

Exacting the Science of Emergency Preparedness

International MACCS User Group (IMUG) Meeting
September 20, 2022

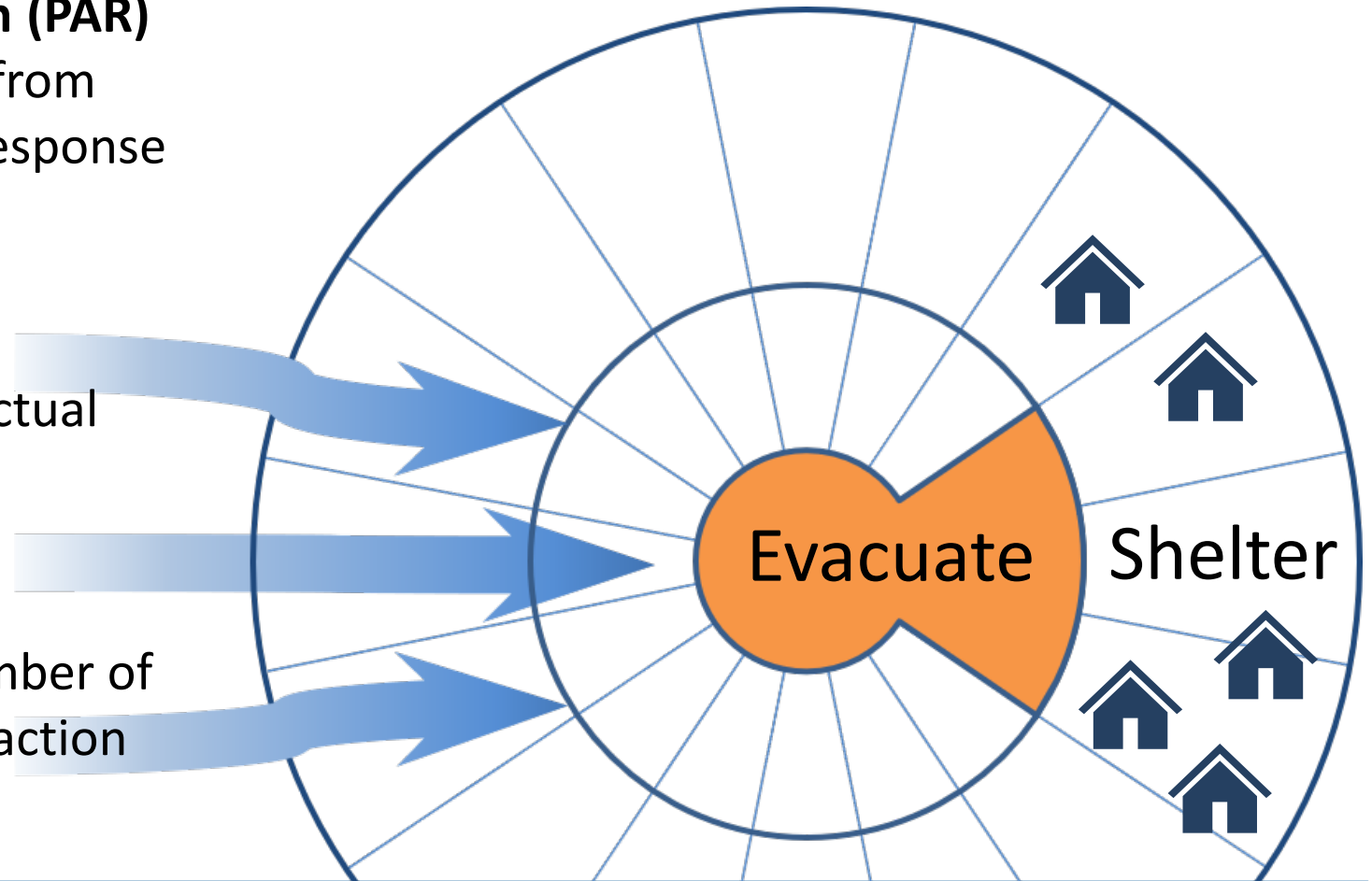
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U.S. Nuclear Regulatory Commission

Deciding on action

Protective Action Recommendation (PAR)
recommended protective measure from
the nuclear power plant to offsite response
organizations (OROs)

Protective Action Decision (PAD)
measures taken in response to an actual
or anticipated radiological release

Protective Action Guide (PAG)
projected dose to an individual member of
the public that warrants protective action



