U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Regulations, Guidance, and Studies on Evacuations

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U.S. Nuclear Regulatory Commission

- Independent agency established by Congress
  - Authority derives from federal law
  - Includes power of rulemaking
  - NRC sets the regulations and enforces compliance
- Mission:
  - The NRC licenses and regulates the Nation's civilian use of radioactive materials to protect public health and safety, promote the common defense and security, and protect the environment.
- Agency rules (or regulations)
  - Code of Federal Regulations
  - Planning standards for emergency preparedness
    - Mitigate the accident
    - Protect the public health

NRC & FEMA

- NRC responsible for regulating & assessing overall (onsite & offsite) emergency planning, preparedness & response of Nuclear Power Plants (NPPs).
- FEMA responsible for assessing offsite emergency planning, preparedness & response. For NPPs, FEMA performs this role in support of NRC's statutory function.
- Relationship between the agencies is specified in regulation and a Memorandum of Understanding (MOU).

Protective Actions

Action taken during a radiological emergency to avoid or reduce the radiation dose to members of the public.

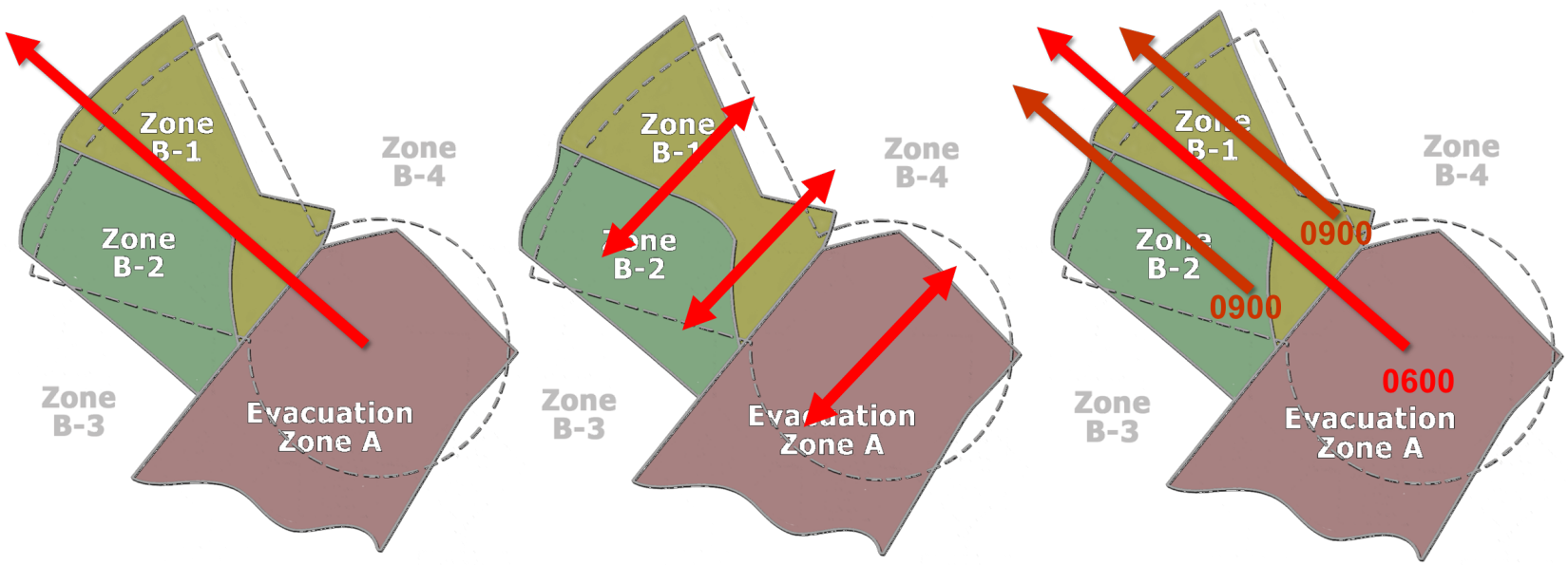
- Risk avoided by taking the action needs to be weighed against the risks involved in taking the action.
- Are to be pre-planned.
- Also implemented to protect NPP personnel and emergency workers.

