

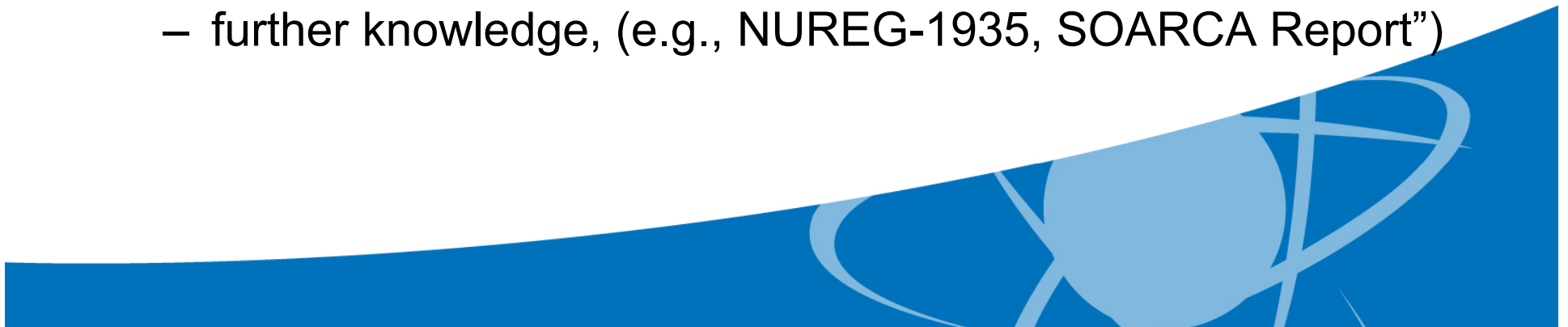
# **Advances in Consequence Modeling**

**ESREL 2015  
ETH Zurich**

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Commission**

# Nuclear Regulatory Commission Applied Research

- NRC performs nuclear power plant (NPP) accident analyses to identify potential hazards
- Ensure regulations protect public health and safety
- Analyses performed when:
  - new information presents, (e.g., 9/11),
  - support “regulatory analysis”, (e.g., post Fukushima),
  - further knowledge, (e.g., NUREG-1935, SOARCA Report”)



## Current Research

- Level 3 Probabilistic Risk Assessment Project (Vogtle Nuclear Power Plant),
- Regulatory analysis to determine need for filtered vents on boiling water reactors and
- Regulatory analysis to determine the need for expedited transfer of spent fuel

**Detailed modeling of emergency response contributed to these analyses**



## METRICS FOR REGULATORY ANALYSES

- Health effects are primary regulatory metric
- Economic considerations are considered for relicensing of NPPs
- Adequate regulatory protection measured in terms of early and latent cancer fatalities using two safety goals



## METRICS FOR REGULATORY ANALYSES (Cont.)

- The risk to average individual near an NPP of prompt fatality is less than 0.1 percent of the sum of prompt fatality risks resulting from other accidents
- The risk to population near an NPP of cancer fatalities that might result from operation is less than 0.1 percent of the sum of cancer fatality risk from all other causes



# MODELING EMERGENCY RESPONSE

- Accident analysis studies beyond design basis accidents
- Estimates frequency of initiating event and failure of:
  - mitigation equipment
  - procedural processes and
  - containment
- Resulting in a source term
- Public health impact is then calculated



## MODELING EMERGENCY RESPONSE (Cont.)

- The NRC MACCS2 program is used
  - NUREG/CR-7009, *MACCS2 Best Practices as Applied in the State-of-the-Art Reactor Consequence Analyses Project*
- Modeling of emergency response has a great impact health effects estimates
- Emergency preparedness (EP) programs are required at all US NPPs and recommended by International Atomic Energy Agency guidance



