

CONF-800471--4

MORSE: CURRENT STATUS OF THE TWO OAK RIDGE VERSIONS

M. B. Emmett
J. T. West

Computer Sciences Division
at Oak Ridge National Laboratory
Union Carbide Corporation, Nuclear Division*

MASTER

By acceptance of this article, the publisher or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering the article.

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

*Operated by Union Carbide Corporation under contract W-7405-eng-26 with the U.S. Department of Energy.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

leg

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

COMPUTING APPLICATIONS DEPARTMENT

Publication Review

Author(s) M. B. Emmett and J. T. West Date May 12, 1980

Title MORSE: CURRENT STATUS OF THE TWO OAK RIDGE VERSIONS

To be submitted to RSIC seminar on Theory and Application of Monte Carlo Methods

Return to Barbara Elder Bldg. 6025 Rm. 1M Phone _____ By _____
Date _____

Please review and comment on the attached publication.

- A. Technical Validity:
a valid announcement of new techniques
- B. Subject Sensitivity:
low
- C. Manner of Presentation:
Concise, but adequate for the purpose
- D. Detailed Suggestions (add pages if necessary):
KENO, DOT IV, SCAWE are referred to in the text but not formally referenced, why? Page 3, question on new BREEZE, is it BREEZE II or something newer?

J. L. Lucius 5-12-80
Reviewer Date

MORSE: CURRENT STATUS OF THE TWO OAK RIDGE VERSIONS

M. B. Emmett and J. T. West, III
Computer Sciences Division
at Oak Ridge National Laboratory
Oak Ridge, Tennessee, USA

ABSTRACT

There are two versions of the MORSE Monte Carlo radiation transport computer code system at Oak Ridge National Laboratory. MORSE-CG is the most well-known and has undergone extensive use for many years. Development of MORSE-SGC was originally begun in order to restructure the cross section handling and thereby save storage, but the more recent goal has been to incorporate some of the KENO⁹ ability to handle multiple arrays in the geometry and to improve on 3-D plotting capabilities. New capabilities recently added to MORSE-CG include a generalized form for a Klein Nishina estimator, a new version of BREESE, the albedo package, which now allows multiple albedo materials and a revised DOMINO which handles DOT-IV tapes.

MORSE-CG

MORSE-CG¹ is almost continuously undergoing development. Among the recent changes or additions are a more generalized Klein Nishina estimator, a new version of the BREESE^{2,3} albedo package, a version of DOMINO⁴ that handles DOT-IV type tapes and free-form input for the SAMBO analysis data.

The Klein Nishina estimator that is now being used takes pair production and Compton scattering cross sections directly from ENDF cross section libraries. The cross section routines have been altered to allow processing of these cross sections. The estimator itself is built into a version of RELCOL which uses the Klein Nishina estimator for gamma ray groups and the 'standard' point detector next-flight estimator for neutron groups. Several tests of this have been made. One such test was a comparison with DOT runs both with and without the standard source fixup which deletes negative fluxes and removes enough small positive values to restore particle conservation. MORSE was run both with and without the Klein Nishina estimator. A comparison of these results is shown in Figure 1 and a more detailed description of the test was given at the 1979 Winter ANS meeting⁵.

