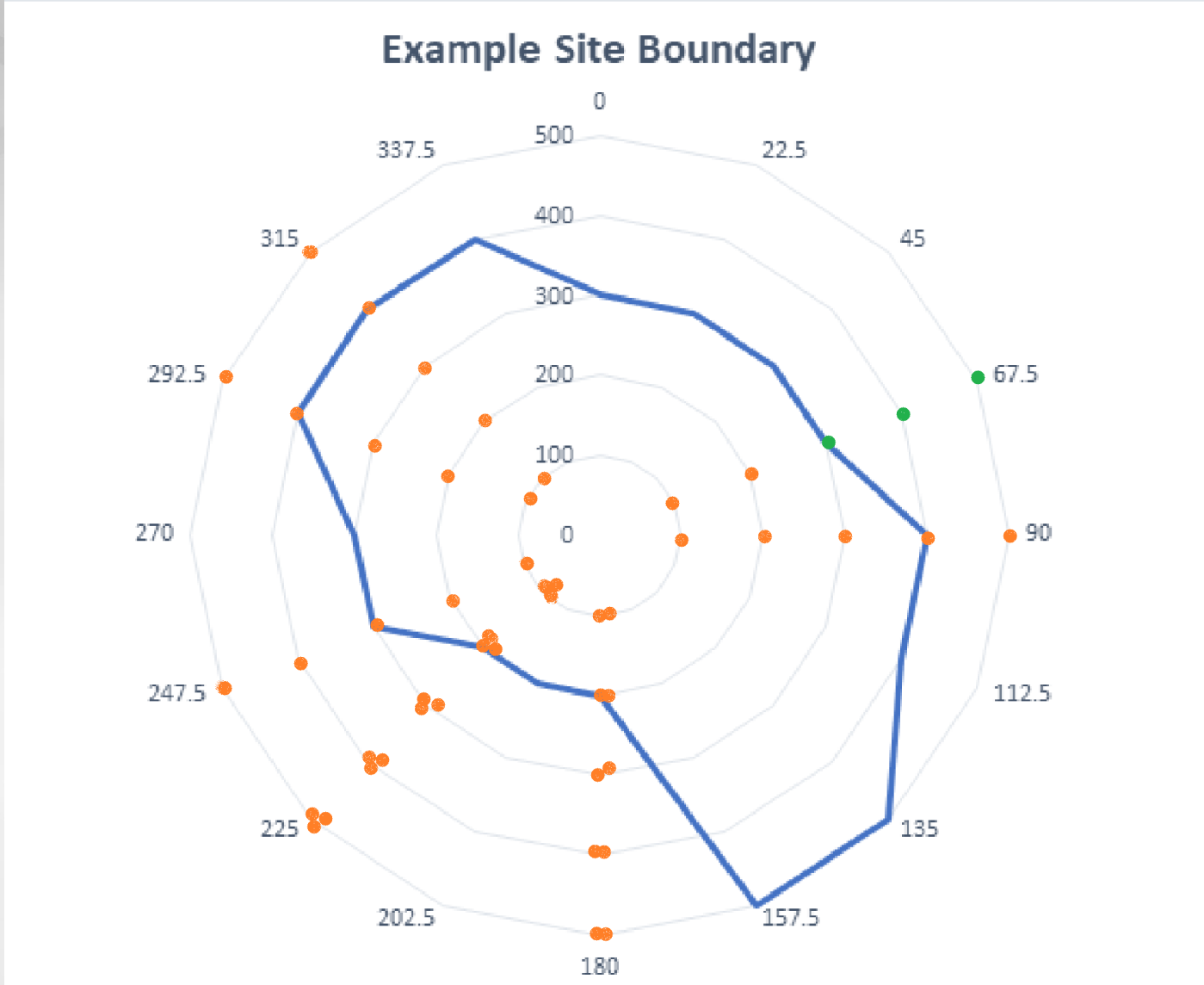
- New options within the Air Module
  - General Model : DOE Acute 95th Percentile
  - Allows original GENII Calculations or
    - DOE/NRC Irregular Boundary – Outside the Fence (Public)
    - DOE/NRC Irregular Boundary – Inside Fence (Worker)
    - NRC 99.5th Maximum Sector (Public)
    - NRC 99.5th User Defined Sector (Public)

