Code Manual for MACCS2:
Volume 1, User's Guide

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2.0 Basic Code Features Preserved in MACCS2

This section presents an overview of the MACCS features that have been preserved unchanged in MACCS2. The present version of the code will be referred to as MACCS2, although the features discussed in this chapter apply to both MACCS and MACCS2.

2.1 Overview of Code Structure

The structure of MACCS2 is based on that of CRAC2 (Ritchie *et al.* 1984), as descended from the *Reactor Safety Study* (NRC 1975). Additional information on the technical background of reactor-based assessment codes can be found in the *PRA Procedures Guide* (American Nuclear Society and Institute of Electrical and Electronic Engineers 1983).

MACCS2 is used to estimate the radiological doses, health effects, and economic consequences that could result from postulated accidental releases of radioactive materials to the atmosphere. The specification of the release characteristics, designated a "source term," can consist of up to four Gaussian plumes (Systems Applications 1982), with these often referred to simply as "plumes."

The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, whether or not there is precipitation, particulate material can be modeled as being deposited on the ground. If contamination levels exceed a user-specified criterion, mitigative actions can be triggered to limit radiation exposures. If mitigative actions are triggered, the economic costs of these actions are calculated and can be reported.

There are two aspects of the code's structure that are basic to understanding its calculations: (1) the calculations are divided into modules and phases and (2) the region surrounding the facility is divided into a polar-coordinate grid. These concepts are described in the following subsections.

2.1.1 Division of Calculations into Modules and Phases

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. The input data they require are described in Sections 5, 6, and 7, respectively.[3]

There is also another fundamental division in the code's calculations. This division is based on the sequence of societal responses that would follow the occurrence of an accident. These phases are defined by the Environmental Protection Agency (EPA) (1992) in its *Protective Action*

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[3] As stated in Section 1.4, the original design of MACCS incorporated five separate FORTRAN programs executed in sequence. These were named ATMOS, EARLY, CHRONC, MERGER, and SUMMER. Functions of the former MERGER and SUMMER are now performed by the OUTPUT module. Results generated by ATMOS, EARLY, and CHRONC are written to binary files, which are then processed by OUTPUT in order to generate CCDFs.

Guides, and referred to as the emergency, intermediate, and long-term phases. Because these concepts are basic to an understanding of the code, the relationships among the code's three modules and the three phases of exposure are summarized below.

2.1.1.1 The ATMOS Module: Atmospheric Transport and Deposition

ATMOS performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs prior to release and while the material is in the atmosphere. The results of the calculations are stored for use by EARLY and CHRONC. The downwind transport of up to four plumes can be modeled. A number of parameters are stored. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

2.1.1.2 The EARLY Module: Emergency-Phase Calculations

EARLY performs all of the calculations pertaining to the emergency phase. The emergency phase begins, at each successive downwind distance point, when the first plume of the release arrives. The duration of the emergency phase is specified by the user, and it can range between 1 and 7 days. The exposure pathways considered during this period are cloudshine, groundshine, and resuspension inhalation. Mitigative actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation.

2.1.1.3 The CHRONC Module: Intermediate- and Long-Term-Phase Calculations

CHRONC performs all of the calculations pertaining to both the intermediate and long-term phases, as is summarized below. The mitigative action models that can be utilized for these periods are not fully described in the MACCS *Model Description.* For that reason, and because MACCS2 incorporates some changes to the corresponding models of MACCS, an expanded description of the CHRONC mitigative action models is presented in Section 7.1. This description supersedes the MACCS *Model Description.*

2.1.1.4 Intermediate Phase

The intermediate phase begins, at each successive downwind distance point, upon the conclusion of the emergency phase. The duration of the intermediate phase is specified by the user, and it can range between 0 and 1 year. The exposure pathways considered during this period are groundshine and resuspension inhalation. Potential doses from food and water ingestion during this period are not considered.

These models are implemented on the assumption that the radioactive plume has passed and the only exposure source is from ground-deposited material. It is for this reason that MACCS2 requires that the total duration of a radioactive release be limited to no more than 4 days. The only mitigative action that can be specified for the intermediate phase is dose-dependent relocation. If a user-specified dose criterion is exceeded, resident individuals are assumed to be relocated for the duration of the intermediate phase.