Standards for Protective Actions

- NPPs must consider a range of protective actions, including evacuation and sheltering.
- Guidelines for the choice of protective actions during an emergency, consistent with Federal guidance, are developed and in place.
- Evacuation time estimates (ETEs) have been developed by NPPs and are used in the formulation of protective action strategies. ETEs are updated on a periodic basis.

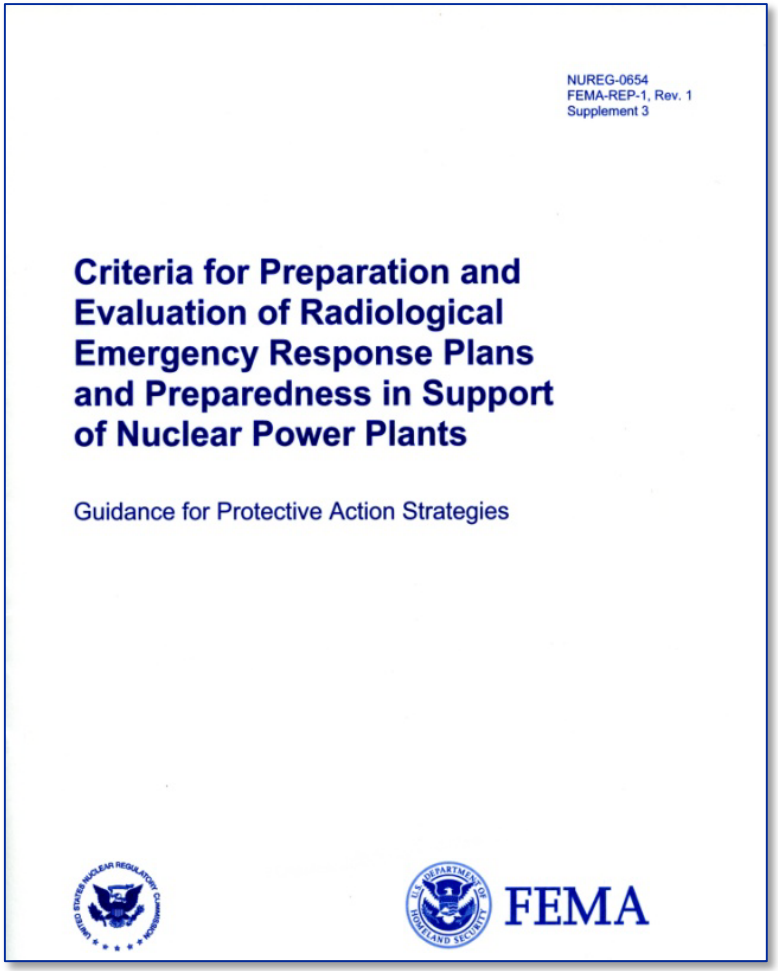
Technical Basis for Protective Actions

- **NUREG/CR-6953 (NRC 2007)** studied alternative evacuation strategies to reduce public dose during severe accidents.