Allows for estimates accounting for a site boundary that is an irregular shape defined in 16 directions

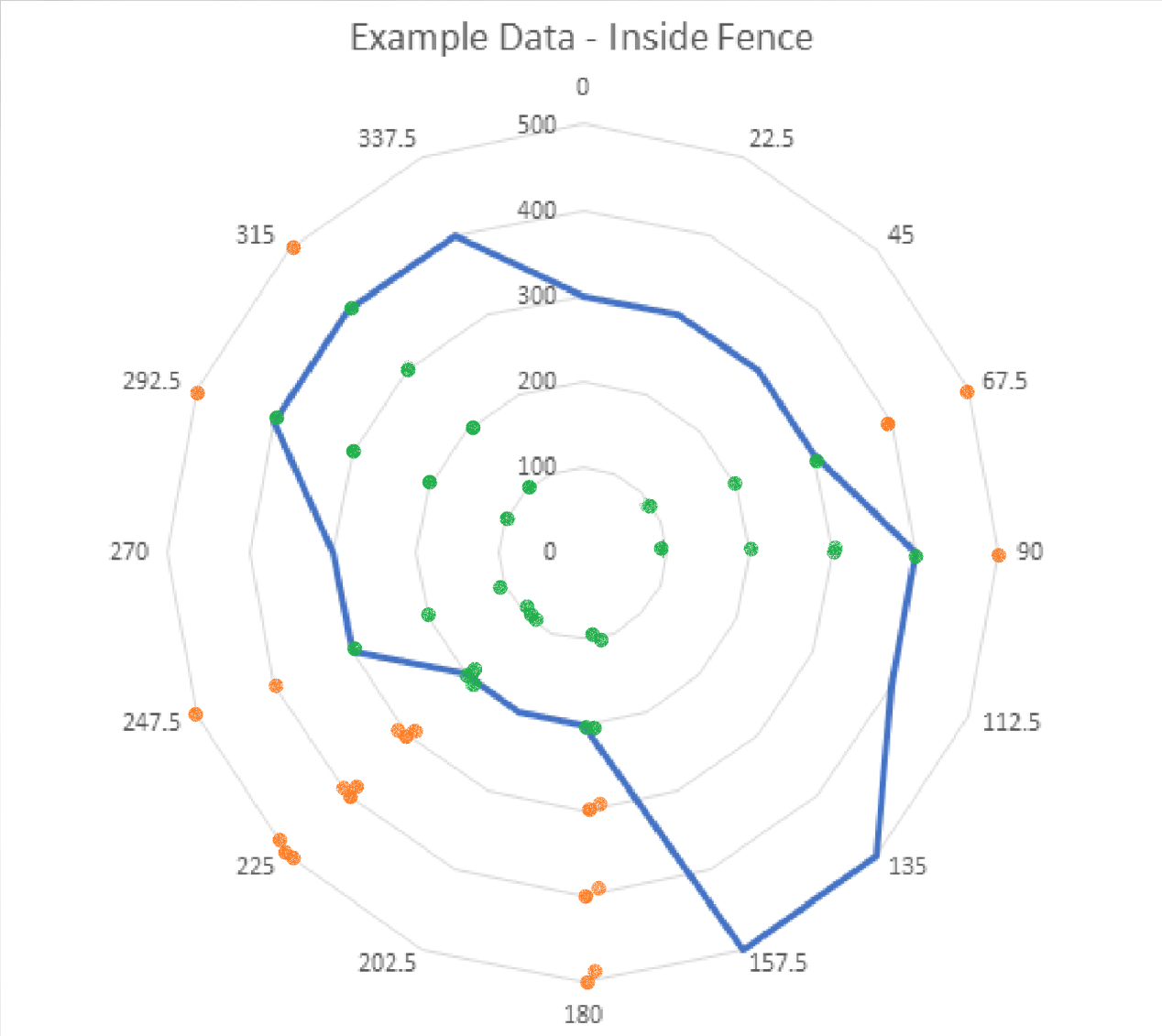
NRC 99.5th Maximum Sector