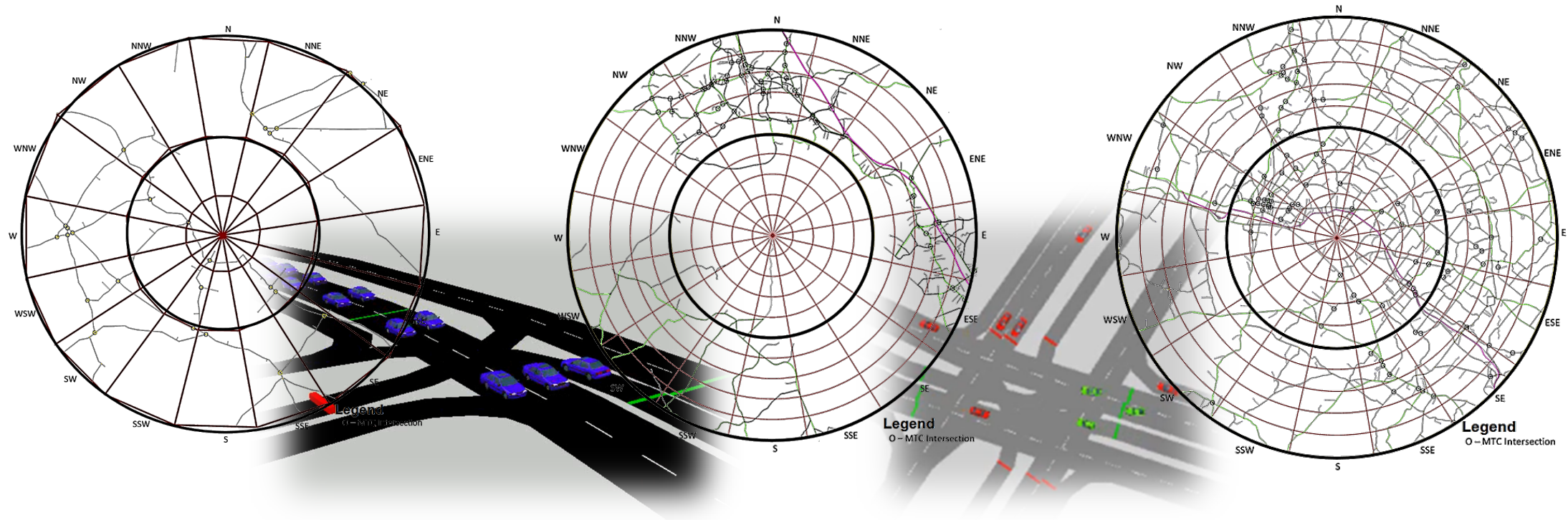
NRC research enhances emergency preparedness

- Protective Action Decisionmaking in the Intermediate Phase (NUREG/CR-7248)
- Evacuation Time Estimate Study (NUREG/CR-7269)
- Emergency Planning Zone (EPZ) Size Methodology
- Sensitivity of Dose Projections to Weather
- Analysis of the Effectiveness of Sheltering-in-Place
- Use of Heating and Ventilation Systems while Sheltering-in-Place
- Dose Reduction Effectiveness of Masks
- Nonradiological Health Impacts of Evacuations and Relocations (NUREG/CR-7285)
- MACCS Consequence Model Improvements Impact on Protective Action Strategies

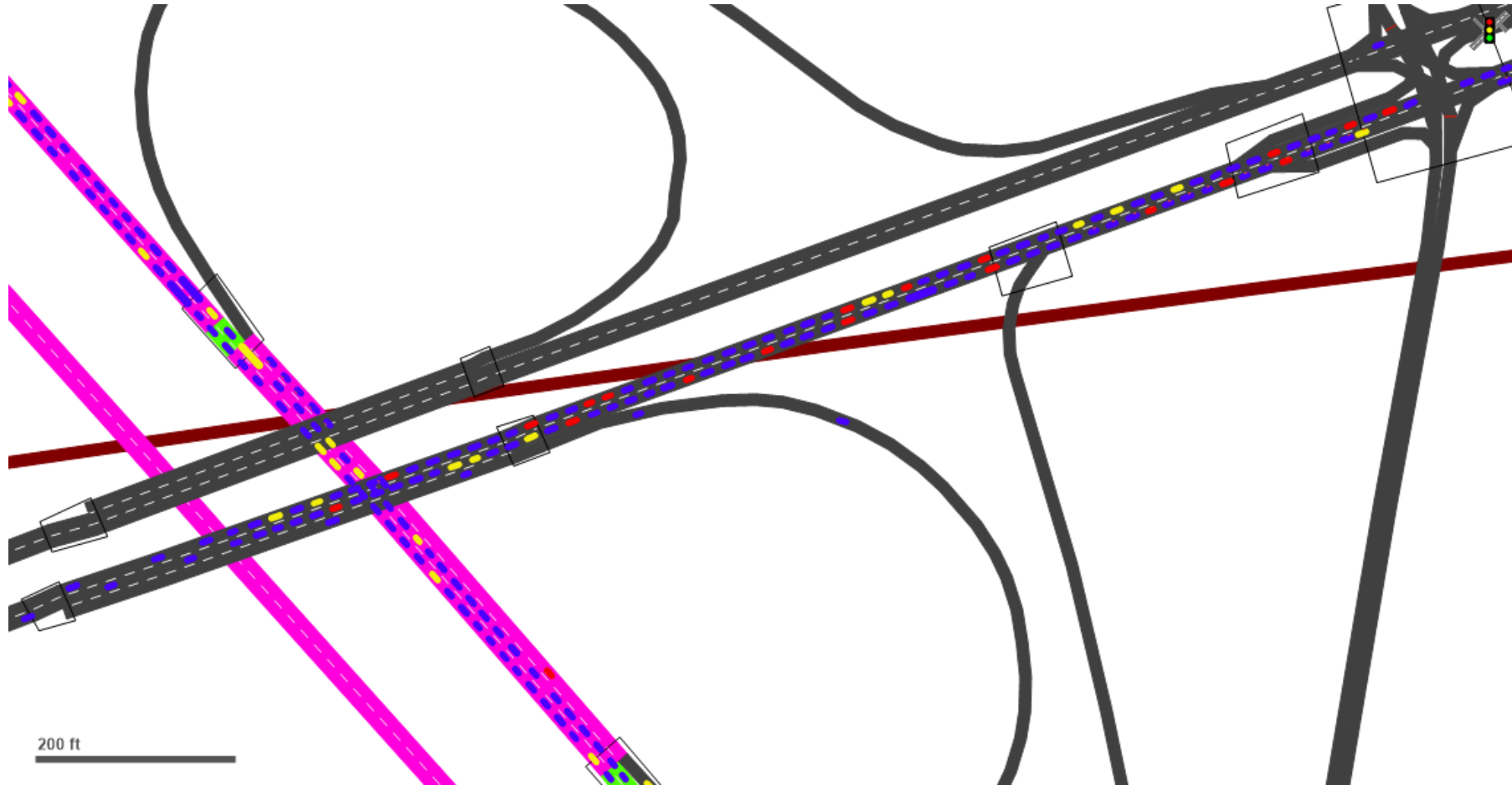
Providing insights into effective evacuation