Radial Lateral Staged

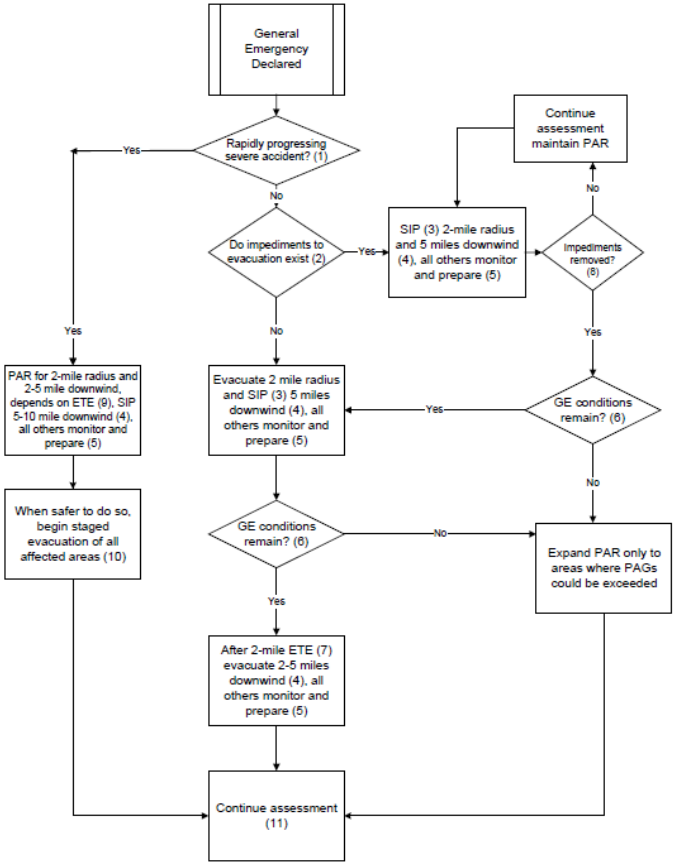
Protective Action Guidance


NUREG-0654
FEMA-REP-1, Rev. 1
Supplement 3

Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants

Guidance for Protective Action Strategies

FEMA



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Protective Action Strategy

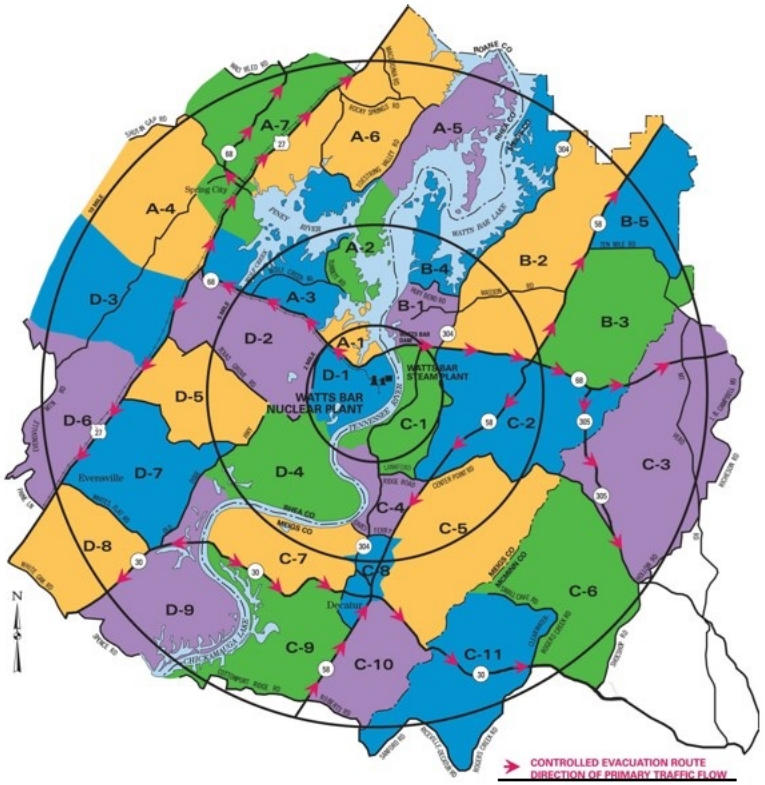
- NPP is required to recommend to civil authorities evacuation or sheltering at most serious emergency (General Emergency).
- Civil authorities must decide and implement protective action.
- Emergency Planning Zone.
- Planning for evacuation routes and care of evacuees.
- Protective actions could be needed beyond planning zone.

