Radiological Emergency Planning and Response

Perception of Risk

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The Perception Gap

• When fears don't match the facts.
• It's the feelings about the facts, not the facts themselves.
• Judgments are a mix of fact and feeling, intellect, instinct, cognition and intuition.
• Lack of understanding of risks to health from radiation due of Linear-No Threshold Hypothesis.
100 Operating Nuclear Reactors

Region 1
King of Prussia, PA

Region 2
Atlanta, GA

Region 3
Chicago, IL

Region 4
Arlington, TX
Defense in Depth

• Emergency planning (EP) was adopted as an added conservatism to the NRC's "defense-in-depth" (DID) safety philosophy.

• DID: Requires high quality in the design, construction/operation of nuclear facilities/equipment to reduce the likelihood of malfunctions in the first instance;

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Defense in Depth

- Recognizes that equipment can fail and operators can make errors
- Requires safety systems to reduce the chances that malfunctions will lead to accidents that release fission products or other radioactive and hazardous materials;
Defense in Depth

- Recognizes that, in spite of these precautions, accidents can happen;
- Emergency planning as part of DID philosophy provides that, even in the unlikely event of an offsite release of radioactive materials there is reasonable assurance that actions can be taken to protect the population around nuclear facilities.
Nuclear Power Plant Emergency Preparedness

• Nuclear Power Plant emergency preparedness programs are intended to reduce dose, not eliminate dose, to the public during a radiological emergency.

• NRC has overall responsibility for licensing decisions considering:
  – On-site emergency preparedness evaluated by NRC
  – Off-site emergency preparedness evaluated by FEMA
  – Final decision on licensing is responsibility of NRC

• EP has always been a licensing requirement for nuclear power plants.
  – Emergency planning zones
  – Requirements for plans
Basis for Emergency Planning for Nuclear Power Plants

• Emergency planning in the US is based on a range of accidents including most severe.

• Two emergency planning zones (EPZs) (10/50 miles) around each nuclear power plant.

• Exact size and shape of EPZ depends upon:
  • specific conditions
  • unique geographical features of area
  • demographic information.
Emergency Planning Zones (EPZ)

Plume Exposure Pathway
- Area requiring immediate protective action
  - Evacuation
  - Sheltering
  - Potassium Iodide
- 10-mile radius
- Monitoring of offsite radiological releases
- Public alerting and notification

Ingestion Exposure Pathway
- Protect from consumption of contaminated food
- Precautionary measures may be taken
- 50-mile radius
Three Mile Island Unit 2

• March 28, 1979 an accident at TMI-2 melted approximately 1/2 of reactor core.
• 13 million curies of radioactive noble gases (primarily xenon isotopes) released.
• ~15 Ci of Iodine-131 released
• No health effects except for stress.
• Average dose to area residents ~1 millirem, maximum dose to a person at the site boundary ~75-85 millirem.
NRC Actions Post TMI

• Upgrade/strengthen plant design and equipment requirements including ability of plants to shut down automatically.
• Identifying critical role of human performance in plant safety.
• Complete overhaul of emergency planning regulations.
  • President Carter directed FEMA to oversee offsite emergency planning.
  • 10 CFR 50.47, 10 CFR 50 Appendix E, NUREG-0654/FEMA-REP-1 articulate 16 planning standards for emergency preparedness for onsite and offsite.
• EP regulations updated in 2011.
Emergency Preparedness System for “on and off site” preparedness

- **Documents**
  - Emergency Plan
  - Implementing procedures
  - Emergency Action Levels

- **People**
  - Emergency Response Organization
  - Training

- **Facilities**
  - Equipment
  - Maintenance
  - Power
  - Communications

- **Agreements**
  - Offsite assistance

- **Exercises**
  - Full participation every 2 years
State and Local Officials

- Have overall responsibility of deciding and implementing the appropriate protective actions for the public during a nuclear power plant radiological emergency.
- Participate in biennial exercises with nuclear power plant which are evaluated by FEMA.
- Large volunteer support of radiological emergency preparedness.
- NRC provides advice, guidance, and support to the State and local government officials.

