



NRC Evacuation Study & Evacuation Time Estimate (ETE) NUREG Update

Federal Radiological Preparedness
Coordinating Committee (FRPCC)

February 23, 2005



Status

- NUREG/CR-6864, *Identification and Analysis of Factors Affecting Emergency Evacuations, Volume I: Main Report and Volume II: Appendices*
- Released January 25, 2005





Major Findings of Evacuation Study

- **Evacuations successfully protect the public health & safety over a broad range of initiating circumstances & challenges**
 - Public evacuations occur frequently (~once every 3 weeks)
 - **Shadow Evacuations Do Not** affect the effective implementation of adequate protective actions
 - **Emergency workers** report to duty when asked
 - **Public education** is an important contributor to efficient & effective evacuations
 - **Route Alerting** is effective & a significant contributor to efficient & effective evacuations



Overview of Project

- Examined efficiency and effectiveness of public evacuations of 1,000 or more people, in response to natural disasters, technological hazards, and malevolent acts, in U.S. between 1/1/90 & 6/30/03
- 230 evacuation incidents identified; subset of 50 selected for case study analysis
- Case study selection based on profiling and ranking scheme designed to identify incidents of sufficient complexity to challenge local & regional emergency response capabilities



Case Study Analysis

- All 50 evacuation cases studied safely evacuated people from the area, saved lives, and reduced the potential number of injuries from the hazard



Eunice, LA Train Derailment & Chemical Spill (2000)



Hurricane Floyd (1999)



Centennial Olympic Park Bombing, Atlanta (1996)



Case Study Analysis (Continued)

- Case study analysis included completion of a detailed question survey for each incident
- Advanced statistical methods (regression analyses & correlation analyses) used to identify factors contributing to evacuation efficiency
- Regression analyses identified that the following were statistically significant for a more efficient evacuation:
 - community familiarity with alerting methods
 - door-to-door notification





Case Study Analysis (Continued)

- The following factors were statistically significant for a less efficient evacuation:
 - traffic accidents
 - number of deaths from the hazard
 - number of injuries caused by the evacuation
 - people spontaneously evacuating before being told to do so
 - people refusing to evacuate, and looting or vandalism



Other Results

- Interviewees stated that the following contributed to the efficiency and effectiveness of their evacuation:
 - a high level of cooperation among agencies
 - use of multiple forms of emergency communications
 - community familiarity with alerting methods
 - community cooperation
 - well-trained emergency responders





Status

- **NUREG/CR-6863, *Development of Evacuation Time Estimate Studies for Nuclear Power Plants***
- **Released January 25, 2005**



Evacuation Time Estimate (ETE) Project

- Update to NUREG/CR-4831, *State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants* (1992)
- Technologies have substantially changed since issuance of NUREG/CR-4831 and additional potential considerations have emerged





ETE Is Estimated Time to Evacuate All Individuals From EPZ

Some of the elements specifically considered in the update include:

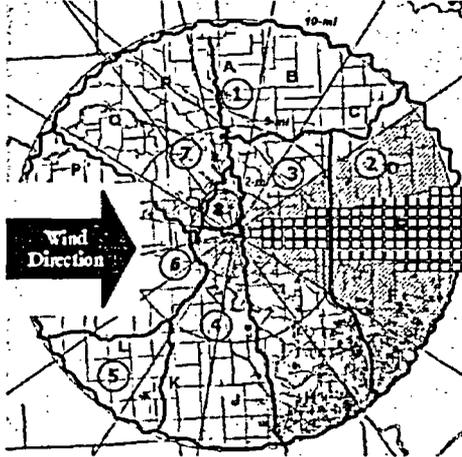
- Computer modeling
- Improved traffic management systems
 - Intelligent Transportation Systems
- Demand estimation
- Shadow evacuations
- Trip generation times
- Changes/additions to support Early Site Permitting (ESP) process
- Results of recent NRC/SNL evacuation study






Community Preparedness Is Essential To Support Defensible Assumptions

- Emergency Response Planning Areas (ERPAs) typically define the local response boundaries
- Evacuation scenarios follow a 'key hole' approach
- Scenarios are evaluated rotating around the sectors identifying a suite of ETEs








Development of the ETE

- **Graded Approach**
 - Not all EPZs are the same and not all ETEs require the same detail (e.g., Grand Gulf, Indian Point)
 - The methodology should be structured and defensible for the ETE
- **Modeling does not replace the need for an analyst**
 - Analyst must completely understand the model
 - Model inputs may be sensitive and require a thorough understanding of transportation activities
 - Can be used to identify recommendations that could improve the ETE

Defensible and transparent documentation is important.





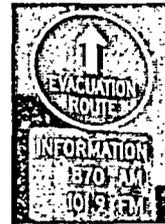

Modeling Can Provide More Realistic ETEs But Requires Thorough Understanding

- **Modeling is available for:**
 - ETE calculations
 - Transportation modeling
 - Geographical information systems (GIS) platforms
- **Model inputs require understanding of the model and transportation activities**
- **Results require interpretation and understanding of what is happening**
- **Some parameters are highly sensitive**
- **Traffic control is automated with dynamic flow models that assign flow at intersections**
 - Controlled intersections should be clearly identified
- **Uncertainty in data should be identified and defended through sensitivity analyses**
- **Shadow Evacuations**
 - Can be modeled to determine potential impact




Transportation Analysis Is Significant Component of the ETE

- Trip generation times are developed to identify the distribution of traffic loading:
 - Generally, not everyone leaves at the same time
 - The sensitivity of trip generation times should be considered
 - Assumptions must be defensible
- Proactive traffic management can help maintain traffic flow and mitigate delays
- Well marked evacuation routes and use of Highway Advisory Radio help inform the public



Conclusion

- Foundation for development of ETEs in NUREG-0654/FEMA-REP-1, Rev. 1, remains
- *Development of Evacuation Time Estimate Studies for Nuclear Power Plants* will provide more detailed guidance that should be considered in development or updating ETEs
- The methodology must be sound and all calculations and assumptions must be documented and defensible
 - Use of computer models requires documentation to fully describe the modeling activities, input data, and sensitivities

