U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

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Office of Nuclear Regulatory Research

MACCS Code Development and Applications

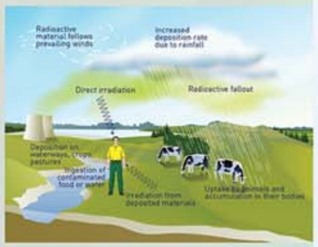
MELCOR ACCIDENT CONSEQUENCE CODE SYSTEM (MACCS)

What Is MACCS?

MACCS is a fully integrated, engineering-level severe accident consequence computer code. It analyzes the offsite consequences of a hypothetical release of radioactive material to the environment.

The code models the following:

- Atmospheric transport and deposition
- Exposure as a result of inhalation, ingestion, and external irradiation
- Emergency response and long-term remediation



Transport and Exposure Pathways Modeled in MACCS

MACCS estimates consequences in three ways:

- Health effects from short- and long-term exposure
- Economic impact as a result of protective actions and remediation
- Land contamination

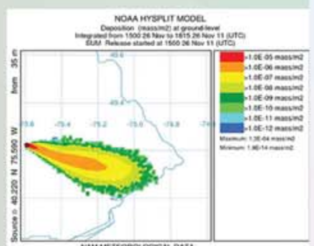
Code Development

Optional Atmospheric Transport Model

- The National Oceanic and Atmospheric Administration HYSPLIT model has been integrated with MACCS
- Offers both puff and particle dispersion models

Alternative Economic Consequences Model

- Employs state of practice input-output modeling
- Computes direct, indirect, and induced economic impacts resulting from business disruption



HYSPLIT Model Deposition Map

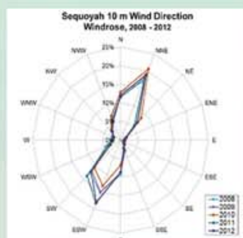
STATE-OF-THE-ART REACTOR CONSEQUENCES ANALYSES (SOARCA)

Sequoyah MACCS Model Development

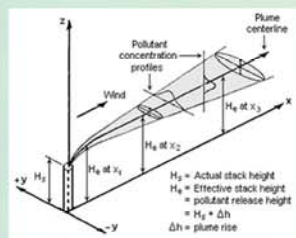
A recent application of MACCS is the SOARCA conducted on the Sequoyah Nuclear Plant. SOARCA is a major research project conducted by the NRC and its contractors to develop best estimates of the offsite radiological health consequences for potential, but not probable, severe reactor accidents.

Atmospheric Transport and Dispersion Model

The transport and dispersion of radioactive materials were calculated in MACCS using a Gaussian plume segment model and sampled site weather data. The MELMACCS preprocessor transformed the output information from MELCOR into a MACCS source term with as many as 500 plume segments. The model calculations considered building wake effects, plume rise resulting from sensible heat content, dispersion, dry and wet deposition, and the decay and ingrowth of up to 150 radionuclides for a maximum of six generations.



Sequoyah Site Wind Rose



Gaussian Plume Segment Model

SOARCA used a nonuniform weather-binning approach to sample weather data from the Sequoyah plant site. This strategy resulted in roughly 1,000 weather sequences representing 1 year of weather.

Sequoyah Protective Actions Model

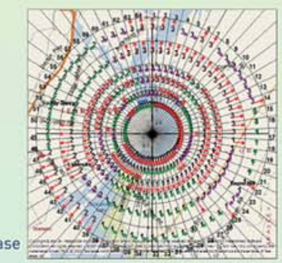
The computer program SecPop was used to calculate estimated population, economic, and land use data in the vicinity of Sequoyah. SecPop accesses population, land use, and economic value databases to map pertinent data to each grid element for any location in the contiguous United States. WinMACCS graphical user interface then allows for the definition of cohorts to model protective action response activities.

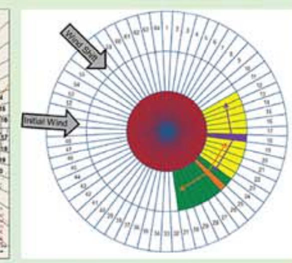
Eight cohorts were developed for Sequoyah SOARCA, representing the population within the 10 mile emergency planning zone. Response timings and travel speeds were developed to model both the direction and communication of protective actions by offsite response organizations and their implementation by the public.

Emergency Response Timelines

Sequoyah Network Evacuation Model

Unlike previous SOARCA studies, this analysis implemented a keyhole evacuation model representative of the expected protective action recommendation. The keyhole model accounts for changing wind direction over the course of the release and preferentially evacuates the population in the downwind sectors as wind shifts occur.


MACCS Network Evacuation Model around Sequoyah



Keyhole Evacuation Area with a wind shift