Radiological Emergency Preparedness
“Back to the Future”

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“Back to the future”

- Whoever wishes to foresee the future must consult the past;
  - Machiavelli

- Those who cannot learn from history are doomed to repeat it.
  - Santayana
Looking back....

• Emergency planning not important consideration in early years of NPP development.
• Up to mid-1960s, experts thought most severe accidents would not breach containment.
• Atomic Energy Commission (AEC) required plans for dealing with radiological emergencies; plans were vague and low priority.
• Increasing size of NPPs focused attention on EP.
• NRC published NUREG-75/111 “Guide and Checklist for Development... of Radiological Emergency Plans (REP)...”
• EPA published Protective Action Guides (PAG) manual in 1975 but did not specify bounds on planning.

U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INTERNATIONAL AND STATE PROGRAMS
Manual of Protective Action Guides and Protective Actions for Nuclear Incidents
Looking back... (cont.)

• 1976 - Conference of (State) Radiation Control Program Directors asked NRC “to make a determination of the most severe accident basis for which radiological emergency response plans should be developed by offsite agencies.”

• NRC and EPA established a task force.

  – a “spectrum of accidents ...not based on a single accident sequence) should be considered in developing a basis for emergency planning”
  – “most important guidance for planning officials is the distance...which defines the area over which planning...should be carried out”
  – Emergency planning zones sizes introduced
EP Planning Basis

• The overall objective of EP is to provide dose savings for a *spectrum of accidents* that could produce *offsite doses in excess of PAGs*
  
  – EPA PAGs are based on stochastic risk, not deterministic threat

• Planning basis elements consider *distance, timing, materials*

• **EPZs** are areas for which planning is needed to assure that *prompt* and effective actions can be taken to protect the public in the event of an accident
  
  – 10 mile plume exposure pathway
  
  – 50 mile ingestion exposure pathway
Three Mile Island Unit 2 Accident
Looking back... (cont.)

• GAO evaluated radiological emergency preparedness;
  – published report calling for improvements to offsite EP;
  – recommended that the NRC issue operating licenses only in locations where State/local governments’ emergency plans met the NRC’S guidelines.

• Report was published on March 30, 1979, during the midst of the TMI accident

• December 1979 President Carter announced that he was transferring to FEMA responsibility for evaluating the adequacy of offsite EP
  – FEMA to submit findings to NRC as part of overall reasonable assurance determination by NRC
Current NRC Emergency Planning Regulations

• First published in 1980
  – Developed as a result of the accident at TMI U-2
• Strong EP framework was important to rebuild trust after the accident
• EP regulatory framework was built to fit the existing large light water reactors
  – based on source term, spectrum of accidents, offsite consequences
Back to the Future

THE FUTURE IS NOW
The Tennessee Valley Authority (TVA) has welcomed the acceptance for regulatory review of its early site permit application for the Clinch River site in Tennessee as a milestone towards the potential use of small modular reactors (SMRs) in its operating fleet.

**Related Stories**
- NuScale makes history with SMR design application
- NRC receives first SMR site application

**WNA Links**
- Small Nuclear Power Reactors
- Nuclear Power in the USA

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- Nuclear Regulatory Commission
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The Future is Now
Molten Salt Reactor -Canada

Terrestrial Energy is developing a 190 megawatt small modular molten salt reactor that will cost less than $1 billion to build. This will result in kilowatt-per-hour costs of less than 5 cents, a price competitive with power from natural gas.

Terrestrial Energy of Canada has signed a contract for technical services with the European Commission’s Joint Research Centre (JRC) in Karlsruhe, Germany. JRC will perform confirmatory studies of the fuel and primary coolant salt mixture for Terrestrial’s Integrated Molten Salt Reactor (IMSR).
The Future is Now
High Temperature Gas Cooled Reactor-Indonesia

Progress with Indonesian SMR project

Indonesia’s National Atomic Energy Agency (Batang) has launched a roadmap for developing a detailed engineering design for its Experimental Power Reactor (Kooiker Days Experiments, RDE). The design of the country’s indigenous small modular reactor is expected to be finalised later this year.

Baton (image: Batan)

The detailed engineering design roadmap – part of Batan’s RDE pre-project phase – was announced on 3 March by Geni Nella Sunarya, Batan’s director of nuclear reactor safety and technology. The roadmap is a continuation of the RDE basic engineering design, which was completed in 2017.