NRC Evacuation Studies

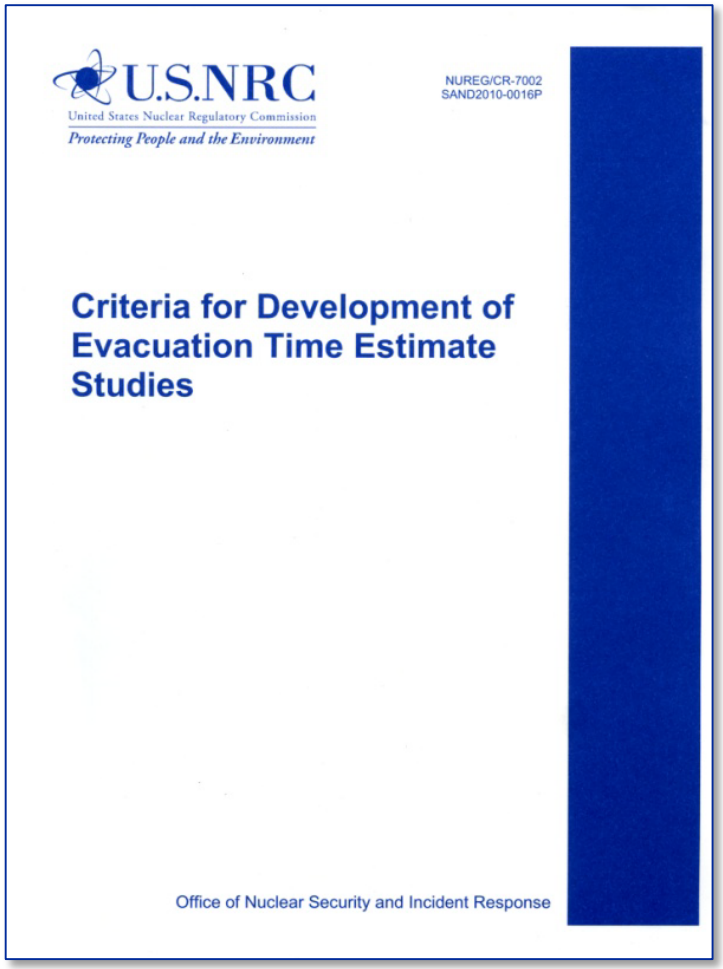
- **NUREG/CR-6864**, "Identification and Analysis of Factors Affecting Emergency Evacuations" (NRC 2005).
  - *Evacuations are effective.*
- **NUREG/CR-6981**, "Assessment of Emergency Response Planning and Implementation for Large Scale Evacuations" (NRC 2008).
  - *Effectiveness in implementing evacuations is directly related to the level of preparedness.*
- Planning and preparedness is enhanced by the information contained in an evacuation time estimate (ETE) study.

Evacuation Time Estimates

- Evacuation Time Estimates are analyses of the time required to evacuate various sectors and distances surrounding an NPP.



ETE Guidance



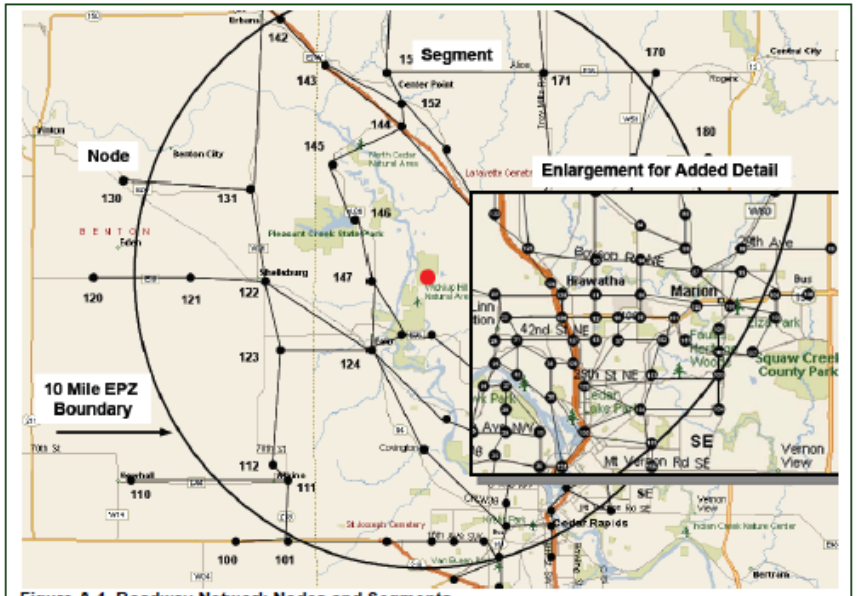


Figure A-1 Roadway Network Nodes and Segments

ETE Guidance

- Approach
  - Process used in development of ETE
  - Meetings with planners, emergency managers, local authorities
  - Field surveys of roadways and traffic control systems
  - Demographic data
  - Traffic control plans
  - Evacuation modeling