HEIGHT 1950 CM

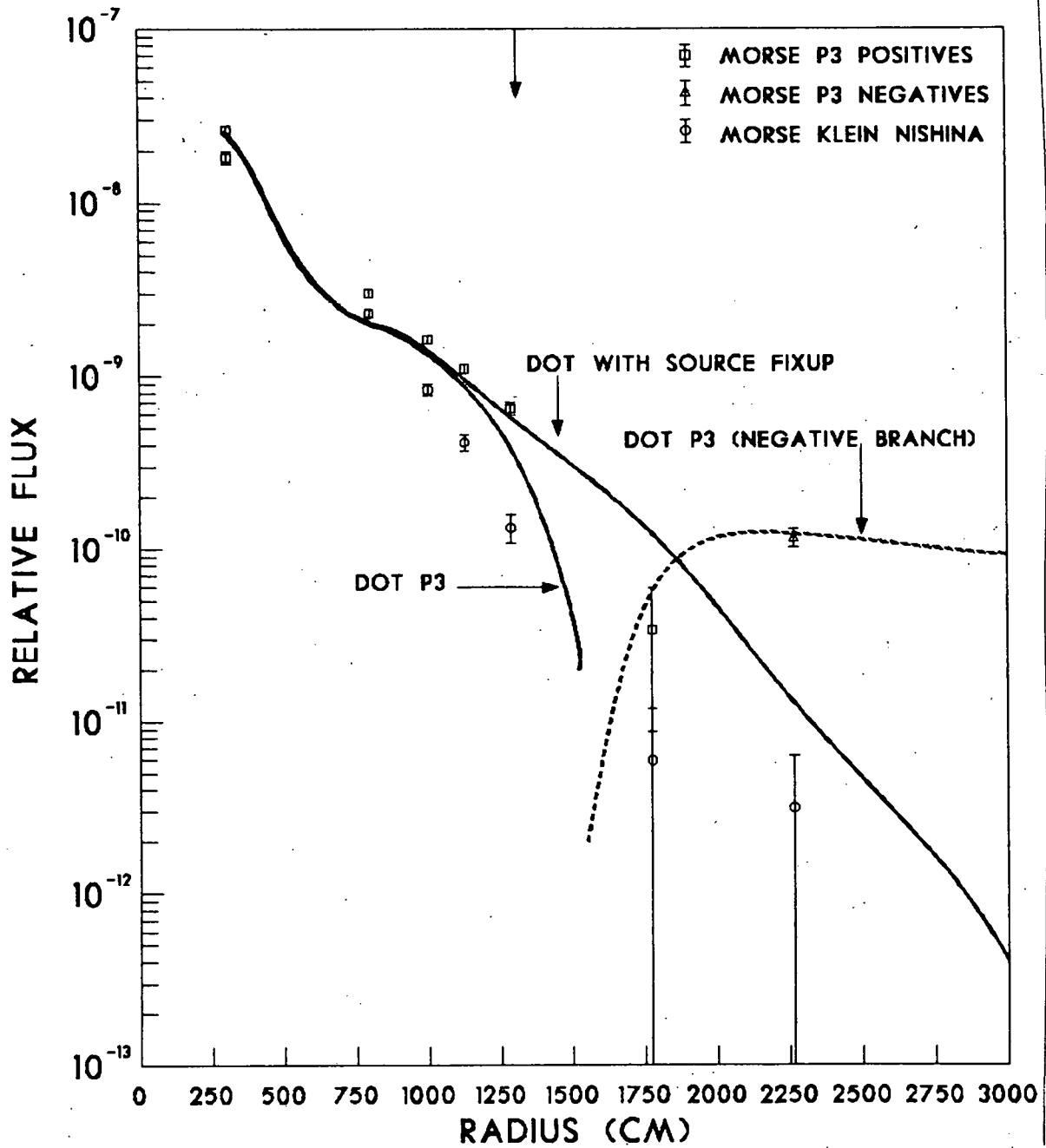


Figure 1. Comparison of MORSE and DOT Results

END TYPING

BREESE-II allows multiple albedo materials in a single MORSE run. It also allows the number of outgoing polar angles to be dependent on the value of the incoming polar angle and the number of outgoing azimuthal angles to be a function of the value of both the incoming and outgoing polar angles. The CARP code which prepares albedo tapes for BREESE usually collapses the group structure of the albedo data so that a reasonable amount of core is used. One method used to test this BREESE was to run the same problem in three ways: with materials only, with albedo only and with some material adjacent to albedo. Satisfactory results were obtained in this way. At present, albedo data is available for four materials: 12-inch water, 12-inch ordinary concrete, 9-inch carbon steel and 1/2-inch steel over concrete. Both the data and the two computer codes are available from RSIC.

DOMINO, the interface code between discrete ordinates (DOT) and Monte Carlo calculations has been modified to allow use of DOT-IV⁸ boundary source tapes since most DOT users now run DOT-IV.

