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Sandia National Laboratories

MACCS Initiatives for Advanced Reactor Consequence Analyses

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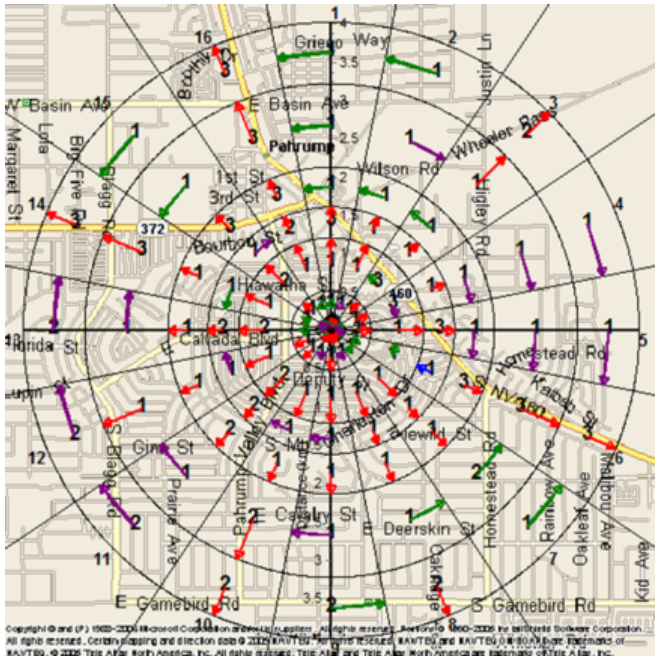
  - History
  - Capabilities
- Advanced reactor initiatives
  - Modeling nearfield dispersion
  - Radionuclide screening
  - MelMACCS update

What is MACCS and what is it used for?

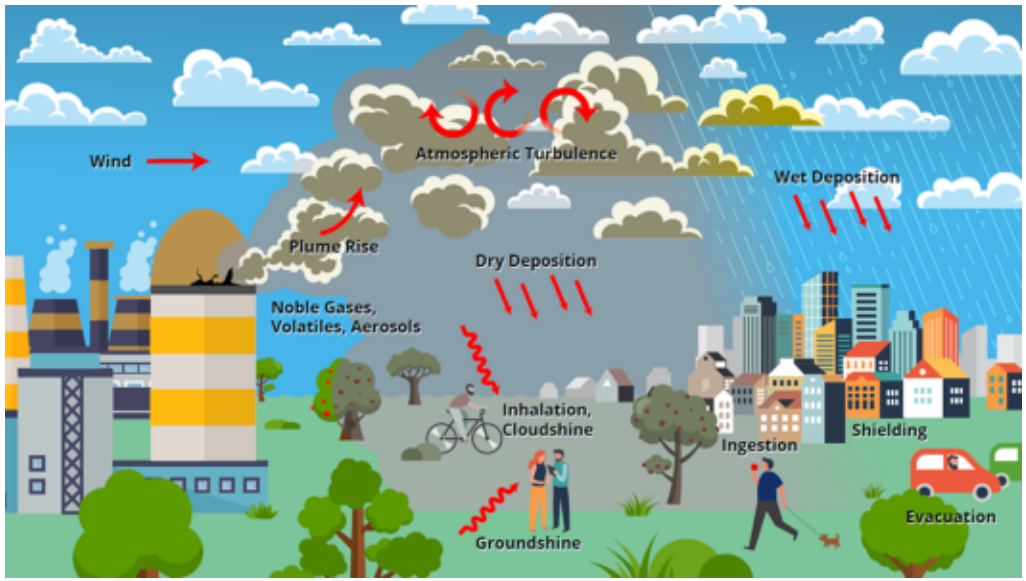
- Nuclear accident consequence analysis code
- Simulates the release of radioactive material on the surrounding environment
- Calculates concentrations, health effects, and economic consequences
- Uses include:
  - Nuclear facility licensing
  - Emergency planning and response
  - Probabilistic Risk Assessments (PRA)