ETE Guidance

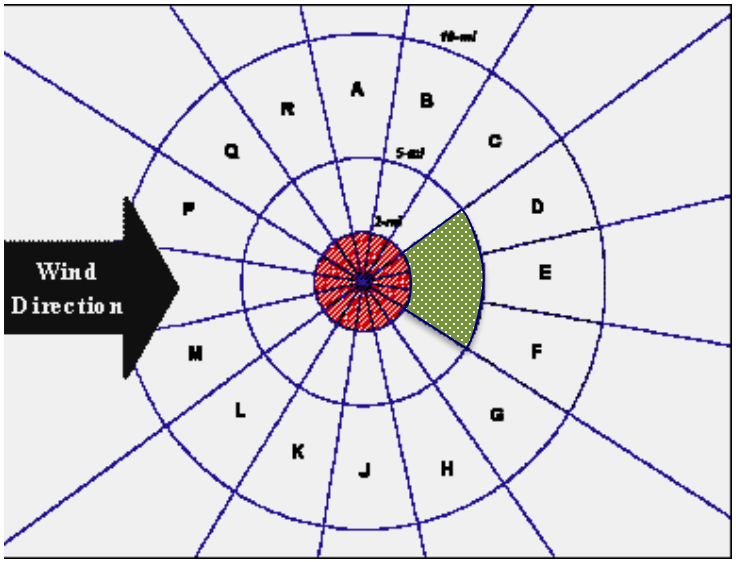
- Four Population Groups
  - Permanent residents and transients
  - Transit-dependent permanent residents
  - Special facility residents
  - Schools
- Multiple scenarios
  - Ensure ETE has range of evacuation times
  - Minimum 10 scenarios

ETE Guidance

- Shadow Evacuation
  - Occurs outside official evacuation zone
  - 20 percent shadow evacuation assumed out to 15 miles from nuclear power plant
- Evacuation Tail
  - 10 percent of public takes longer to evacuate
  - Decision-makers use 90% ETE value for evacuation

ETE Guidance

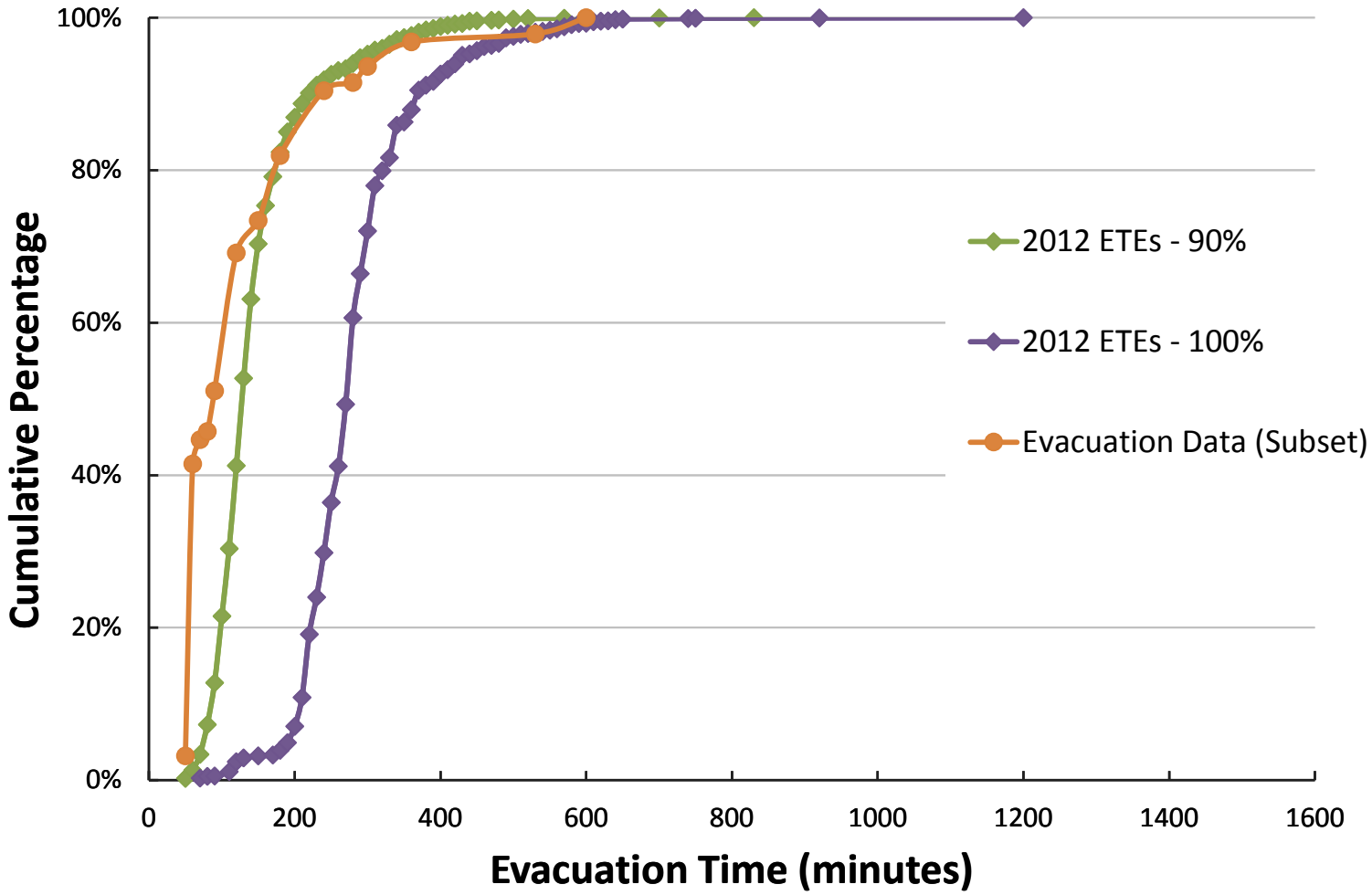
- 90% and 100% ETEs for
  - 0-2 mile zone
  - 2-5 mile staged evacuation
  - 0-5 mile zone
  - Full 10 mile EPZ
  - Affected zones based on protective action recommendations



