



# Evacuation Research to Support Evidence-based Policy for Radiological Emergency Preparedness

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# ***Evolution of Evacuation Time Estimate (ETE) Policy***

## **ETE Regulations**

- In 1980, ETEs required as part of emergency plan, but updates not required.
- In 2011, NRC published regulatory requirements for use of ETEs to inform protective actions and to require updates after every decennial census.

## **ETE Guidance**

- Guidance updates reflected advancements in state-of-the-art and state-of-practice
    - **1980:** NUREG-0654/FEMA-REP-1
    - **1992:** NUREG/CR-4831, “State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants”
    - **2004:** NUREG/CR-6863, “Develop of Evacuation Time Estimate Studies for Nuclear Power Plants”
    - **2011:** NUREG/CR-7002, “Criteria for Development of Evacuation Time Estimate Studies”
    - **2021:** Revision 1 to NUREG/CR-7002
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# ***The NRC is committed to evidence-based decisions***

## **NRC Evidence-Building and Evaluation Policy Statement**

- Consistent with Evidence Act (Public Law 115-435)
- NRC is an evidence-based organization, with a culture of continuous learning and improvement
- NRC evaluations depend on objective technical analyses
- Evidence-building standards:
  - Rigor
  - Relevance and Utility
  - Transparency
  - Ethics
  - Independence and Objectivity
  - Collaboration

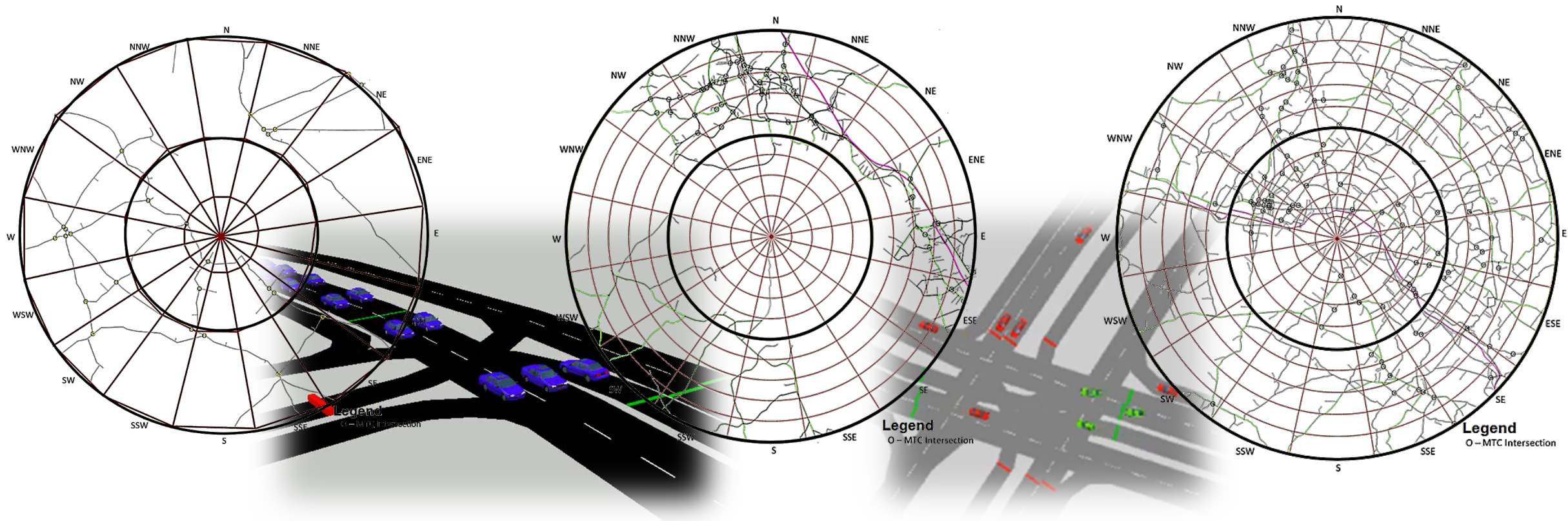
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1. NRC Evidence Building and Evaluation Policy Statement (86 FR 29683, June 3, 2021).

