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Evacuation Time Estimates

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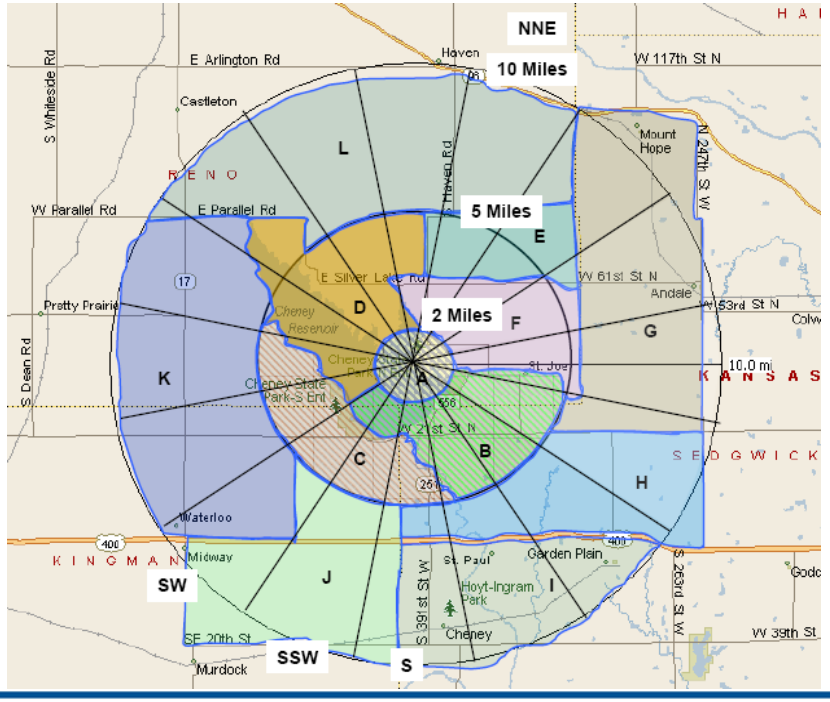
What is an Evacuation Time Estimate (ETE)?

Analyses of the time required to evacuate various sectors and distances within the plume exposure pathway emergency planning zone (EPZ).

- Used to inform protective action recommendations in the event of an emergency
- Required by 10 CFR 50 App. E and 50.47(b)(10)
- NRC's current guidance in NUREG/CR-7002



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ETE Study

Applied research study to examine topics associated with the modeling and simulation of evacuations and independent verification of the NRC's methodology for ETE development.

Who is Performing the Study?

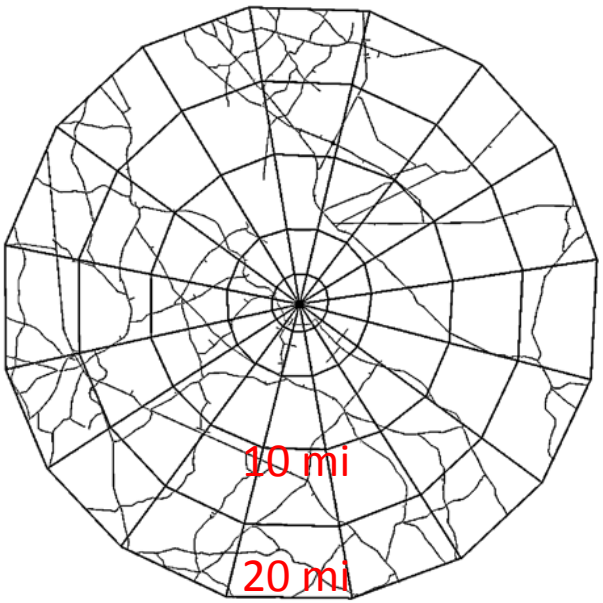
- Transportation and evacuation experts at Louisiana State University