Evacuation Time Estimates

- ETEs submitted to the NRC are reviewed for completeness.
- Completeness review provides verification of model development.
- Validation of ETEs against real world data is desirable.

ETE vs. Evacuation Data



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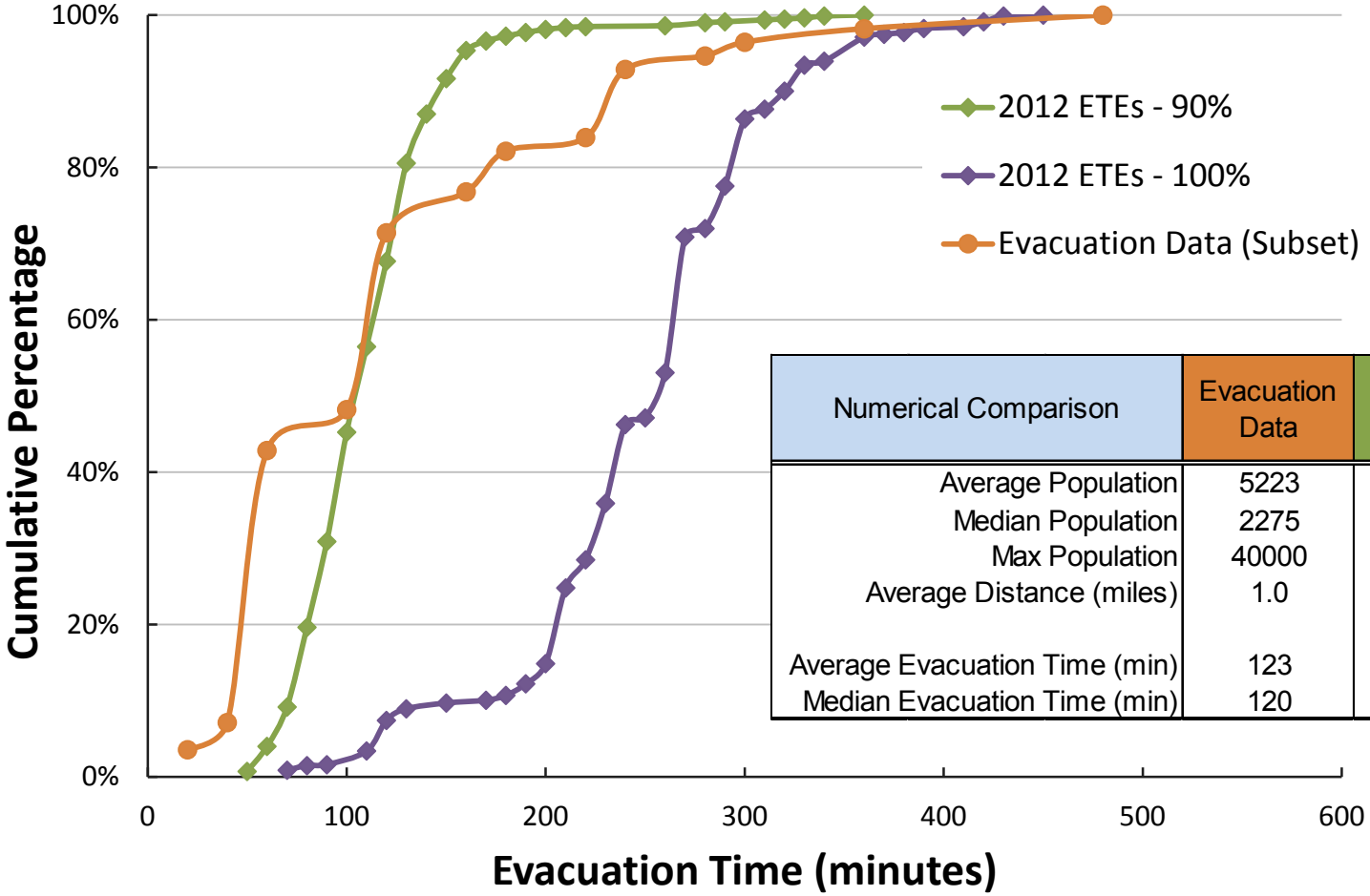
2 Mile ETE vs. Evacuation Data