2. Evidence Act “Foundation for Evidence-Based Policymaking Act of 2018” (Public Law 115-435).

# Evacuation Time Estimate Study (NUREG/CR-7269)

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



U.S. NRC. NUREG/CR-7269, "Enhancing Guidance for Evacuation Time Estimate Studies," January 2020.

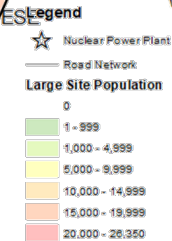
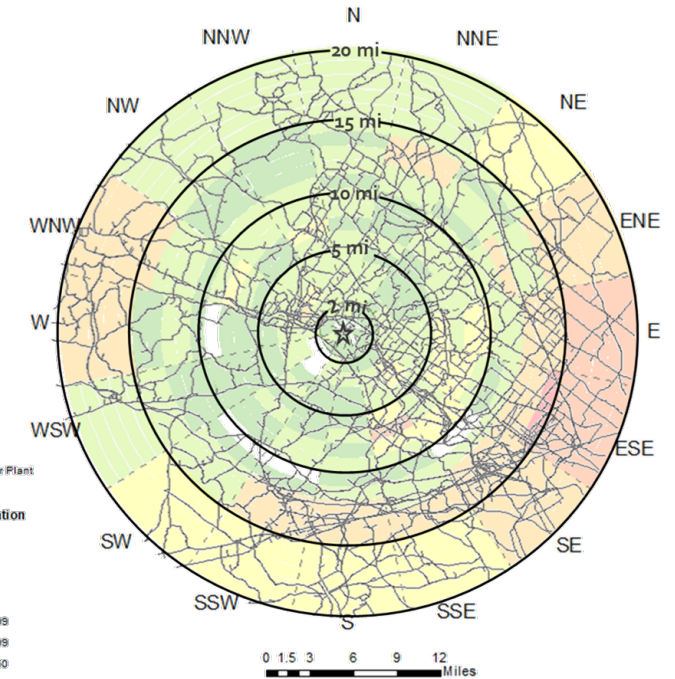
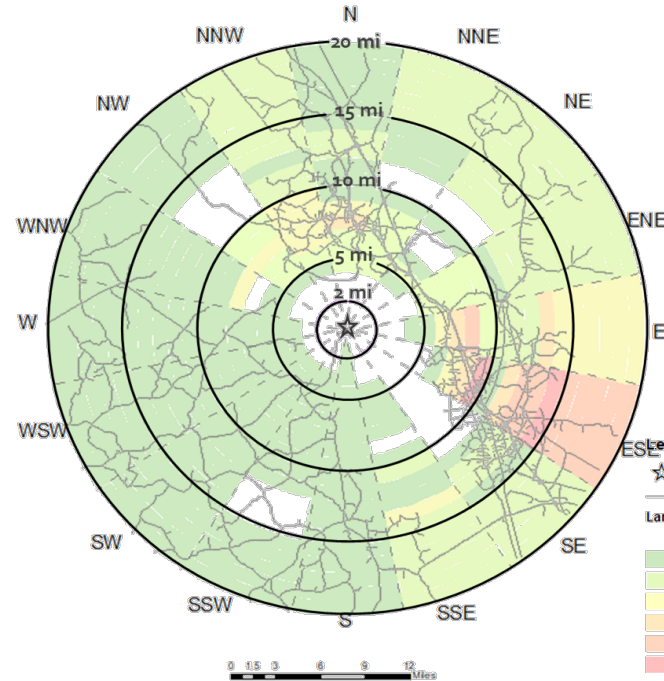
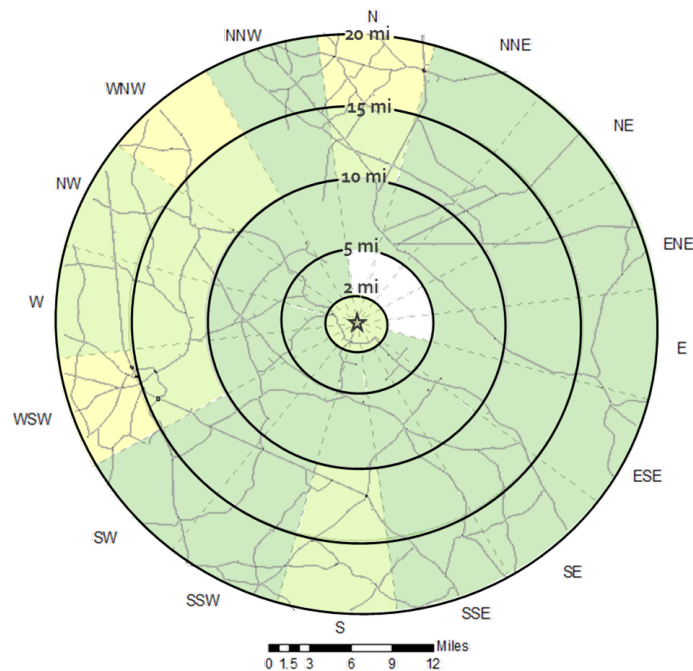
<https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7269/index.html>