Baton said the detailed engineering design document, together with the safety analysis report, will be an important requirement for it to achieve approval for the RDE design from the Indonesia’s Nuclear Energy Regulatory Agency (Baspeten).

Baton said it aims to complete the RDE detailed engineering design this year by involving a consortium of Indonesian universities and private companies. It plans to have the first draft of the detailed engineering design ready for review in June by an expert mission from the International Atomic Energy Agency (IAEA). It will follow up recommendations from that review by September. The Indonesian government aims to announce the design to the global community during this year’s IAEA General Conference, Batan said.

“The detailed design means that the design is close to construction, and the ultimate goal is to determine how much the RDE will cost,” Sunarya said.

Baton launched a plan in 2014 to build 10 MVA RDE at its largest research centre site – the Puslitrik Complex, in Semarang, South
To the future and beyond

• Building on the lessons learned reactor designers developing new/innovative designs that focus on safety and security as an integral part of design
  – “EP by design”
    • Stronger reinforcement against aircraft impact
    • Most designs under consideration incorporate passive or inherent safety features which require no active controls or operational intervention to avoid accidents
    • Rely on gravity, natural convection or resistance to high temperatures
    • Limited to no penetrations below top of active fuel
Small Modular Reactors/Other New Technologies

- Small Modular Reactors
  - NUSCALE
  - Holtec SMR-160
  - Westinghouse
  - Babcock & Wilcox Generation mPower
- Advanced, non-light water reactors
  - Sodium-cooled Fast Reactor (SFR) and Liquid metal fast reactors (LMFR)
  - Molten-salt Reactor (MSR)
  - High-temperature, Gas-cooled Reactor (HTGR) and Very-high-temperature reactor (VHTR)
  - Traveling Wave Reactor (TWR)
  - Canadian Heavy-water Reactor (Candu)
Rulemaking

- Rulemaking to provide clear set of rules, guidance on EP for small modular reactors (SMR) and other new technologies (ONT)
  - Reduce the need for emergency preparedness exemptions
  - Provide regulatory stability and predictability
  - Be effective and more efficient
To the future and beyond
EP for SMRs & ONT

• Rulemaking to develop a clear set of rules and guidance for small modular reactors (SMRs) and other new technologies (ONT)

- Technology Neutral
- Risk-Informed, Performance Based
- Principle of dose-at-distance and consequence-oriented approach to determine EPZ size
To the future and beyond

• Technology neutral: “independent of reactor technology”
• Risk Informed, Performance Based: uses risk insights, engineering analysis/ judgment (including defense-in-depth and incorporation of safety margins), and performance history to:
  – (1) focus attention on the most important activities,
  – (2) establish objective criteria for evaluating performance,
  – (3) develop measurable/calculable parameters for monitoring system and licensee performance,
  – (4) provide flexibility to determine how to meet the established performance criteria in a way that will encourage and reward improved outcomes,
  – (5) focus on the results as the primary basis for regulatory decision-making.
**To the future and beyond**

• Principle of dose-at-distance and consequence oriented approach to determine EPZ size:
  – dose/distance boundaries to which planning for initiation of predetermined protective actions is warranted
    • Scalable EPZ size; can be site boundary EPZ or larger
  – time-dependent characteristics of potential releases and exposures
  – isotopic characteristics of radioactive materials that can potentially be released off site into the environment
Past, Present and Future

• NUREG-0396/EPA-520 concluded that the objective of emergency response plans should be to provide dose savings for a spectrum of accidents that could produce offsite doses in excess of the U.S. EPA PAGs
  – rationale established bounds on the planning effort
  – resulted in a planning basis that is easily stated and understood in terms of areas (or distances), timeframes, and radiological characteristics that correspond to the consequences of a wide range of possible accidents
  – dose-based, consequence-oriented guidance also provided consistency and uniformity in the planning recommendations made to State and local governments
  – Dose savings
Rulemaking

• Regulatory basis  ADAMS accession number ML17206A265
  – Rulemaking for Emergency Preparedness for Small Modular Reactors and Other New Technologies
  – Draft rule to be published for public comment Jan 2019
  – Final rule expected to be published mid 2020
Reactor technology is changing, EP is evolving, but the NRC’s mission to protect the health and safety of the public remains unchanged.
QUESTIONS?

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