## MODELING EMERGENCY RESPONSE (Cont.)

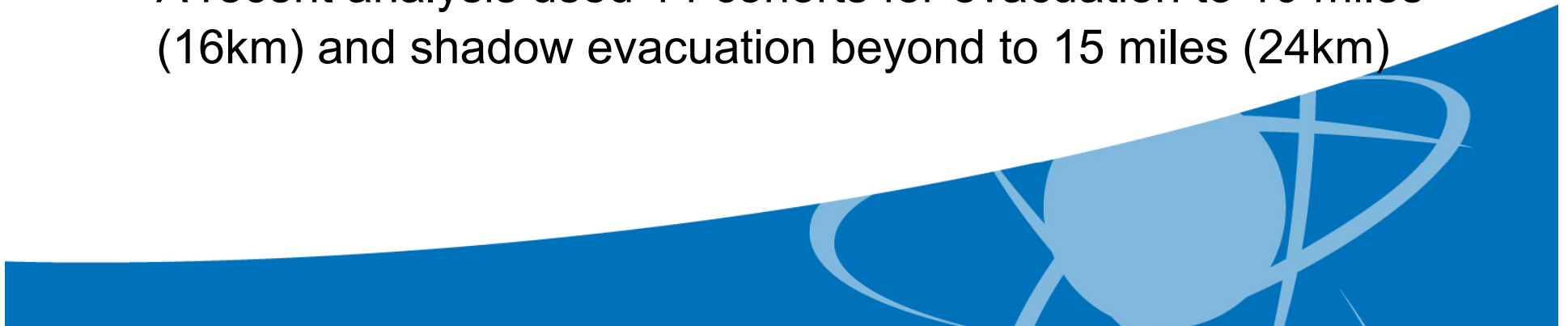
- Onsite and offsite response is modeled considering operational awareness:
  - Declaration of emergency
  - Offsite notification
  - Activation of sirens
  - Instructing the public
  - Protective actions (shelter, evacuation, relocation)
- Exercise reports and performance indicator data provide insight



