U.S. Nuclear Regulatory Commission
38th Annual Regulatory Information Conference

RIC2026

Regulation, Innovation and Collaboration for a Safer Tomorrow

March 10-12, 2026

Bethesda North Marriott Hotel
and Conference Center
Rockville, MD

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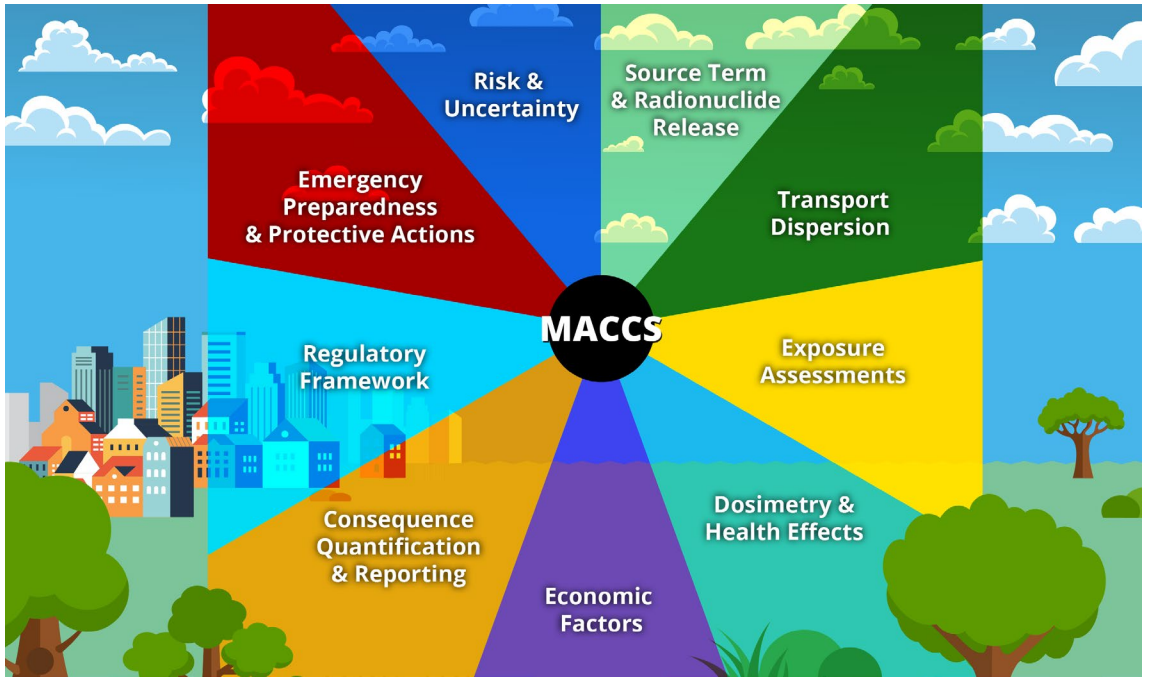
MACCS Consequence Analysis Code in Action:

Enhancing Radiological Safety for Advanced Reactors



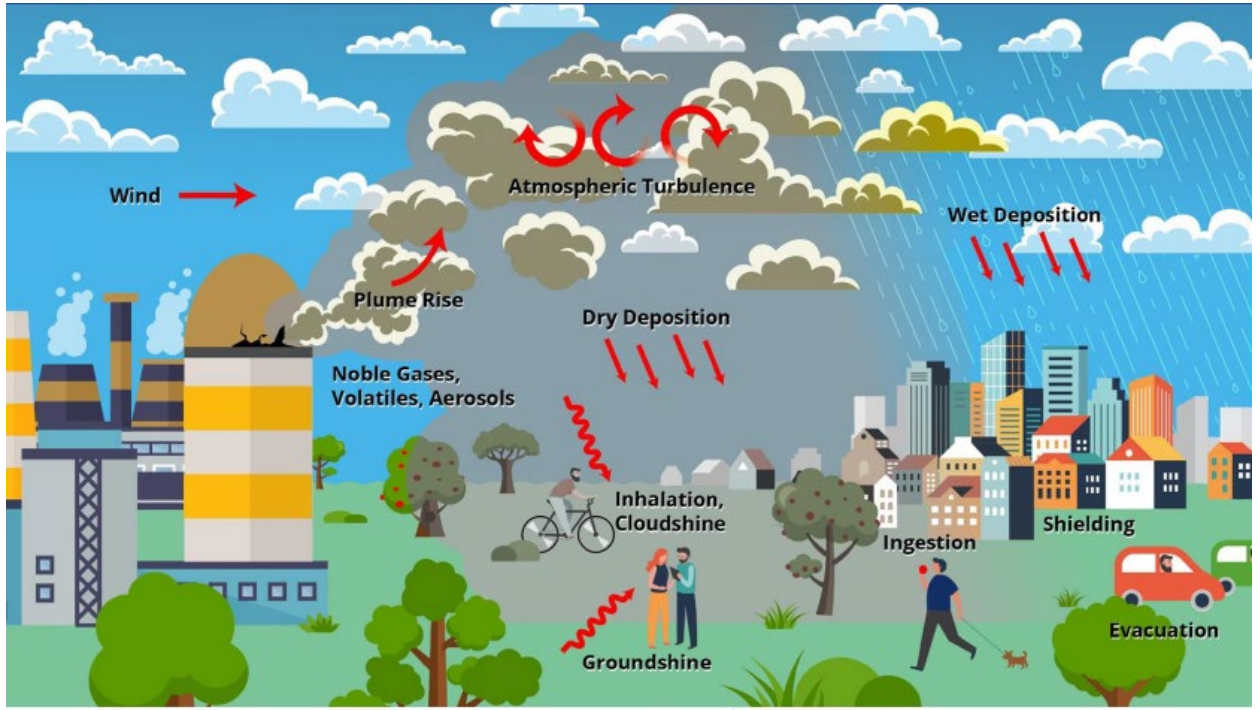
Office of Nuclear Regulatory Research
Division of Systems Analysis
Accident Analysis Branch