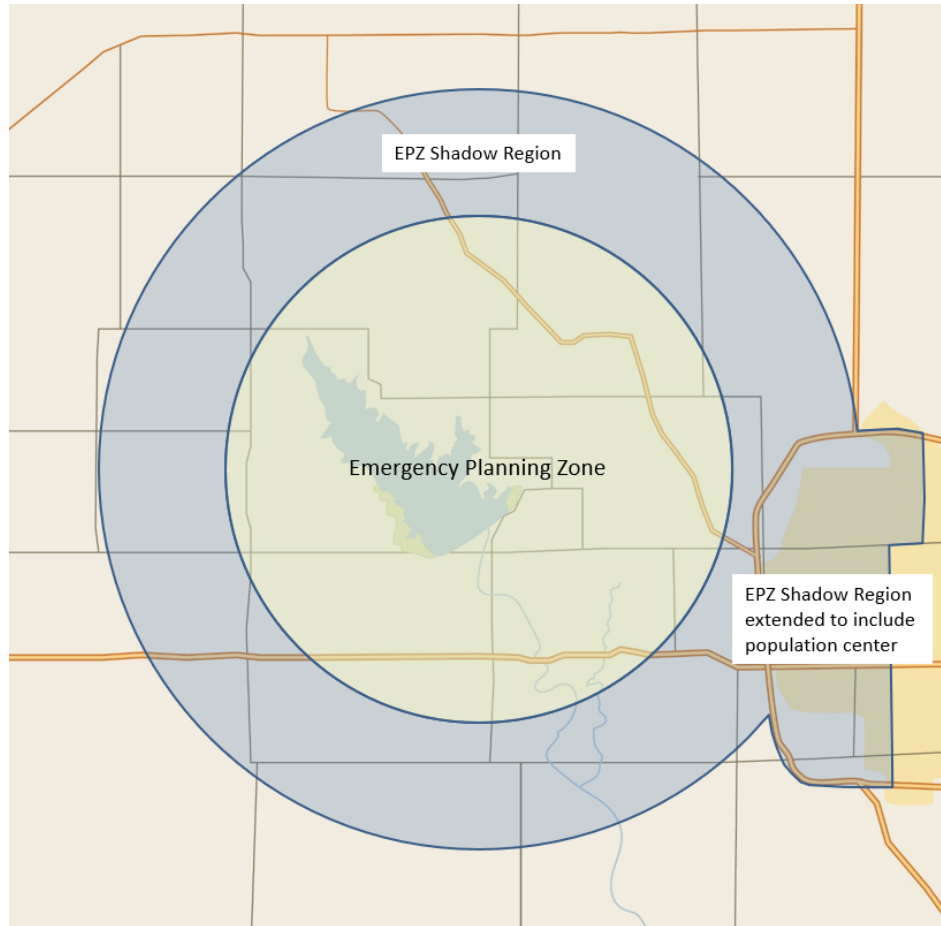


# ETE Study Model Development

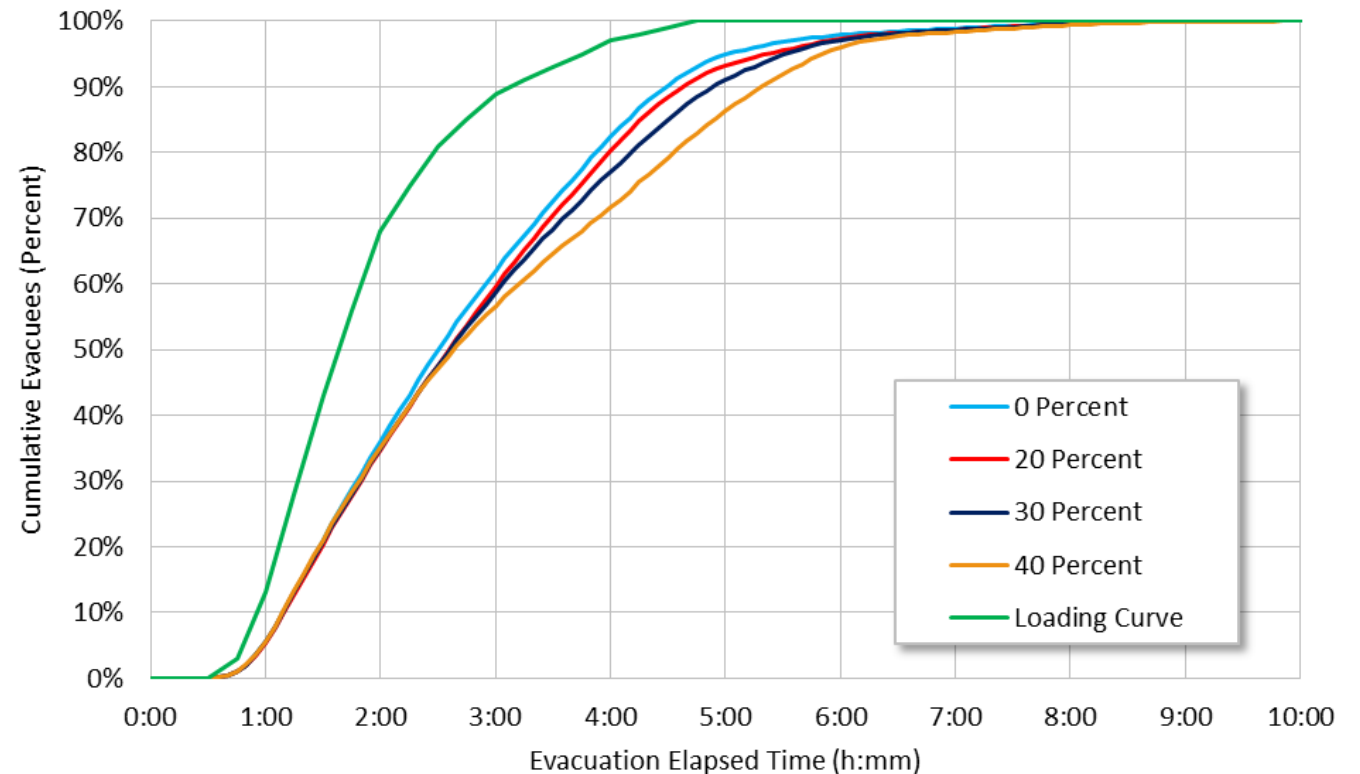
Model Comparison	EPZ POPULATION	MODEL EPZ POPULATION		MODEL STATS		
	0-10 MILE	0-10 MILE	20% SHADOW	INTER-SECTIONS	MILES OF ROAD	LINKS/CONNECTORS
SMALL	0 – 50,000	7500	3000	174	1196	376/863
MEDIUM	50,000 – 200,000	200,000	30,000	449	3313	2645/3846
LARGE	> 200,000	325,000	60,000	974	3712	10605/14719