Another change to MORSE-CG allows use of both specular reflection media and actual albedo media in a run. This is done by using a media number greater than 1000 for the specular reflection media.

The use of free-form input data in the SAMBO analysis package has been implemented in subroutine SCORIN through a call to a new routine, RFRE. Old input decks are compatible only if there are no spaces within a number and no blanks used for zeroes and if a card containing either a \$\$ or an ** in Columns 2 and 3 is placed in front of the array to indicate integer or floating point.

The above is a brief summary of the current status of MORSE-CG at Oak Ridge. Now the status of MORSE-SGC will be presented.

MORSE-SGC

MORSE-SGC⁶ is a supergroup version of the MORSE family of Monte Carlo codes. It has the ability to supergroup the cross section storage and particle tracking to allow fine group problems to be run on medium to small computer systems. This technique is especially beneficial on CDC computers. The combinatorial geometry system in MORSE-SGC has undergone extensive revision. The new geometry system, based on combinatorial geometry, is called MARS, an acronym for a Multiple ArRay System. This is a powerful tool for modeling either lattice geometry or complex geometry having repetitive features.

The MARS geometry system allows the user to describe many rectangular cells of arbitrary content, called "universes". These universes can be arbitrarily combined to describe arrays. Arrays may contain sub-arrays, universes, and vacancies. There exist three methods of nesting arrays inside of arrays in the MARS geometry system. There is no limit to the depth of geometric nesting. Geometry may be optionally

modeled around an array or arrays and repeated in its entirety. Furthermore, the position of an array is arbitrary, thereby allowing rotation as well as translation, when an array is repeated. Vacancies in an array may occur either on an array periphery or internal to an array. MARS allows the user to exit or enter an array from any cell in the array, providing the geometry surrounding the array is well defined. This feature was demonstrated recently in modeling the Three Mile Island Core for the Kemeny Commission. The core was modeled first as it was designed and then later modeled in a hypothetical disrupted configuration. This work was reported in ORNL-TM-106⁷. In both models no material homogenization was needed. The proper material composition and geometry description was achieved for the entire core taking into account three different fuel enrichments, two types of control rods, three types of burnable poison rods, orifice rods, and instrument channels. The design core required 6000 words of memory and the disrupted core required 9000 words of memory. The design core modeled about 40,000 pins and the disrupted core modeled about 241,000 pins. In both models the core periphery shape was described and in the disrupted core model a three step conical hole was modeled in the top center of the core. Inside this hole other material regions were modeled. Criticality studies were performed on both models. The work was performed in three weeks.

The development of the MARS system in MORSE-SGC was sponsored by the NRC Transportation Division. It is operational in the SCALE system (Standard Computer Analysis for Licensing Evaluation) in the SAS3 and SAS3X sequences. This system uses simple input and automatic cross section processing for quick efficient problem setup and execution. MORSE-SGC has been used in this system for both shielding and criticality analysis of several different shipping casks. A typical PWR Shipping Cask is shown with 7 PWR assemblies in Figure 2. This drawing was generated with the JUNEBUG Graphics code which was developed to allow three-dimensional display of the MORSE/MARS geometry. The geometry for this model required 1805 words of memory, and 74 cards of input. Figure 3 shows the array nesting for this model. Notice most of the arrays are very small arrays, such as 3 by 1 by 1, 2 by 6 by 1, 5 by 1 by 1, etc. By modeling small arrays, nesting other arrays inside these arrays, and repeating arrays, very efficient memory utilization is achieved. Figure 4 shows the different "Levels" of geometry nesting used in this model.

The MORSE-SGC code will be available from RSIC during the summer of 1980, along with the JUNEBUG graphics code, and the CDC version of SCALE.¹⁰ It is hoped that the features of MORSE-SGC will complement the existing MORSE-CG capability and aid the criticality and shielding analyst in providing quick and efficient computer analysis.

