Sandia National Laboratories

Energy, Climate & Infrastructure Security

MACCS2

MACCS2 is a fully integrated, engineering-level computer code developed to analyze the off site consequences of an accidental atmospheric release of radioactive material.

Assessing the Impact of Severe Accidents

The computer code MACCS (MELCOR Accident Consequence Code Systems) was developed at Sandia National Laboratories for the U.S. Nuclear Regulatory Commission (NRC) to simulate the impact of severe accidents at nuclear power plants on the surrounding environment. The second generation code, MACCS2, provides detailed analyses of accidents by calculating a radiological release's atmospheric transport and environmental dispersion. Designed primarily as a probabilistic risk assessment (PRA) tool, MACCS2 can sample annual weather data and generate statistics that describe the effects of weather variations at the time of a release. MACCS2 analyses results include land contamination areas and levels of contamination, doses to individuals and populations, health effects and risks, and economic losses resulting from an accident.

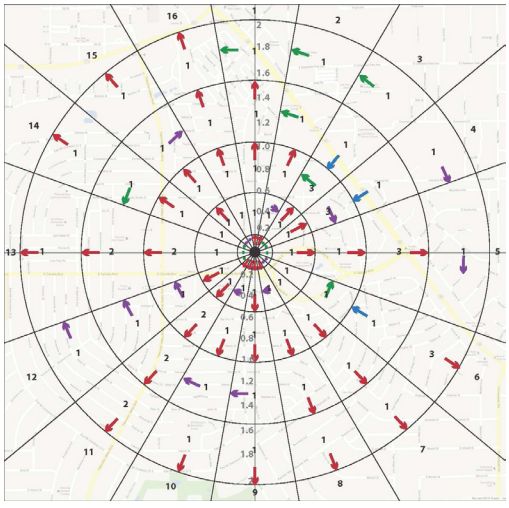
Almost 3 million Americans live within 10 miles of an operating nuclear power plant.

Dose Threshold Treatment

Traditionally, a linear no-threshold assumption has been used to estimate the chance of a health effect from the dose of harmful material received as the result of an accident. This assumption is still used in licensing and other arenas. However, a number of other dose-response models have been proposed, including the Health Physics Society's model that considers both annual and lifetime thresholds. Unlike other codes, MACCS2 incorporates nearly any dose-response model the user chooses, and provides a comparative set of results using a variety of dose threshold treatment models. By providing a set of results instead of a single dose threshold, MACCS2 allows the user to see how each dose-response model affects the analyses, quantifying the uncertainty associated with choosing among the various models.

Network Evacuation Model

MACCS2 uses two models to govern public evacuations to avoid exposure to a radioactive release. The first model assumes evacuation directly away from the plant. The second, newly implemented model, allows evacuation on a network that represents a system of roads. The arrows (see figure below) show the direction that an individual takes in moving from one grid element to the next. This model provides a more detailed, accurate representation of public evacuation from an accident.



Network evacuation model allowing evacuation paths to follow a representative road network