NUREG/CR-7269, “Enhancing Guidance for Evacuation Time Estimate Studies”

State-of-the-art traffic simulation models used to better understand evacuation dynamics and to develop insights for protecting the public and first responders

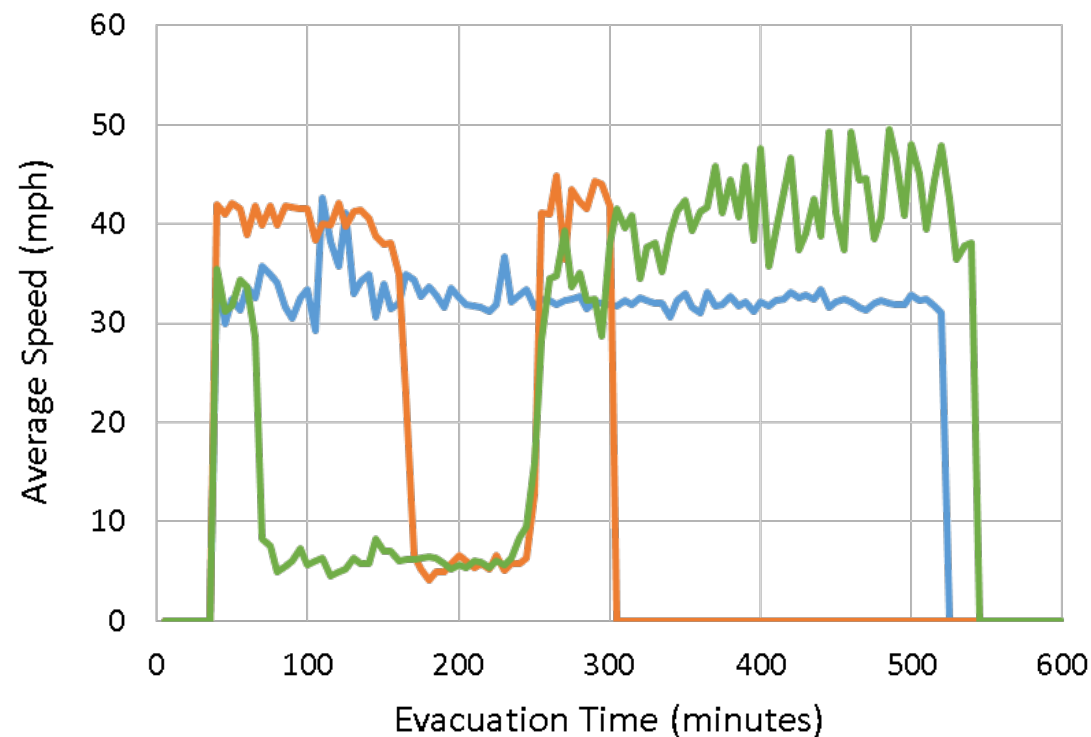
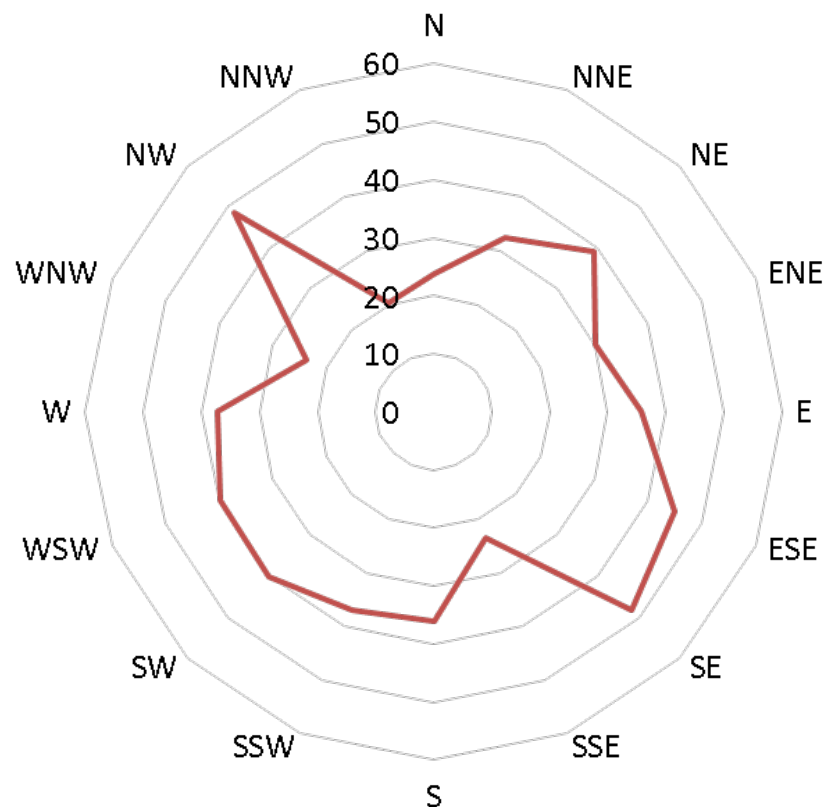