The content and views captured are those of the RIC participant and do not necessarily represent the official views of the NRC.

What Is MACCS?

MACCS is an offsite consequence analysis code that uses Monte Carlo simulations to integrate weather variability into a radionuclide release analysis.

- The user chooses one of two atmospheric models and may calculate radionuclide concentrations, short- and long-term health effects, environmental consequences, and more.
- The full MACCS suite includes **MelMACCS**, **SecPop**, and **COMIDA** (for input pre-processing) and **AniMACCS** (for plume travel visualization).



MACCS
Accident Consequence Model

MelMACCS
AniMACCS
SecPop

MACCS for Advanced and Small Modular Reactors

The MACCS team has been assessing current code capabilities and areas for improvement for non-light-water-reactor (LWR) applications.

Area	Status	Documents
Near-Field Transport	Improvements in MACCS have enabled more realistic estimates of near-field (< 500 meters/1,640 feet) consequences.	ML20059M032, ML21257A120
Radionuclide Screening	Staff has developed new approaches for identifying important radionuclides for non-LWR applications, and MACCS Version 4.2 can model up to 999 radionuclides—more than are in the dose conversion file.	ML21274A182, ML22270A046

MACCS for Advanced and Small Modular Reactors

Area	Status	Documents
Radionuclide Size, Shape, and Chemical Form	MACCS deposition models reflect state-of-practice. Candidates for future work include investigating gaseous releases and explicitly modeling chemical forms.	ML22270A049
Tritium Modeling	MACCS can conservatively accommodate tritium in atmospheric transport. Candidates for future work include more detailed modeling of its chemical forms and including tritium ingestion pathway doses as well as creating guidance for addressing tritium in consequence analysis.	ML22270A054, ML23292A364
Radionuclide Evolution in Atmosphere	Virtually no codes were found to model both physical-chemical and radioactive transformations in the atmosphere, meaning MACCS reflects state-of-practice.	ML24261B964

MACCS for Advanced and Small Modular Reactors

Two areas could be explored further:

- **Decontamination modeling.** Candidates for future work include developing site-specific parameters for decontamination costs and incorporating the use of geographic information system (GIS) mapping.
- **Chemical hazards.** MACCS could be expanded to include risk due to chemical hazards posed by non-LWR designs, which may release hazardous chemicals alongside radionuclides.

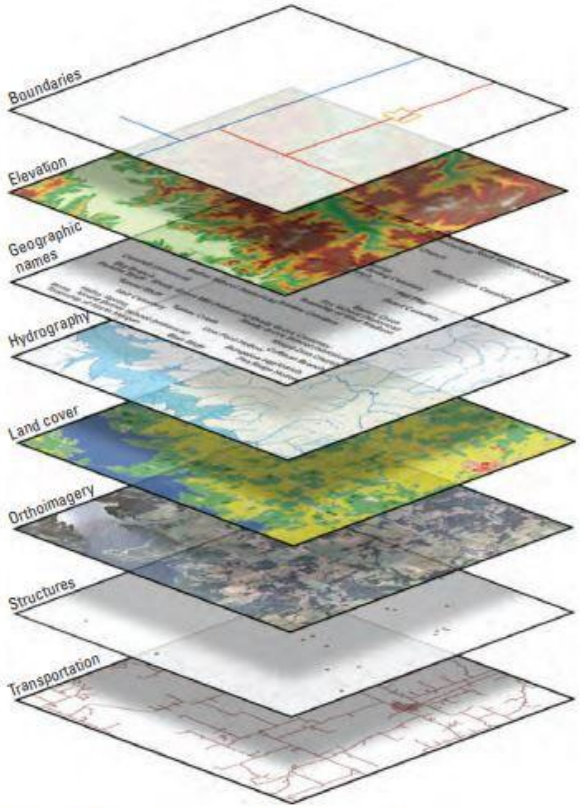


Figure 1. Eight base layers of *The National Map*.

Credit: Sexton, Pamela Ann. Public domain.

Atmospheric Transport and Dispersion (ATD) in Cold Environments

A series of benchmarking tests between MACCS and the Canadian Nuclear Laboratories (CNL) code ADDAM are being conducted to assess the capability to model ATD in cold environments. MACCS is designed for the continental United States and does not strongly consider the unique challenges of colder environments.