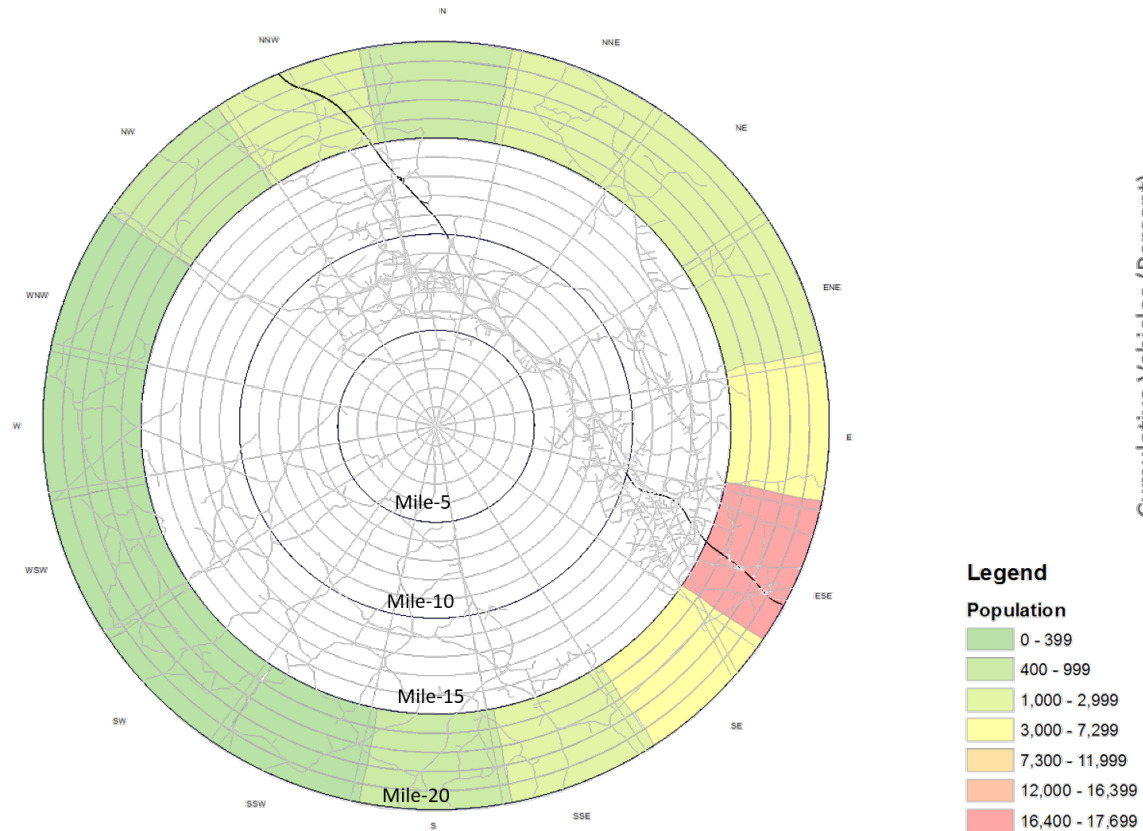
# Task 1: Impact of Shadow Evacuation



Example Results for Large Population Site Model for various shadow participation rates (by percent)

