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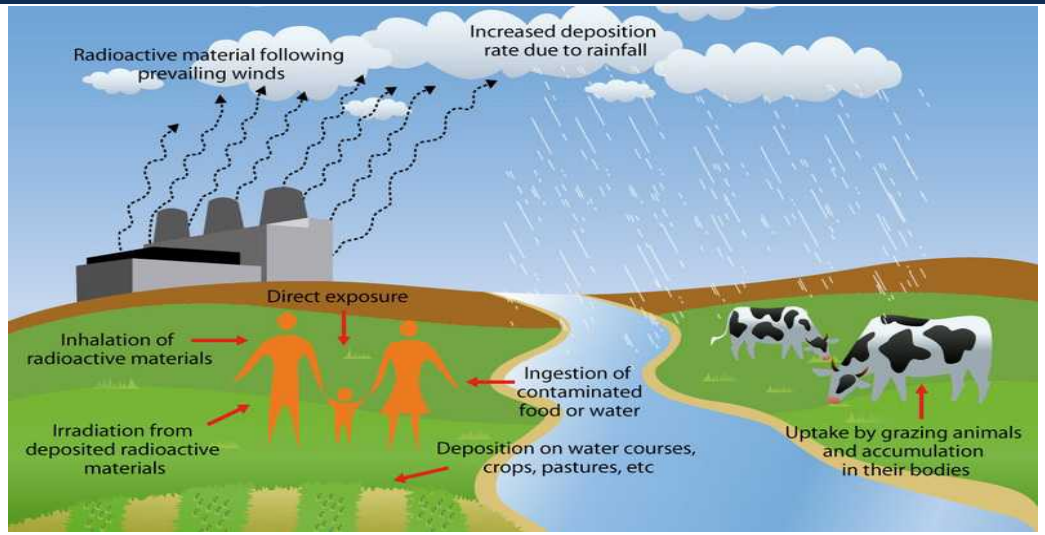

Level-3 Consequence Analysis Part 3 Protective Measures

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Objectives

- Distinguish between the three phases of the accident for the application of protective measures
- List the various zones that can be modeled and their spatial relationship
- List the mitigative measures available in each phase and their general objectives
- Understand how different portions of the public can be treated via different cohorts

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Outline

- Introduction to Protective Measures
- MACCS2 Modeling
- Emergency-Phase Actions
- Intermediate-Phase Actions
- Long-Term-Phase Actions

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Introduction to Protective Measures

- Mitigative actions are protective measures designed to reduce exposures and health effects
- Mitigative measures in MACCS are divided into three phases (as defined by the EPA) with different protective actions possible in each phase
  - Emergency phase – up to one week from the beginning of an accident
  - Emergency-phase protective actions are called emergency-response (ER) actions
    - Evacuation
    - Sheltering
    - Temporary relocation

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Introduction to Protective Measures (cont.)

- Intermediate phase - begins immediately after the emergency phase and extends up to 1 year
  - Continuation of temporary relocation when projected dose exceeds the user specified limit
- Long-term phase - follows the intermediate phase
  - Mitigative actions attempt to reduce long-term health effects
    - Decontamination*
    - Temporary interdiction*
    - Condemnation*
    - Crop disposal
    - Restricted crop production

* Long-term exposure is based on groundshine and resuspension inhalation

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MACCS2 Modeling of Phases

- ATMOS does not model a phase directly but provides necessary information to EARLY and CHRONC:
- The Emergency Phase is modeled by EARLY.
  - Duration is specified by user
  - Extends up to one week after the arrival of the first plume at a spatial location
- EARLY can model up to twenty emergency response cohorts.

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MACCS2 Modeling of Phases (cont.)

- CHRONC models intermediate and long-term phases.
- These combined, weighted results are termed the “overall combined” results.
- The discussion in the balance of this section is for a single emergency response cohort.