Cold Weather Considerations

- Increased atmospheric stability
- Changes in plume rise
- Changes in plume trapping/ downwash
- Effects of snow on surface roughness
- Wet deposition/dispersion due to snow

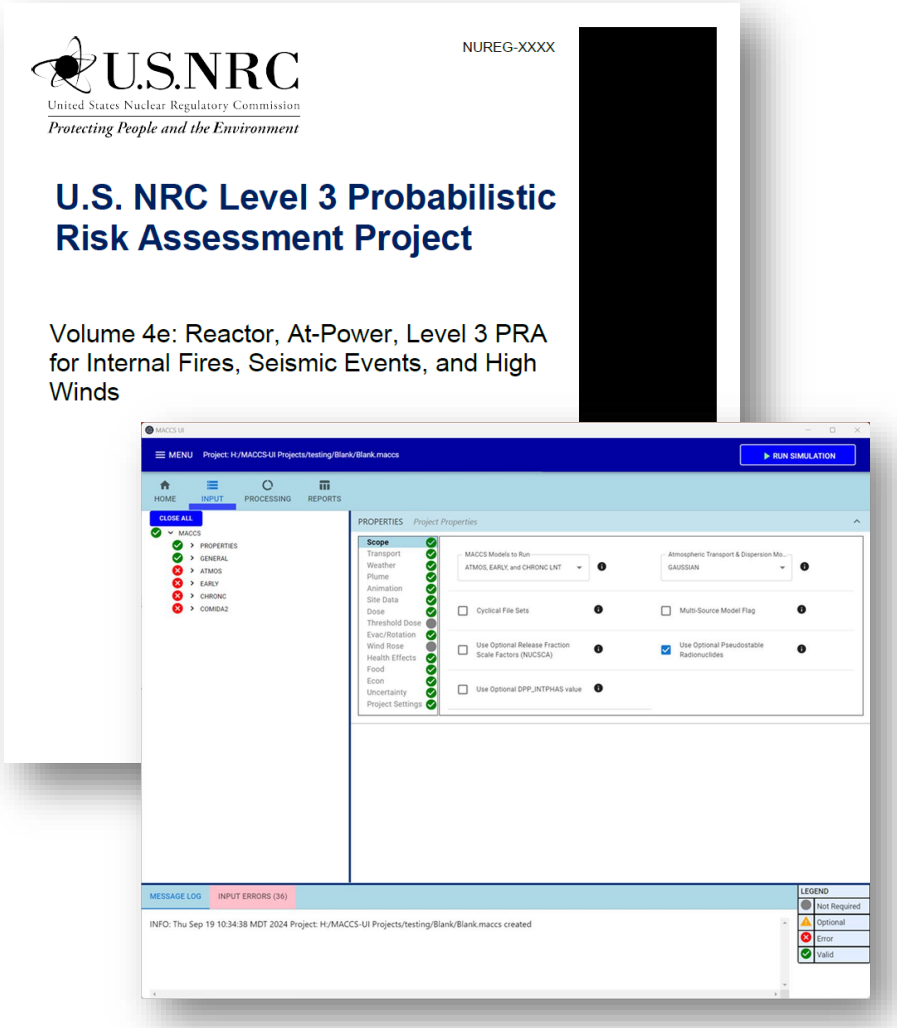
Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Ongoing Tasks

Task	Purpose
KI Ingestion Modeling	Assess various potassium iodide (KI) distribution strategies to determine a quantitative efficacy using MACCS.
CNL Benchmarking	Assess MACCS's ability to model ATD in cold environments relative to the CNL code ADDAM.
COMIDA Documentation	Develop input guidance for the MACCS food model preprocessor.
Survey of Candidate Advanced Reactor Research Projects	Address user needs for advanced reactors by soliciting input and assessing MACCS's current capabilities.
NUREG/CR-7270 Updates	Improve and update recommendations for user inputs for MACCS.
Long-Term Protective Actions and Costs Improvement	Improve MACCS's ability to account for long-term protective actions and their costs through a version update.
MACCS/MELCOR Workshops	Enhance collaboration, identify code interface enhancements, and improve code integration.

Recent Accomplishments

- NRC Level 3 Probabilistic Risk Assessment (PRA) Project
  - This project demonstrates the use of MACCS in conducting state-of-practice PRA and advances since NUREG-1150.
- MACCS-UI Version 5.1
  - MACCS-UI provided a new user interface (UI) replacing WinMACCS and recently received its first major update.
- Disposition of Non-LWR Consequence Analysis Tasks
  - Staff has dispositioned all seven tasks for potential MACCS gaps from the non-LWR Vision and Strategy plan for NRC codes and identified candidates for future work.
- Upcoming International MACCS User Group (IMUG) 2026 Meeting
  - IMUG 2026 is in June this year and will include a demonstration of MACCS-UI.



More on MACCS

MACCS Website

https://maccs.sandia.gov/

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MACCS
Accident Consequence Model

Sandia National Laboratories

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