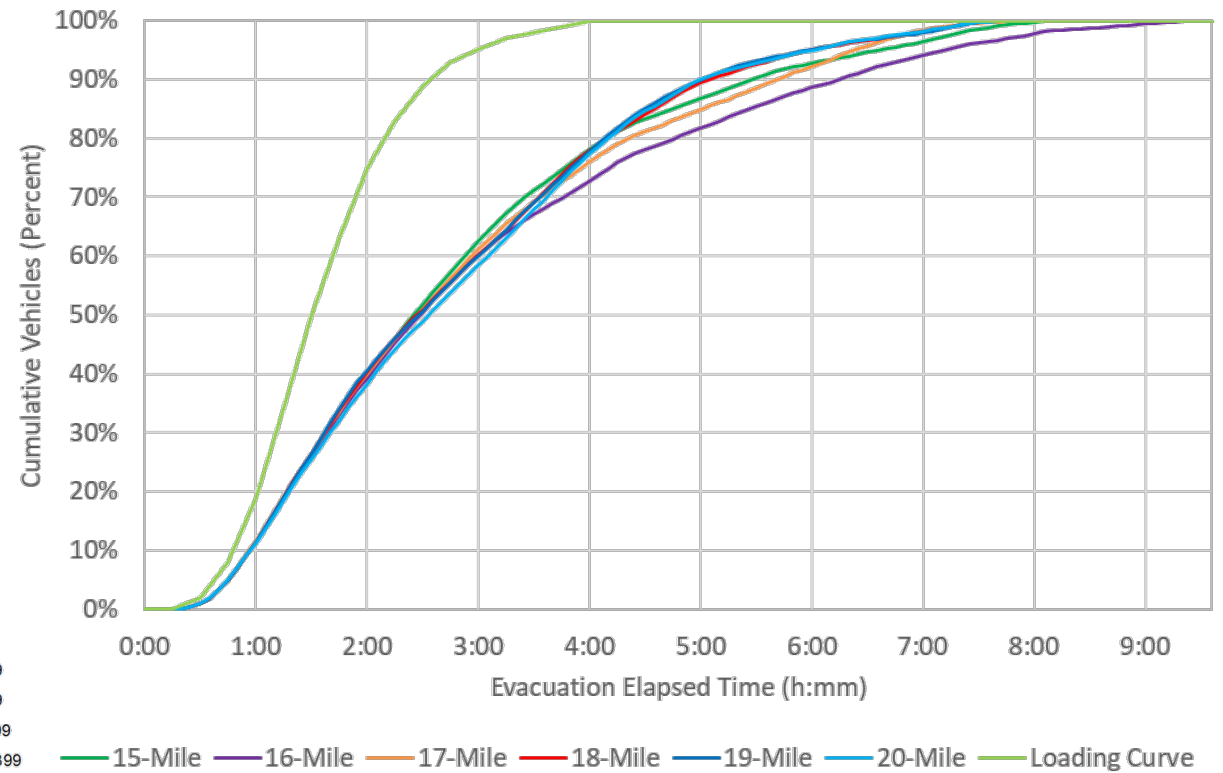


## Task 2: Distance of Evacuation Travel



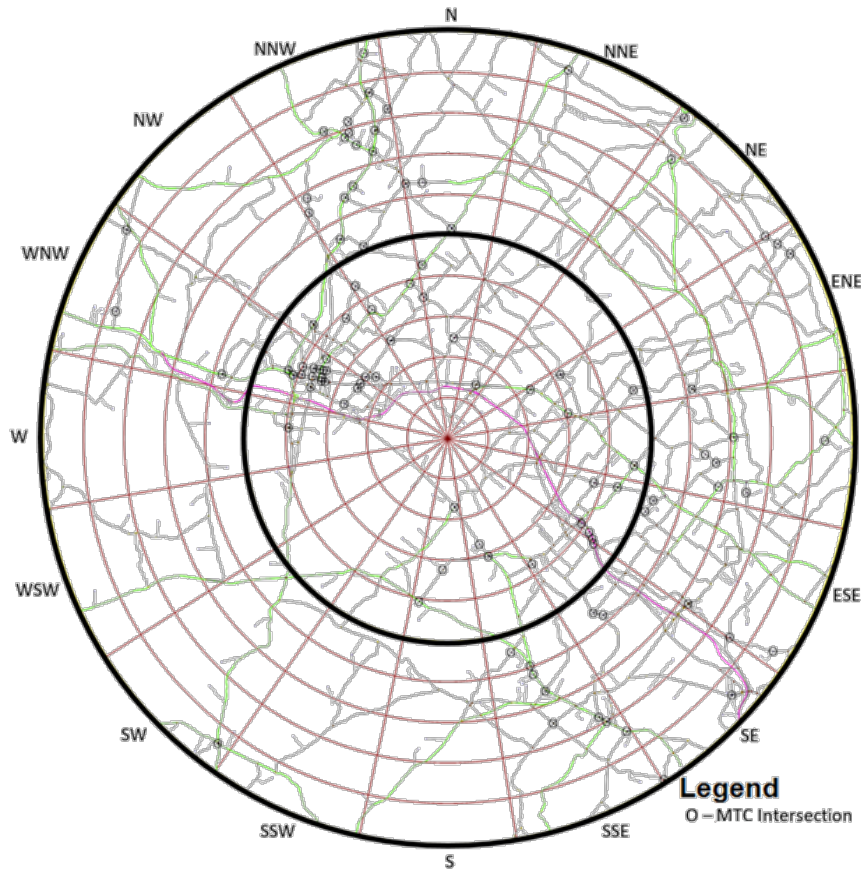
Medium Population Site Model

Example Results for Medium Population Site Model



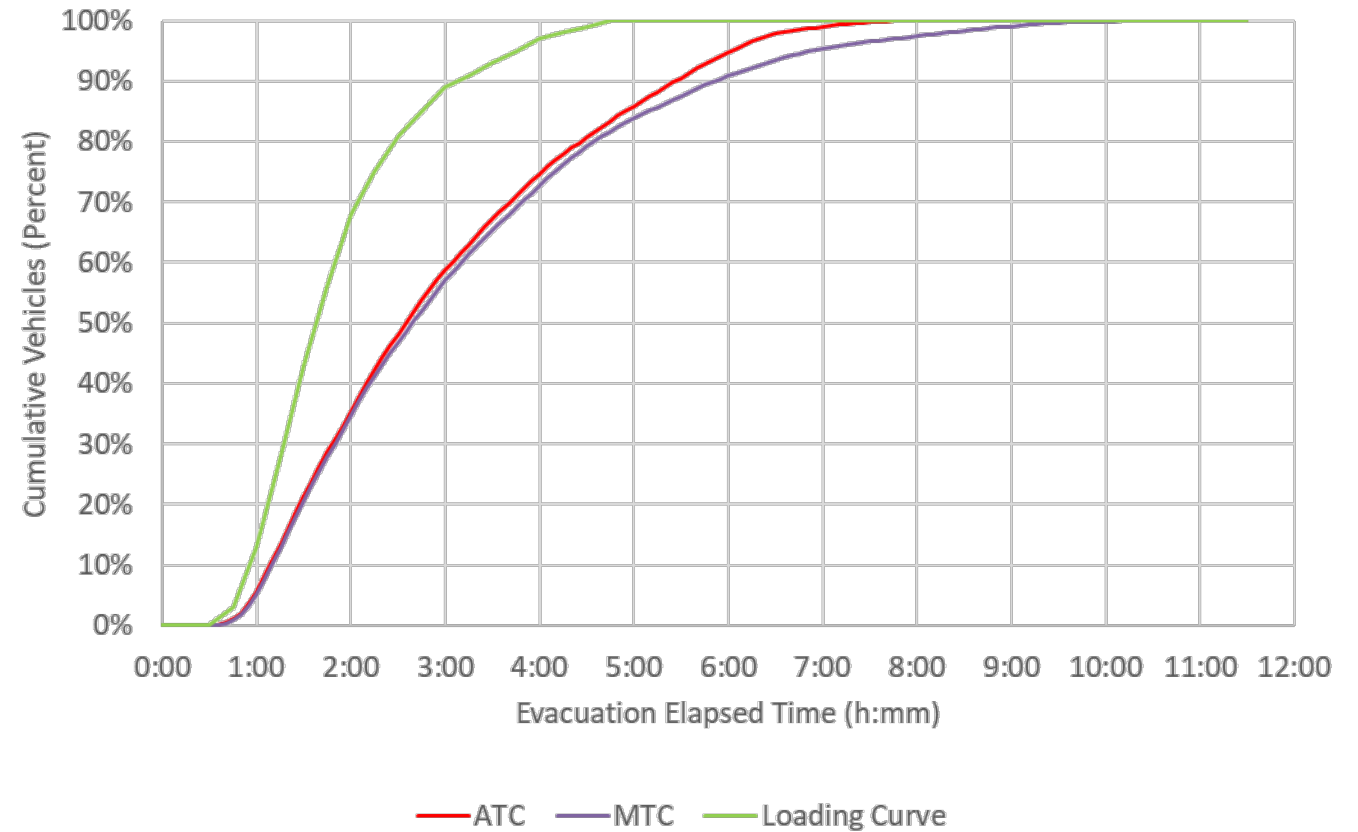
Model Extent (Miles)

# Task 3: Manual Traffic Control



Large Population Site Model

Example Results for Large Population Site Model





## ***Task 4: Parameters of Importance***

### Demand Variables



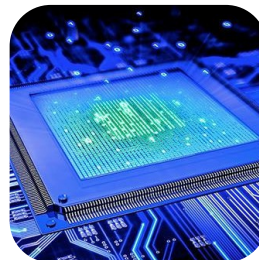
Population  
Mobilization Time  
Background and Heavy Vehicle Traffic

### Supply Variables



Roadway Impact  
Free-flow Speed  
Adverse Weather

### Process Variables



Processing Time Step  
Random Seed Uncertainty

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## ***Key insights from the ETE Study***

- Useful measures of effectiveness (MOEs) to demonstrate model performance were identified
- Shadow evacuation is appropriately modeled in ETE studies
- Tradeoffs on use of manual traffic control should be considered
- Important Demand parameters
  - Population
  - Mobilization time (including adverse weather)
- Important Supply (capacity) parameters
  - Traffic control (intersections, traffic lights, etc.)
  - Roadway impacts





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## ***The ETE Study provided evidence to:***