Numerical Comparison	Evacuation Data	ETE Data
Average Population	5223	5055
Median Population	2275	1649
Max Population	40000	36769
Average Distance (miles)	1.0	1.3
Average Evacuation Time (min)	123	119
Median Evacuation Time (min)	120	113

Comparative Validation

- Comparison of 63 individual site ETEs to Real time evacuation Planning Model (RtePM) clearance times:

RtePM Time Difference (minutes)	vs. Evening, Fair Weather ETE	vs. Average ETE
Average	30	31
Median	17	15
Mode	8	2

- Only 8 of 63 sites had greater than 1 hour difference.
  - Typically large population sites.
  - Accounted for due to parameters such as transient and shadow populations, mobilization curves, roadway capacity, vehicle demand, and simulation scale.

Enhancing Guidance for ETEs

- Applied research study to examine topics associated with the modeling and simulation of evacuations and to perform independent verification of the NRC's methodology for ETE development.
  - Task 1: Shadow evacuation analysis
  - Task 2: Distance of evacuation travel
  - Task 3: Manual traffic control study
  - Task 4: Determination of variable importance
  - Task 5: Documentation

Enhancing Guidance for ETEs

- Results of ETE study will be beneficial:
  - Independent verification of NRC's methodology (NUREG/CR-7002).
  - Technical basis for potential enhancements to guidance document for ETE development.
  - Enhance NRC staff understanding (KM tool).
  - Enhance NRC's regulatory function (consequence analysis, rulemaking).

- Builds upon multi-disciplinary approach:
  - As evacuation planning has evolved it has become a multi-disciplinary effort among emergency managers, first responders, transportation officials, and government agencies.

Summary

- NRC regulations and guidance on protective actions provide for protection of public health and safety.
  - Evacuations remain major element of protective action strategy for NPP incidents.
  - Evacuations are effective.
  - Effectiveness in implementing evacuations is directly related to the level of preparedness.
  - Evacuation time estimate (ETE) studies enhance evacuation planning.
  - NRC regulations and guidance require on-going evaluation of emergency planning and preparedness.

More Information

NRC Public Website
https://www.nrc.gov/about-nrc/emerg-preparedness.html

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