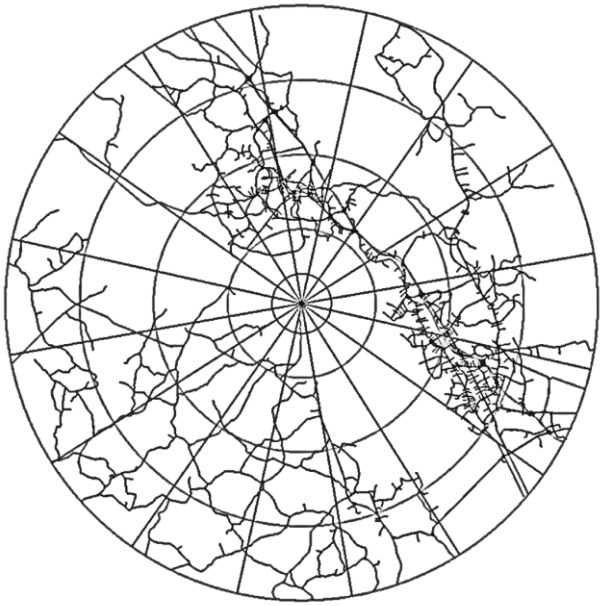
Methodology

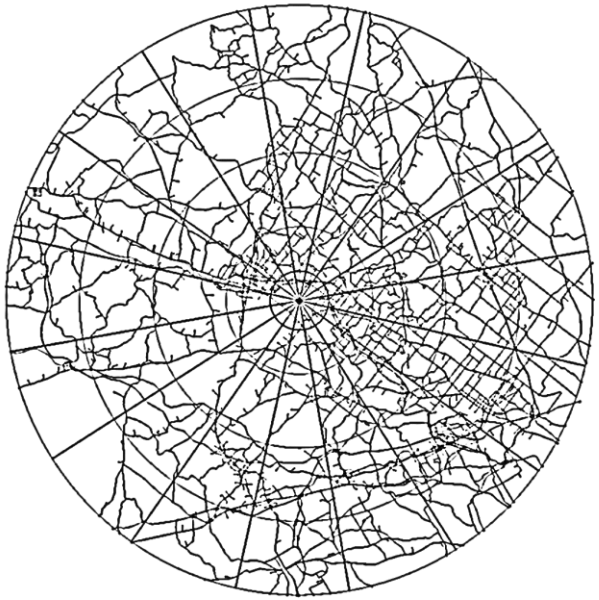
- Model 3 representative sites (small, medium, large population and representative roadway networks)
- Develop micro-simulation models using commercial software
- Produce generalized results that reveal effects of the study variables (impact to clearance times)

Representative Sites

Model Comparison	EPZ POPULATION	MODEL EPZ POPULATION		MODEL STATS		
	0-10 MILE	0-10 MILE	20% SHADOW	INTER-SECTIONS	MILES OF ROAD	LINKS/ CONNECTORS
SMALL	0 – 50,000	7500	3000	174	1196	376/863
MEDIUM	50,000 – 200,000	200,000	30,000	449	3313	2645/3846
LARGE	> 200,000	325,000	60,000	974	3712	10605/14719







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ETE Study

Task 1: Impact of Shadow Evacuation

- Sensitivity of shadow participation rate on clearance times

Task 2: Distance of Evacuation Travel

- Sensitivity of model extent on clearance times
- Assess travel times outside of EPZ

Task 3: Manual Traffic Control (MTC)