Traffic models can provide cohort data



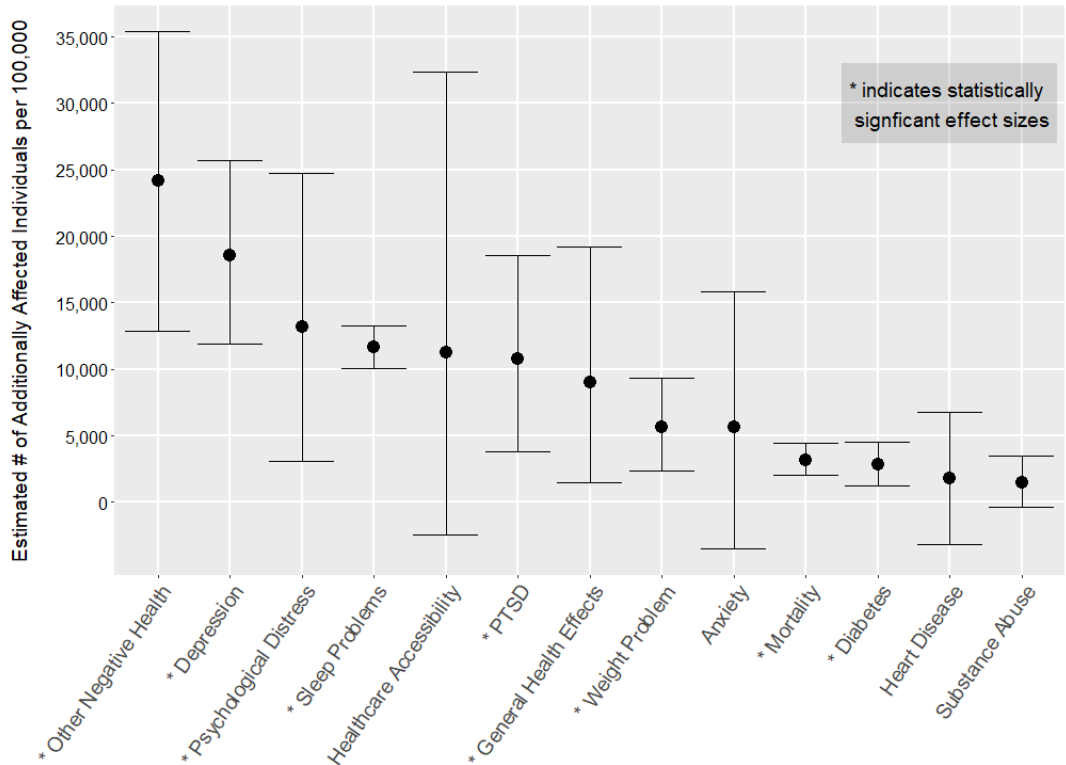
Traffic models provide vehicle speed data