- Neither the nuclear power plant operator nor the NRC can order the public to take protective actions.
September 11, 2001

- NRC took immediate action by advising nuclear power plants to go the highest level of security

- NRC issued Interim Compensatory Measures (ICMs) requiring all U.S. nuclear power plants to perform specific plant design studies, add additional security personnel, enhance physical protection features, improve EP, and provide additional training

- NRC reevaluated emergency preparedness planning basis
  - 10/50 mile EPZs are adequate
  - Planning basis is still valid

- Review of emergency preparedness at nuclear power plants showed programs were strong but could be improved
  - communications, resource management, drill programs, and NRC guidance.

- Protecting public health and safety has always been paramount in nuclear power plant design and operation.
  - Robust structures, such as reactor containment buildings, protect the reactor.
  - Safety systems, such as diesel generators, are redundant and independent.
  - These design features provide excellent protection from external hazards, such as tornadoes and hurricanes, as well as nuclear accidents.
  - The same design features also protect against potential acts of terrorism, making nuclear power plants among the most robust and well-protected civilian facilities in the country.
Whether the initiating event is terrorist based or a nuclear accident, the EP planning basis provides reasonable assurance that the public health and safety will be protected.

EP plans have always been based on a range of postulated events that would result in a radiological release, including the most severe.

Terrorists can change the way an event is initiated and the response to the event, but cannot make the consequences worse than the planning basis spectrum of events.
Hurricane Katrina
Hurricanes Katrina and Rita
Lessons Learned

• Evacuation is an important protective action for emergency preparedness.
  – NRC sponsored additional research into large scale evacuations and emergency planning.

• Evacuations are effective and save lives.

• Greater awareness of the transportation dependent population.

• Independent communications equipment for plant operator to communicate with NRC et al:
  – Satellite telephones
EP Rule change

• NRC updated its emergency planning regulations to capture lessons learned from 9/11 and Hurricane Katrina/Rita
  • Hostile Action Based exercises as part of required bi-annual evaluated exercises.
  • Staffing, communications, dose assessment, facilities and equipment, exercises.
  • Alert/Public Notification & backup systems.
  • Evacuation time estimates
Fukushima
March 15, 2011
Fukushima Lessons Learned Task Force

• July 2011, task force provided recommendations to enhance U.S. reactor safety, prioritized by urgency, resources, need for additional study
  – Tier 1 Activities
  – Tier 2 Activities
  – Tier 3 Activities
Fukushima Task Force Issues Relevant to Emergency Preparedness

- Regulations for events involving multiple units (staffing, training, drills, exercises)
- Consequence assessment for multi-unit sites
- Communications
- Response to extended station blackout events
Emergency Planning Zone Size

• NRC reevaluated size of emergency planning zone.

• Current basis provides for adequate protection of public health and safety.
Decommissioning and Emergency Preparedness

• Four nuclear power plant sites notified NRC that they will shut down and decommission.

• Emergency planning basis changes for decommissioned plants.

• Plants can seek relief from NRC for emergency planning requirements.
Accident Considerations

- All fuel moved to spent fuel pool (SFP).
- Risk of a SFP accident is lower than accident risk in an operating plant
  - SFP at atmospheric pressure
  - Fuel is subcritical
  - Heat source is low
  - Significant amount of time available to take protective measures offsite
Accident Considerations

- SFP accident risk dominated by beyond design basis earthquake.
  - Under certain conditions, spent fuel assemblies could heat up if SFP water inventory is lost.
  - Possible oxidation of fuel cladding becomes self-sustaining ("zirconium fire")

- SFP accidents consequences:
  - Dominated by long-lived radionuclides (Cs-137 / Sr-90), vs. short-term radionuclides for operating NPP
  - Risk of immediate life threatening doses is considered very low
Independent Spent Fuel Installations (ISFSI)

Independent Spent Fuel Installations (ISFSI) are hardened casks that contain spent fuel from nuclear power plants typically located on power plant site.

Formal offsite emergency plans **NOT** required

- Highest classification is an “Alert”
- Prompt notification of offsite authorities and NRC
- Onsite exercises (required) with opportunity for offsite participation (not required)
- Arrangements and training for offsite response organizations (police, fire and medical services) that may respond to onsite emergencies
In conclusion

• Nuclear power plants among the most robust and well-protected civilian facilities in the country.

• Emergency preparedness programs both on and off site are rigorous programs supported by thousands of professionals and community volunteers.

• “Continuous improvement”
Questions?

• “Failing to prepare is preparing to fail”
  – Ben Franklin

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