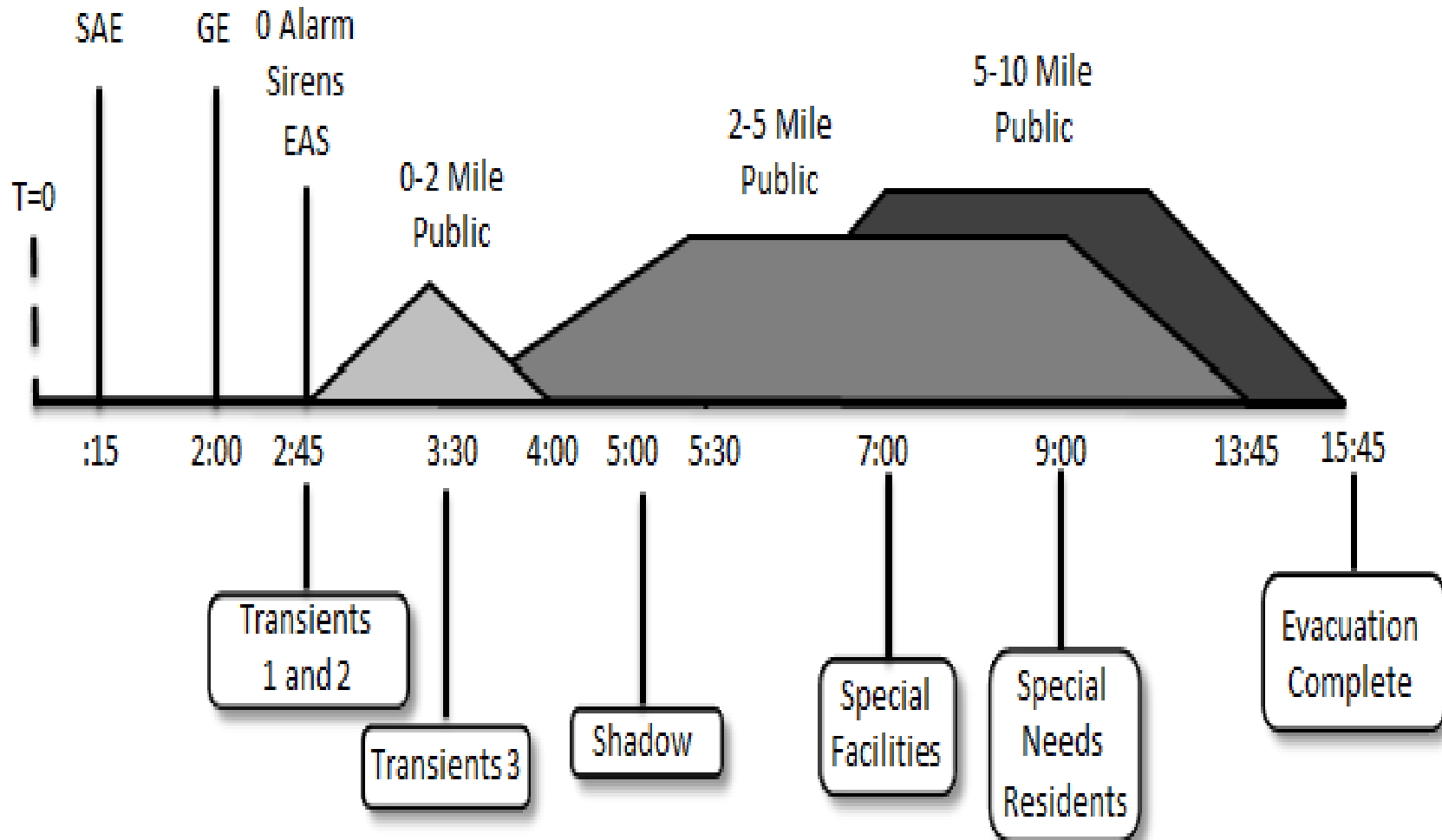


## MODELING EMERGENCY RESPONSE (Cont.)

- The site evacuation time estimate provides:
  - demographics,
  - roadway network,
  - public response timing and
  - travel speed
- Population divided into cohorts to model evacuation
- A recent analysis used 14 cohorts for evacuation to 10 miles (16km) and shadow evacuation beyond to 15 miles (24km)

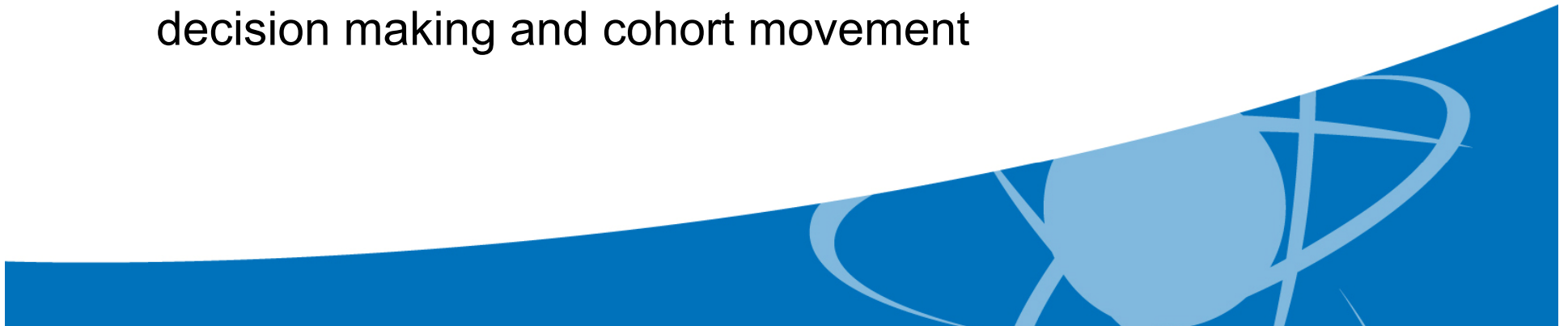


# MODELING EMERGENCY RESPONSE (Cont.)



## MODELING EMERGENCY RESPONSE (Cont.)

- Model is loaded into the MACCS program
- MACCS requires many parameters and EP model is only one portion
- Source term, environs characteristics and meteorological data are inputs
- The detailed EP model represents realistic response actions by the emergency response organization and the public
- Modeling is communicated visually to show the timing of decision making and cohort movement



## CONCLUSION

- Advanced modeling of EP can more accurately estimate the impact of radiological (or other) hazardous releases on public health
- Regularly inspected and exercised emergency plans should be credited with appropriate decision making and protective action implementation
- Effort reflects realistic impact on public health and provides technical information to support rule making