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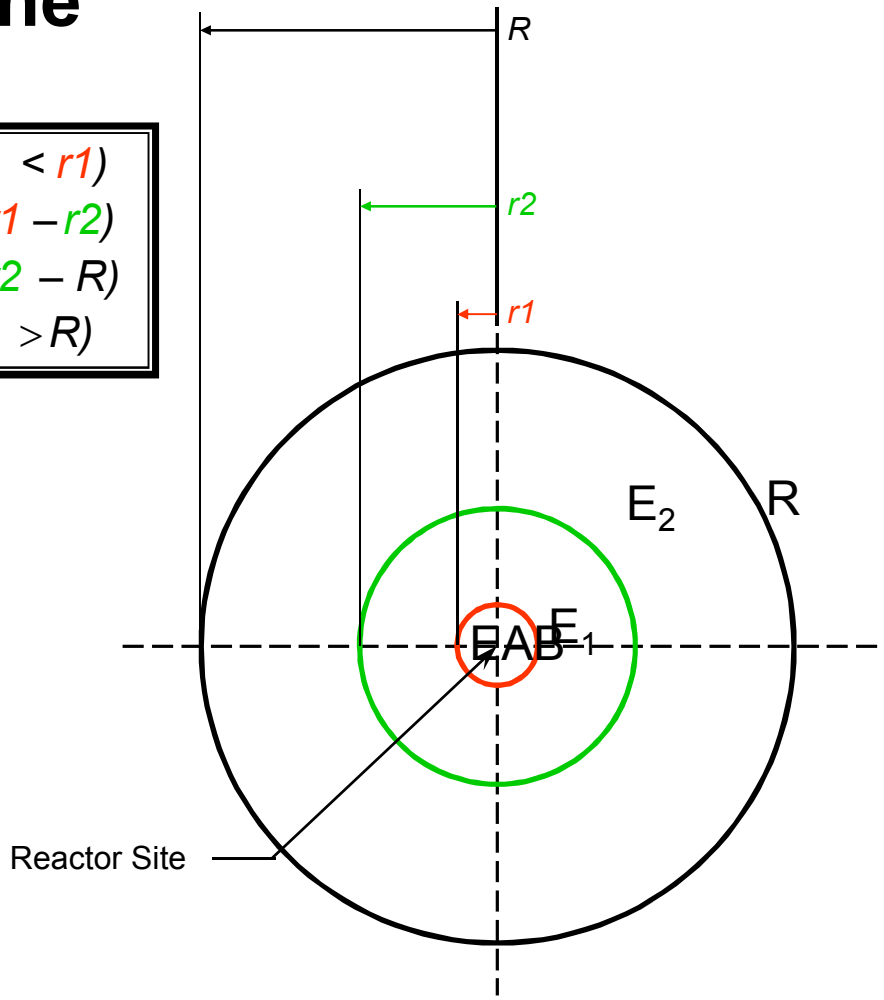
Emergency Planning Zone

Exclusion Area Boundary	(< *r1*)
↗ E_1: Emergency Planning Zone (EPZ)	(*r1* – *r2*)
↗ E_3: Shadow Evacuation Zone	(*r2* – *R*)
↗ R: Relocation Zone	(> *R*)



- The exclusion area boundary is bounded by *r1*.
- Evacuation and sheltering generally occur within the EPZ.
- Shadow or ad hoc evacuation may occur beyond the EPZ.
- Relocation applies to all spatial elements beyond the evacuation or sheltering zones.

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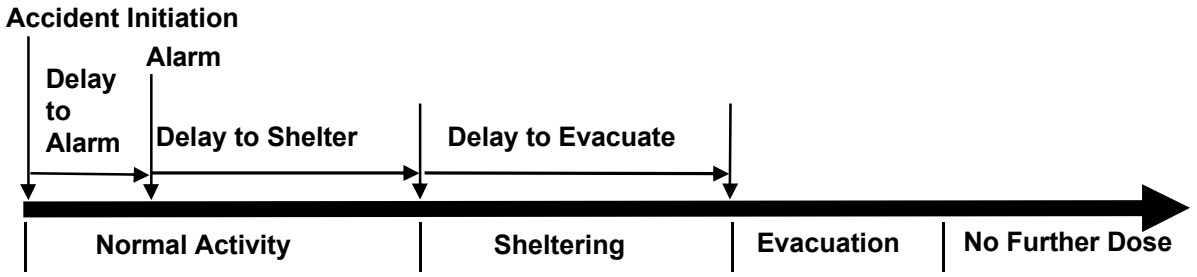
Shielding Factors