Spatial and Temporal Speed Data Representations

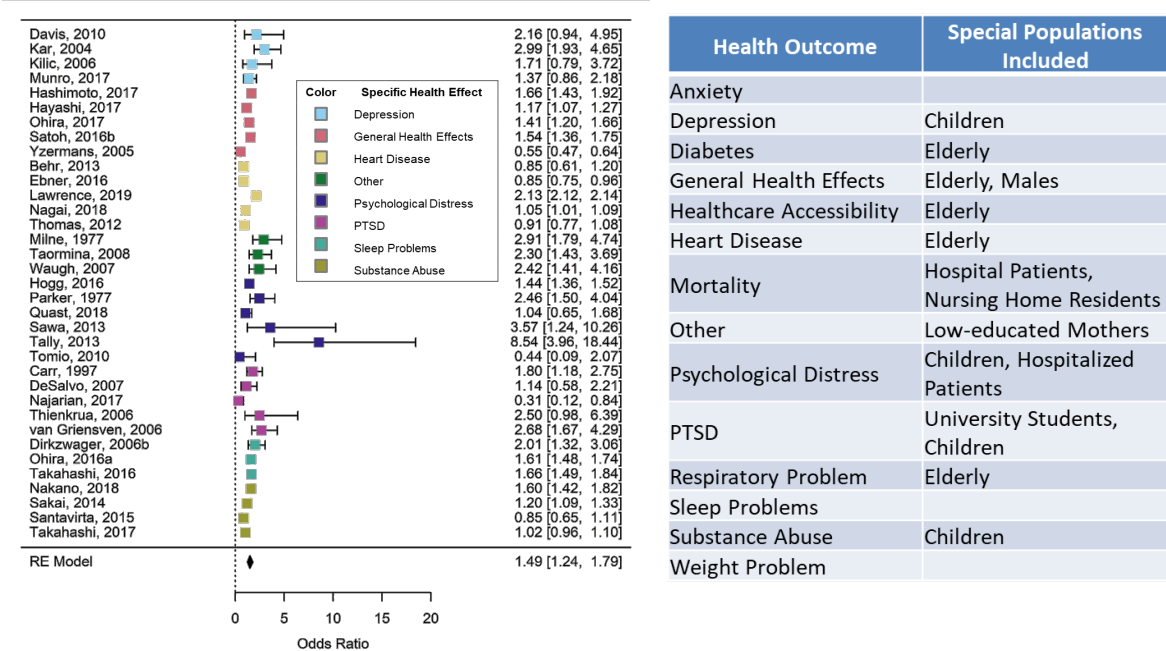


Assessing the balance of the risk

NUREG/CR-7285, “Nonradiological Health Consequences of Evacuation and Relocation” Meta-analysis of the impact of prolonged displacement across all types of emergency events



Meta-analysis of Odds Ratio for All Health Effects



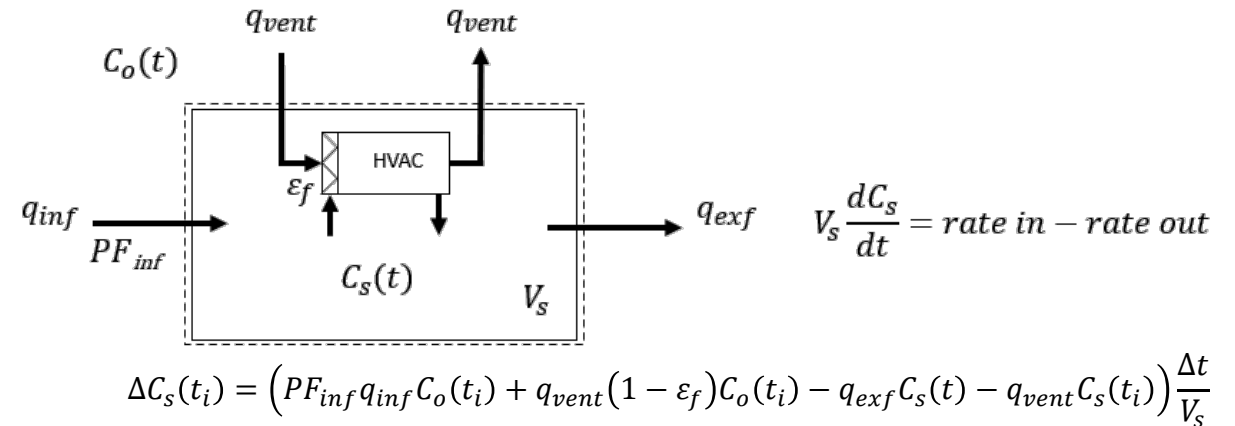
Health Outcome	Special Populations Included
Anxiety	
Depression	Children
Diabetes	Elderly
General Health Effects	Elderly, Males
Healthcare Accessibility	Elderly
Heart Disease	Elderly
Mortality	Hospital Patients, Nursing Home Residents
Other	Low-educated Mothers
Psychological Distress	Children, Hospitalized Patients
PTSD	University Students, Children
Respiratory Problem	Elderly
Sleep Problems	
Substance Abuse	Children
Weight Problem	