MACCS Network Evacuation Map

Phenomena Treated by MACCS

- Representation of source term
- Atmospheric transport and dispersion
  - Statistical sampling of archived weather data
- Wet and dry deposition
- Exposure pathways to humans
  - Inhalation
  - Cloudshine
  - Groundshine
  - Resuspension
  - Ingestion

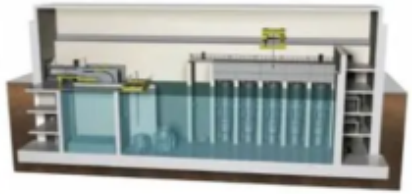


- Emergency actions
  - Sheltering
  - Evacuation
  - KI ingestion
  - Relocation
- Long-term remedial actions
  - Decontamination
  - Temporary or permanent interdiction of property
  - Crop disposal
- Economic losses
  - Evacuation and relocation per diem costs
  - Long-term relocation cost
  - Decontamination costs
  - Loss of property use
  - Depreciation during interdiction
  - Property value for permanent interdiction

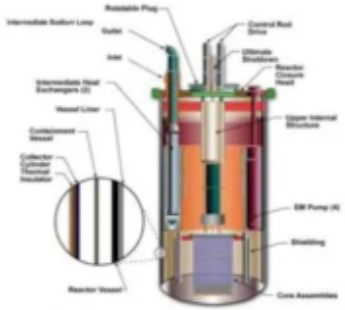
How might advanced reactors be different?

- PWR
- BWR

- AP1000
- ESBWR



- NuScale
- B&W mPower
- Holtec SMR-160
- Westinghouse SMR



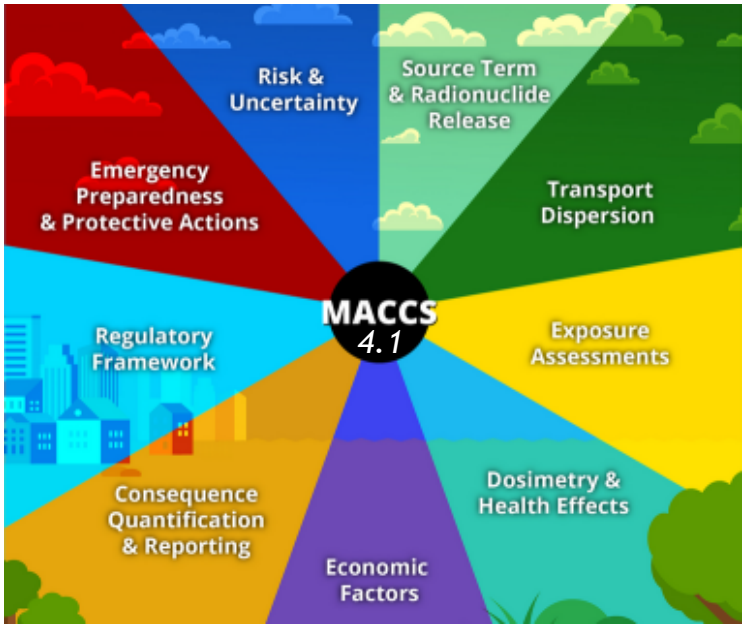
- Sodium Fast Reactor
- High Temperature Gas Reactor
- Lead Fast Reactor
- Gas Fast Reactor
- Molten Salt Reactor

GEN II → GEN III + → SMR → GEN IV Advanced Reactors

- Significant differences in design, size, spectrum, and materials
- Different reactor materials lead to differences in activation products
- Different fuels lead to differences in fission products and actinides
- All of these aspects lead to changes in releases and associated health and economic consequences following an accident

Advanced Reactor Initiatives

- Modeling nearfield dispersion
  - Release of MACCS 4.1
  - Potential update for HYSPLIT
- Radionuclide screening
  - Preliminary assessment of potentially released radionuclides from HTGRs, MSRs, FHRs, and LMRs
  - Next step to evaluate gaps and priorities for consequence analysis
- MelMACCS update in process:
  - Expansion of inventories
  - More flexibility in chemical group selection



MACCS 4.1 was released on 30 July 2021

Summary

- MACCS is actively investigating and improving to meet advanced reactor needs!
- Current activities include:
  - Modeling nearfield dispersion
  - Radionuclide screening
  - MelMACCS update