- Simulated MTC vs. signalized intersection control

Task 4: Parameters of Importance

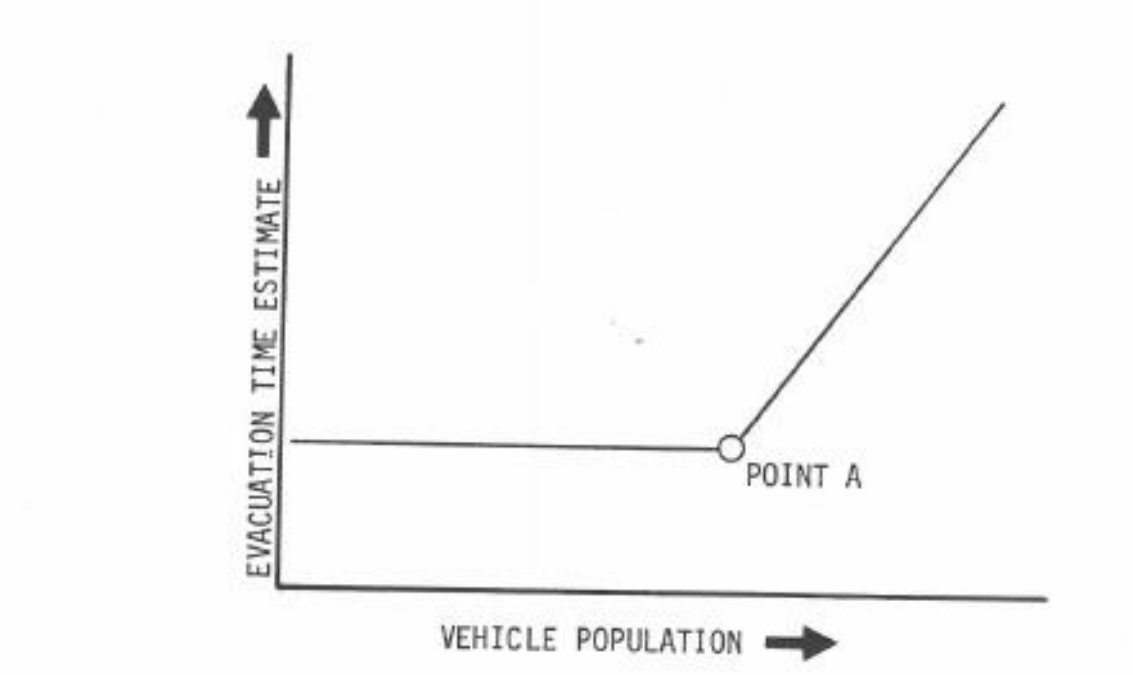
- Sensitivity analysis to determine importance of input and process variables to clearance times

Task 4: Parameters of Importance

Categories	Parameters	Applicable Section of NUREG/CR-7002
Emergency Evacuation Process	Population	Section 2.1
	Mobilization Time	Section 4.1
	Background Traffic	Section 2.5.3
	Heavy Vehicles	Section 3.2
Simulation Process	Free Flow Speed	Section 3.0
	Roadway Capacity	Section 3.0
	Adverse Weather	Section 3.4
	Processing Time Step	Section 1.0 and Table B-1
	Stochastic Uncertainty	

Population

Directly relates to the number of vehicles



Mobilization Time

Duration from the time an evacuation order is received to the time vehicles depart from their origins

- Use to develop vehicle loading curves that show the rate vehicles are loaded into the network.
- Studies suggest that ETEs increase linearly with increasing mobilization times after a certain threshold.

Background Traffic

Traffic that is present on the roadway when initial evacuation notification occurs

- Creates realistic conditions in the computation of clearance times.
- Acts like a friction factor to impede the movement of evacuees.

Heavy Vehicles

Vehicle having more than four wheels on the ground during normal operation.

- Literature suggest that 8 to 10 percent may be normal for urban roadways
- Impact traffic operations because of their vehicle dynamics and operational characteristics

Free-Flow Speed

Maximum desired speed that a vehicle would attain when it is not impeded by congestion

- Determine from field observations or estimated based on roadway classification (e.g., freeways or arterials), roadway geometrics, frequency of access points, complexity of the driving environment, and posted speed limits.