Analyzing the protection of shelters

Current dose reduction factors estimate shelter effectiveness



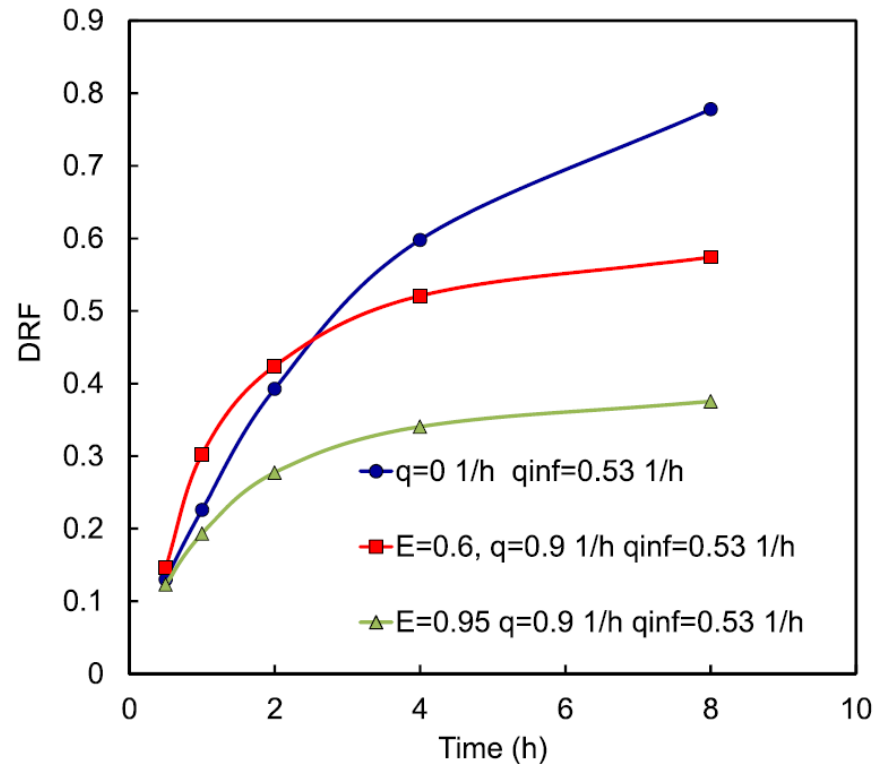
U.S. EPA. EPA-400/R-17/001, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents," Office of Radiation and Indoor Air, January 2017.



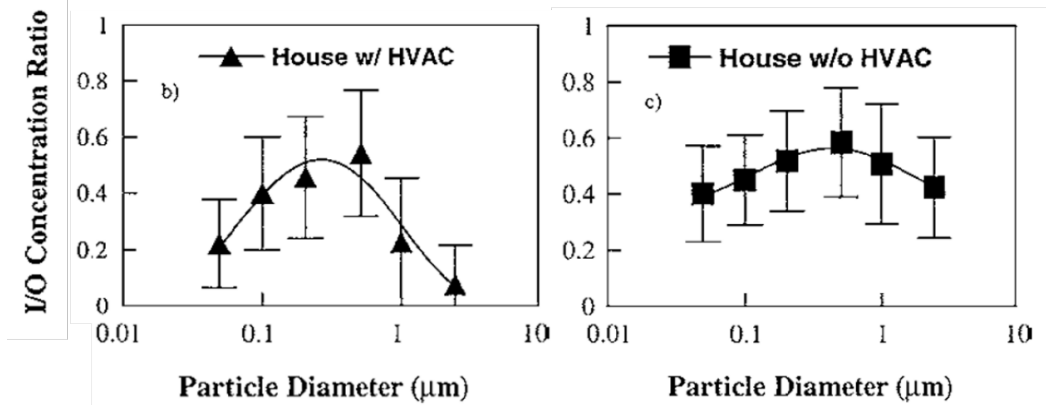
Shelter effectiveness can also be examined through dynamic models and lessons from other hazards to provide additional insight

Smith, Todd R. *Transforming Protective Action Strategies for Radiological Emergencies—Exacting the Science of Sheltering-in-Place*. Oregon State University, 2021.

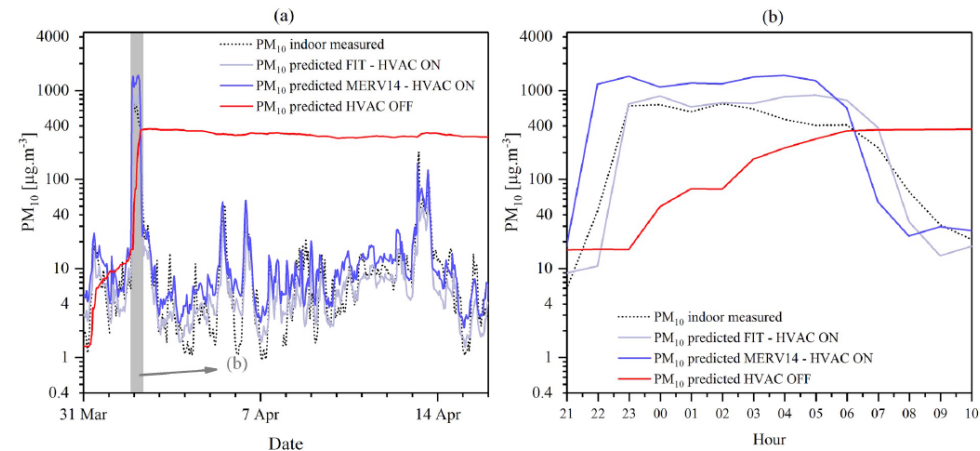
Exploring effective use of shelters and ventilation