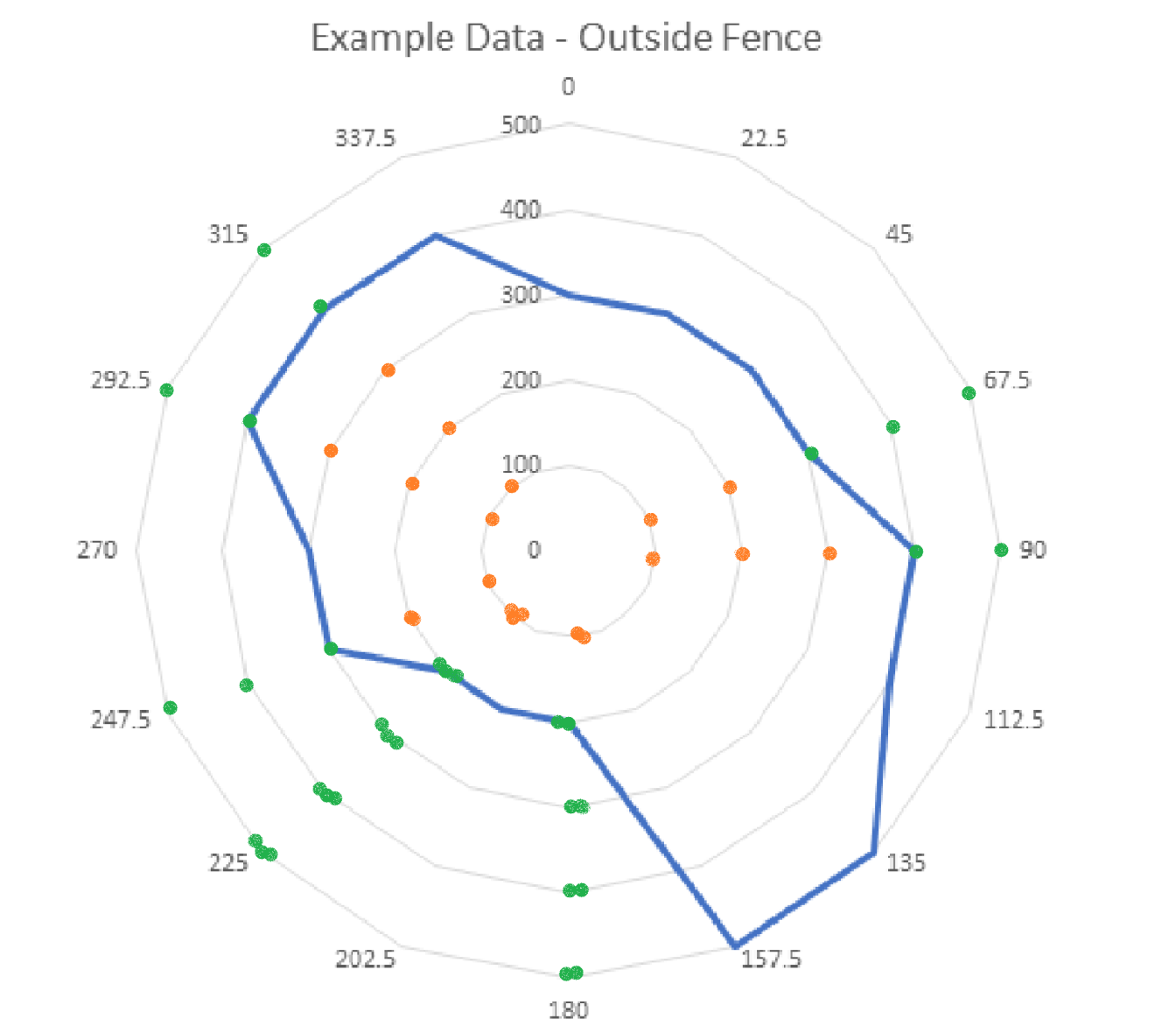
NRC 99.5th User Defined Sector



DOE/NRC Irregular Boundary – Inside Fence



DOE/NRC Irregular Boundary – Outside Fence



Questions?