- Address Government Accountability Office recommendation to improve understanding of the effect of shadow evacuation (GAO-13-243)
  - Understand the utility of modeling severe weather events as it relates to informing protective action strategies
  - Expand knowledge of evacuation dynamics
  - Enhance NRC capability to perform technical reviews of ETE studies
  - Provide modeling input for radiological consequence analyses
  - Highlight to Congress the value of evacuation research for enhancing policy  
[report on EP enhancements per Section 105 of the Nuclear Energy Innovation and Modernization Act (NEIMA)]
  - Provide a technical basis for revisions to guidance
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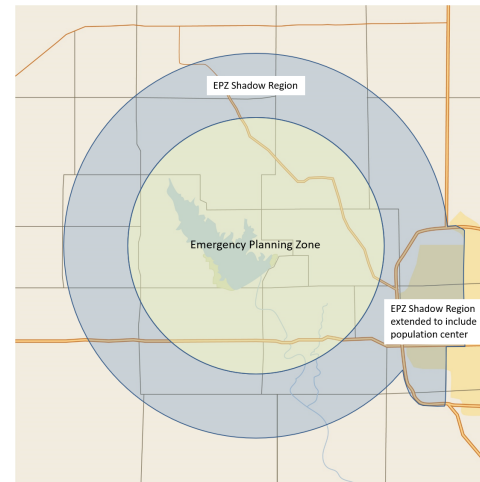
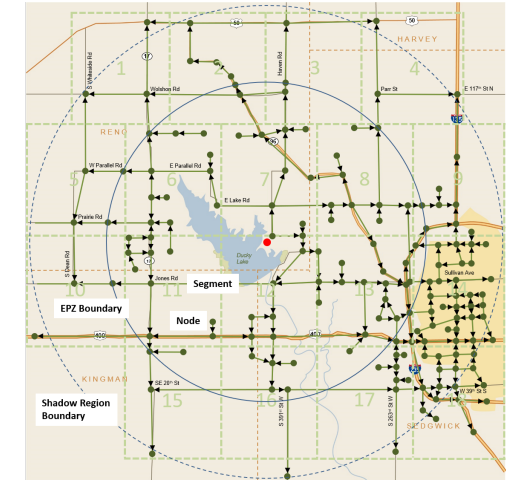
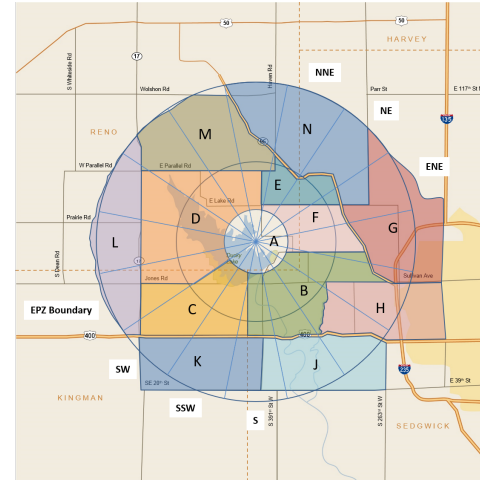
# Revisions to guidance in NUREG/CR-7002

## New Guidance

- Scalable Emergency Planning Zone (EPZ)
- Model boundary conditions
- Application of microsimulation models
- Modeling adverse weather
- Use of ETEs for siting analyses

## Revised Guidance

- Manual Traffic Control (MTC)
- Parameter importance
- Updated measures of effectiveness



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# ***NRC research builds evidence for effective policy***

- **Evacuation Time Estimate Study (NUREG/CR-7269)**
  - Protective Action Decision-Making in the Intermediate Phase (NUREG/CR-7248)
  - Nonradiological Health Impacts of Evacuations and Relocations (NUREG/CR-7285)
  - Emergency Planning Zone (EPZ) Size Methodology
  - Sensitivity of Dose Projections to Weather
  - Analysis of the Effectiveness of Sheltering-in-Place
  - Dose Reduction Effectiveness of Masks
  - MACCS Consequence Model Improvements
  - Technical Basis for Protective Action Recommendations (PARs)
  - Sequoyah State-of-the-Art Reactor Consequence Analysis (SOARCA) – earthquake impacts (NUREG/CR-7245)
  - Level 3 Probabilistic Risk Assessment (PRA) – Full offsite consequence analyses
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***Research to support evidence-based policy  
is a win-win-win for public health and safety***