Modeled office building (Kulmala, 2016)



Monte Carlo simulations (Thornburg, 2001)

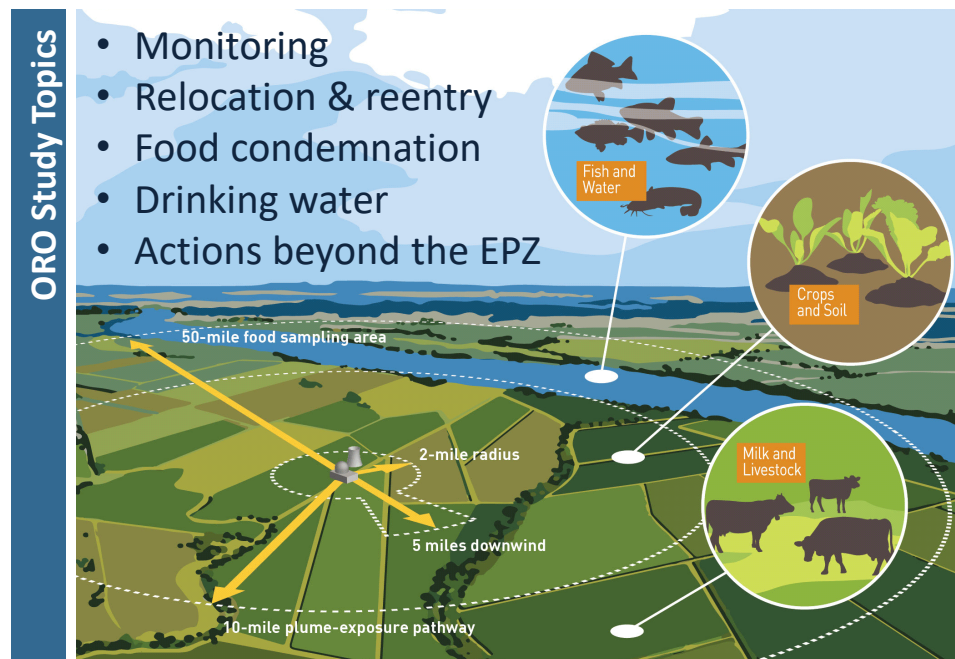


Dust storms (Argyropoulos, 2020)

Gathering and sharing best practices

NUREG/CR-7248, “Capabilities and Practices of Offsite Response Organizations for Protective Actions in the Intermediate Phase of a Radiological Emergency Response”

Shared understanding of offsite response organization capabilities and practices for protecting the public after the emergency phase



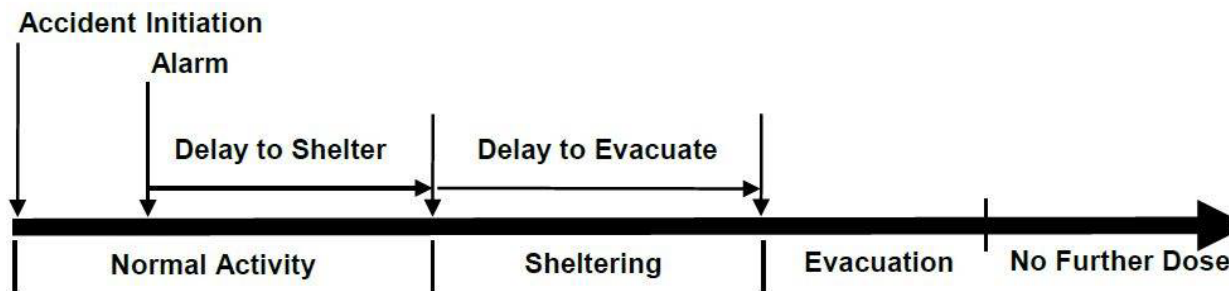
Best Practices identified for—

- Communicating with the public
- Developing partnerships and sharing resources for monitoring
- Making situation-dependent decisions based on science
- Leveraging technology
- Assisting vulnerable populations, livestock, and pets

Modeling EP in MACCS to inform protection strategies

Emergency Phase Modeling

- Protective actions (evacuation, sheltering, relocation, KI)
- Cohort timeline (general population, schools, special facilities, evacuation tail, shadow evacuees, non-evacuees)



How parameters are informed

- Evacuation time estimate (ETE) studies and traffic simulation models (NUREG/CR-7269)
- MACCS modeling best practices
- Discussions with state and local authorities (NUREG/CR-7248)

Providing evidence to support protective actions

WHERE TO GO IN A RADIATION EMERGENCY

If a radiation emergency happens in your area, you should get inside immediately.