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U.S. DEPARTMENT OF ENERGY

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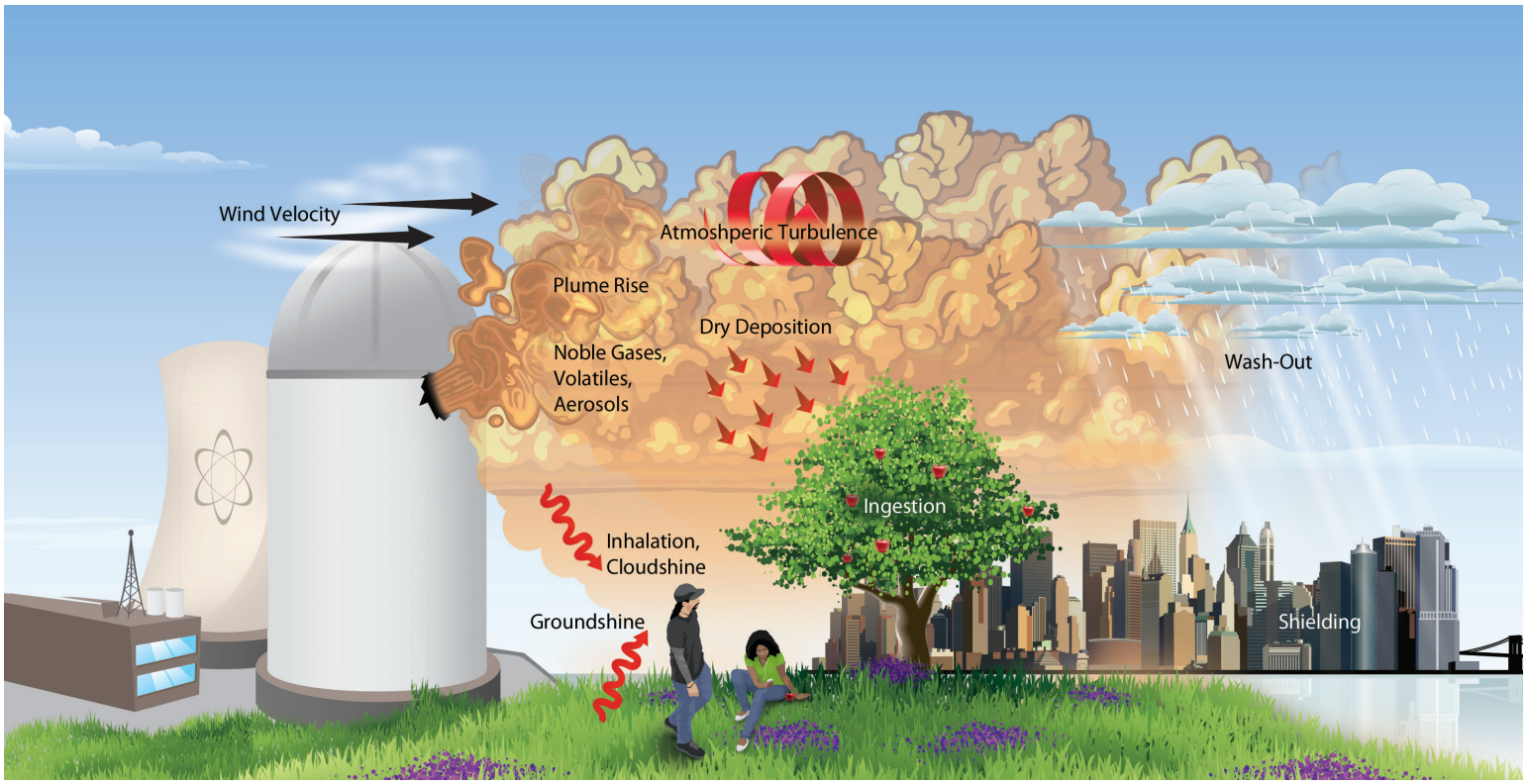

Depiction of atmospheric radioactive particle transport and deposition processes: These are the possible exposure pathways by which a person can receive a dose, as modeled by MACCS2.

MELMACCS

MELMACCS was created to automate and improve the connection between a source-term analysis from MELCOR, a Sandia-developed code used to model the progression of severe accidents, and a MACCS2 consequence analysis. It facilitates a high-fidelity representation of timing, buoyancy and other characteristics of the release from an accident. The convenience of automatically coupling MACCS2 and MELCOR enables users to include more detail in their analyses, which allows for more accurate results.

Cost-Benefit Analyses

Cost-benefit analyses are one of the most common MACCS2 applications. The NRC requires nuclear plants applying for a first-time license or a license extension to provide a cost-benefit analysis. MACCS2 is the only tool used in the U.S. by the licensees and regulators to fulfill and review this requirement.

MACCS2 In Action

MACCS2 is the only code used by the NRC to support Level-3 PRAs. It is currently used in a study to risk-inform emergency response guidance in the U.S. and to support the licensing of a nuclear power plant in Argentina. It is also being used in an NRC study, the State of the Art Reactor Consequence Analysis, to assess the safety of existing power plants.

Department of Energy Applications

To operate its nuclear facilities, the Department of Energy (DOE), like the NRC, requires potential accidents be evaluated and the facility demonstrates the site boundary doses are below a regulatory limit. MACCS2 is one of the DOE toolbox codes developed to perform analyses in support of this requirement and is widely used to assess the safety of DOE's nuclear facilities.

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