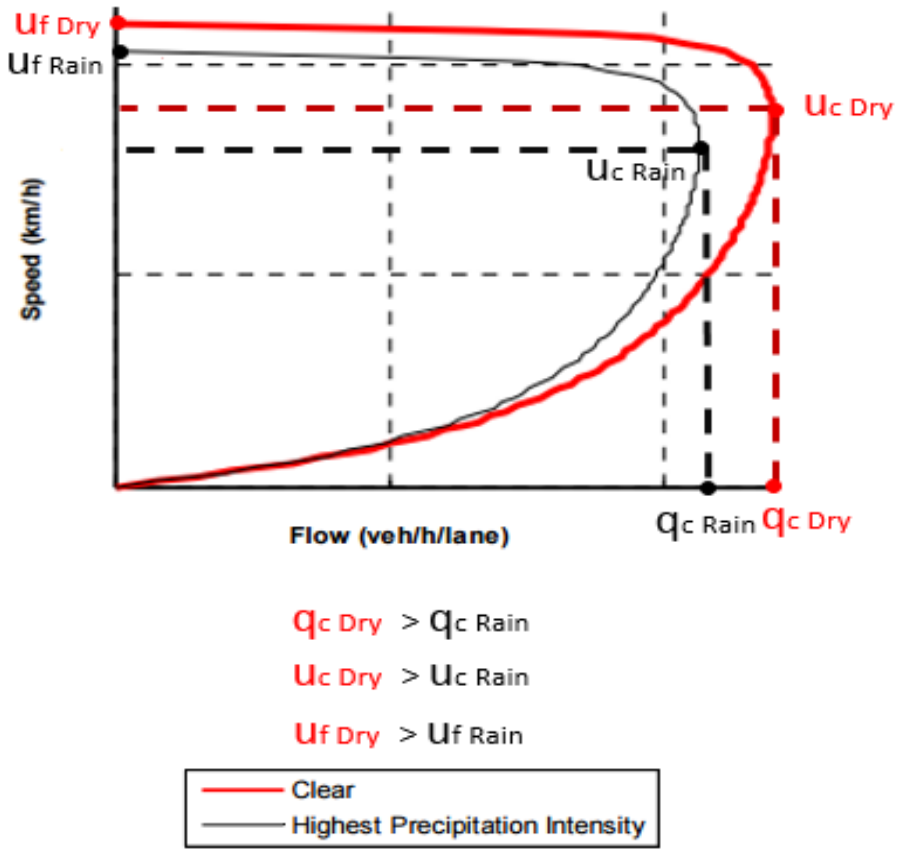
Roadway Capacity

The maximum traffic flow rate that
a roadway is capable of servicing in a unit of time
under prevailing conditions

- Capacity can be increased/decreased as a result of many factors.
- Current guidance recommends ETE studies consider roadway impact scenarios.
  - Case 1: Road closure of one segment of one of the top five highest volume roadways
  - Case 2: Lane closure of outbound lane on an interstate highway

Adverse Weather

- Recognized to adversely affect traffic flow.
- The US Department of Transportation suggests that the effect of wind, rain, snow, temperature and visibility can lower operating speeds by between 5 and 15 percent and capacities by 2 to 25 percent.



roadway capacity (q_c), free-flow speed (u_f), and speed-at-capacity (u_c)

Processing Time Step

- Determines the fidelity of the simulation
- Previous study assessed the sensitivity of ETEs to different processing times using the macroscopic tool
  - Findings may only be relevant to that simulation tool

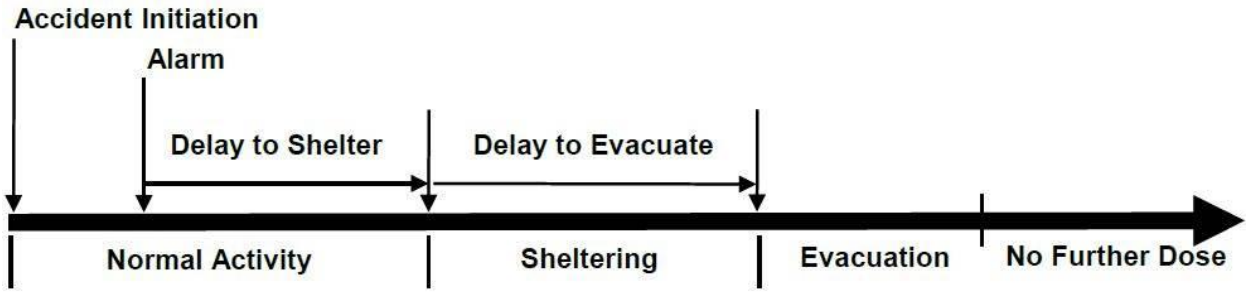
Stochastic Uncertainty

- Multiple runs are typically performed in microscopic traffic simulation using different random seeds to capture the stochastic variations in traffic flow.
- Typically, research recommends averaging the results from at least 10 random seeds or at least five seeds in congested corridors

MACCS

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 codes
- MACCS modeling best practices
- Discussions with state and local authorities

Summary

- Microsimulation models offer flexibility and fidelity
- ETE study will provide technical basis to update NRC ETE guidance.
- ETEs and traffic simulation models can inform modeling of evacuations in MACCS

Point of Contact

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