No matter where you are, the safest action to take is to: **GET INSIDE. STAY INSIDE. STAY TUNED.**

- Close and lock all windows and doors.
- Go to the basement or the middle of the building. Radioactive material settles on the outside of buildings; so the best thing to do is stay as far away from the walls and roof of the building as you can.
- If possible, turn off fans, air conditioners, and forced-air heating units that bring air in from the outside. Close fireplace dampers.
- Bring pets inside.
- Stay tuned for updated instructions from emergency response officials.

Adapted from Ventura County Public Health, Ventura County, CA

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
<http://emergency.cdc.gov/radiation>

Shelter-in-Place for Multistory Buildings

Includes condos, apartments, offices, and schools

Active Shooter
Shelter-in-Place: **Run. Hide. Fight.**
What to do: **Run** away from shooter. Call 911 if safe to do so. **Hide** if you cannot get away safely. Silence electronic devices. Lock and block doors, close blinds, turn off lights. **Fight** as a last resort.
How long to stay: If you are not able to run to safety, stay in place until law enforcement gives you notice that the danger is over.

Hurricane (High Wind, Flooding, Storm Surge)
Shelter-in-Place: Go to a sturdy building. For high wind go to a windowless room on the lowest level. For flooding go as high as possible but not into the attic.
What to do: For high wind, go to a small, interior, windowless room in the lowest level.
How long to stay: Stay inside until local authorities provide other instructions.

Thunderstorm
Shelter-in-Place: Stay inside.
What to do: Pay attention to weather reports. Be ready to change plans if necessary. Unplug appliances, avoid using running water or landline phones.
How long to stay: For the length of the storm.

Winter Storm
Shelter-in-Place: Stay inside. Limit time outside.
What to do: Avoid carbon monoxide poisoning by using generators and grills ONLY outdoors, 20 feet from the house and away from windows. Never heat a building with a gas stove top or oven.
How long to stay: For the length of the storm.

Flooding
Shelter-in-Place: Go to the highest level in the building but not in the attic. If the floodwaters rise to a dangerous level, get on the roof and call 911.
What to do: Listen for current emergency information and instructions. Use a generator or other gasoline-powered machinery ONLY outdoors and away from windows.
How long to stay: Stay inside until authorities indicate it is safe to leave.

Flash Flooding
Shelter-in-Place: Go to the highest level in the building but not in the attic. If the floodwaters rise to a dangerous level, get on the roof and call 911.
What to do: Listen for current emergency information and instructions. Use a generator or other gasoline-powered machinery ONLY outdoors and away from windows.
How long to stay: Stay inside until authorities indicate it is safe to leave.

Pandemic
Shelter-in-Place: Stay Home. Minimize access to your home from anyone not isolating with you.
What to do: Reduce trips outside to only essential requirements. Clean surfaces often with disinfectant. Wash hands for 20 seconds frequently with soap. Avoid touching your eyes, nose, or mouth. Gather supplies in case you need to stay home for several days or weeks. If you must go to an office, campus, or live in a multi-story building, make sure to wear a mask and keep a physical distance of at least 6 ft apart.
How long to stay: As advised by local public health officials.

Chemical Hazard
Shelter-in-Place: Stay inside your home and seal the room. Use duct tape around the windows and doors to make an unbroken seal. Tape over vents and electrical outlets.
What to do: Lock all doors and windows. Drink stored water, not water from the tap. Turn off the air conditioner, heater, and fans. Close the fireplace damper and seal off any other place where air may come in from outside.
How long to stay: A shelter in place will last approximately 12 hours or less, rarely will it go longer.

Earthquake
Shelter-in-Place: Stay where you are and take cover. Get under and old on to sturdy furniture until the shaking stops. Protect the head and neck with arms.
What to do: Drop, Cover and Hold On. If in a bed, turn onto stomach and cover your head and neck with a pillow.
How long to stay: For the length of the earthquake.

Nuclear/Radiological
Shelter-in-Place: Go to the basement or middle of the building. Stay away from the outer walls and roof. Take shelter in the basement, underground parking garage, or other lowest level in the structure.
What to do: Remove contaminated clothing and wipe off or wash unprotected skin if you were outside after the fallout arrived.
How long to stay: Stay inside for 24 hours unless local authorities provide other instructions.

Tornado
Shelter-in-Place: Go to basement or lowest level in the structure. Go to a small, interior, windowless room in a sturdy building on the lowest level.
What to do: Protect your head and neck. Take additional cover by putting blankets around you.
How long to stay: Stay inside until weather forecasts and local authorities say it is safe to do so. Use extreme care when leaving a building as there may be dangerous debris.

Visit <https://community.fema.gov/ProtectiveActions/s/> for more information.

For more information

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2. U.S. NRC. NUREG/CR-7269, “Enhancing Guidance for Evacuation Time Estimate Studies,” January 2020. <https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7269/index.html>
3. U.S. EPA. EPA-400/R-17/001, “PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents,” Office of Radiation and Indoor Air, January 2017. https://www.epa.gov/sites/default/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf
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6. U.S. Federal Emergency Management Agency. “Protective Actions Research,” Web page, last accessed January 2022. <https://community.fema.gov/ProtectiveActions/s/>