- Specified for each of three groups
  - Evacuees
  - People taking shelter
  - People continuing normal activity
- Shielding factors are multipliers in dosimetry calculations for each pathway and activity
  - Cloudshine
  - Groundshine
  - Inhalation
  - Skin
- Typical relationship

  1.0 ≥ SFs for evacuees ≥ SFs for normal activity ≥ SFs for sheltering ≥ 0.0

Sheltering and Evacuation

- First period: Delay time prior to sheltering (user-specified for each zone)
  - Normal activity (and normal activity shielding factors) assumed
  - Delay time is from off-site alarm time
- Second period: Delay time prior to evacuation (user-specified for each zone)
  - Shielding factors for sheltering are used
  - Delay time is from beginning of sheltering



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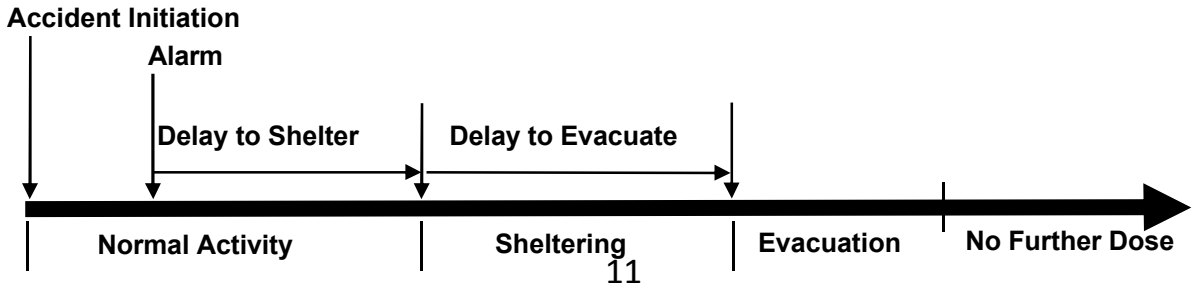
Sheltering and Evacuation (cont.)

- Third period: Evacuation
  - Speeds are user specified and can vary with
    - Three subphases
    - Weather
    - Grid element
  - Evacuation is to (user-specified) distance from reactor site
  - Evacuating shielding factors apply
  - Exposure to plume depends on location relative to front and back of plume
- Fourth period: After evacuation
  - Following evacuation, evacuees avoid further exposure in EARLY



Sheltering and Evacuation (cont.)

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- Fifth period: After end of Emergency Phase
  - Evacuees move back to original spatial element if habitability criterion satisfied.
  - Population unaffected by plume effectively are not evacuated.
  - Any additional exposures are from long-term exposure pathways.

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Intermediate Phase

- The Intermediate Phase begins at the end of the Emergency Phase
- Extends for a user-specified interval of time
- Optional (interval can be set to zero)
- Relocation is the only mitigative action during intermediate phase
- Relocation criterion parameters
  - Dose limit
  - Critical organ

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Long-Term Phase

- Initiation
  - End of intermediate phase
  - At the end of the emergency phase if there is no intermediate phase
- Mitigative actions depend of the following:
  - Projected doses
  - Cost-effectiveness of the action
- Decontamination worker doses are calculated for
  - Farmland
  - Non-farm properties

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Decontamination and Temporary Interdiction

- Habitability criterion
  - Based on dose projection over a user-specified time period
  - Land is habitable when projection is less than dose limit
  - Population is present for rest of long-term phase when habitability criterion is met
  - Mitigative actions are considered in order when the habitability criterion is not met
    - Decontamination (three levels of increasing effectiveness)
    - Period of interdiction following the maximum decontamination
      - Atomic decay
      - Weathering
    - Condemnation of land

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Long-Term Ingestion Doses

- Three mitigative actions are modeled for farmland.
  - Removal of farmland from production when uninhabitable
  - Removal of farmland from production when too contaminated to grow crops (not farmable)
  - Disposal of milk and/or crops during growing season
- The user specifies the maximum allowable food doses.
  - Short-term milk dose
  - Short-term food dose (other than dairy)
  - Long-term dose from all food

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Long-Term Ingestion Doses (cont.)

- Farmland is condemned if
  - Land cannot be restored to habitability
  - Costs of decontamination and interdiction exceed farm value
- User-specified limits affect
  - Milk disposal
  - Crop disposal
  - Ability to farm

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