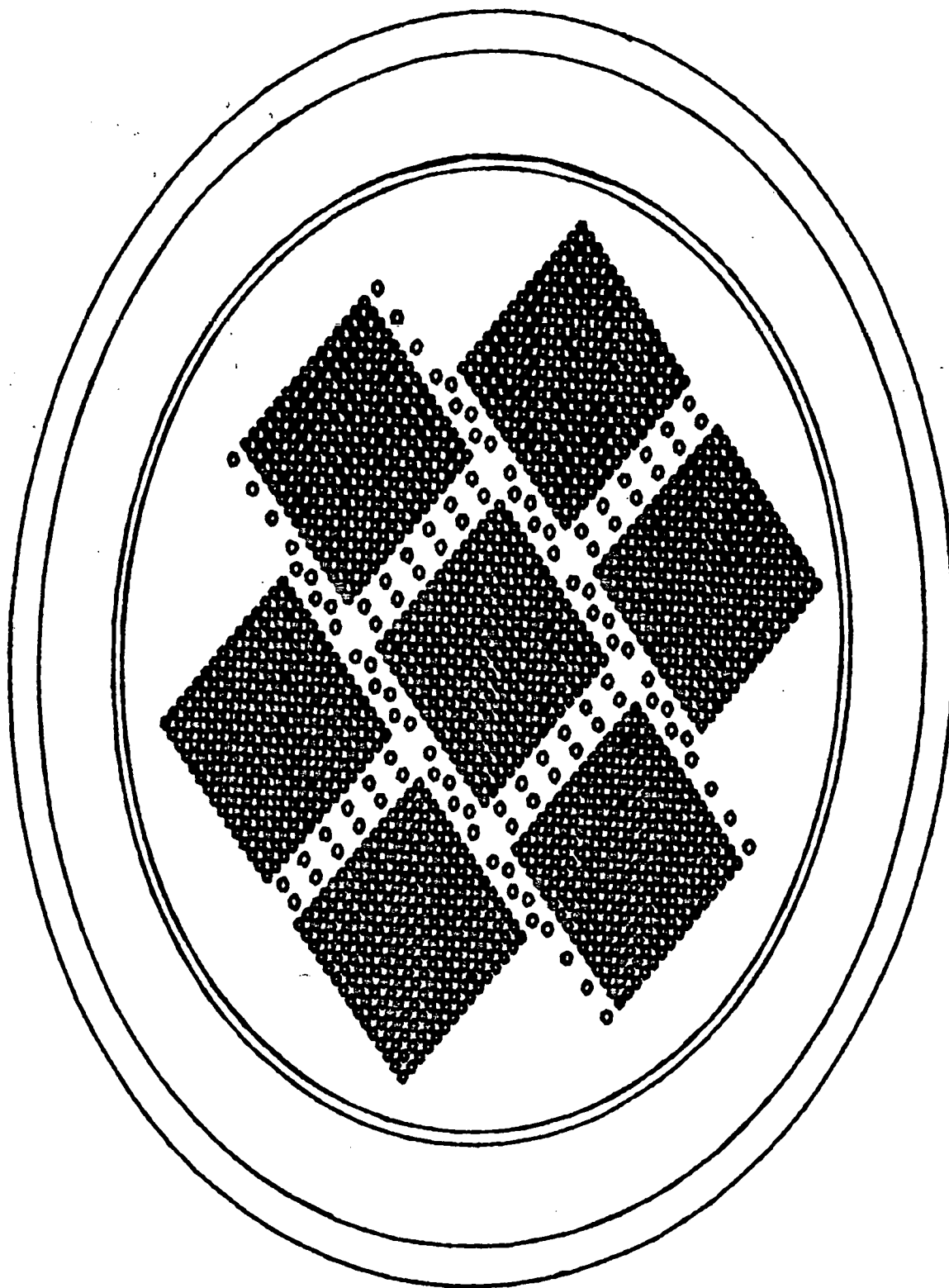


Figure 2. Typical PWR Shipping Cask

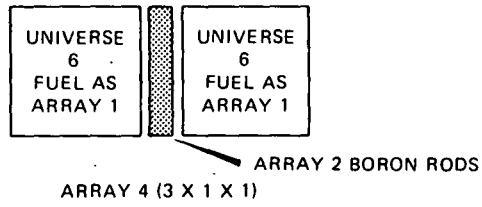
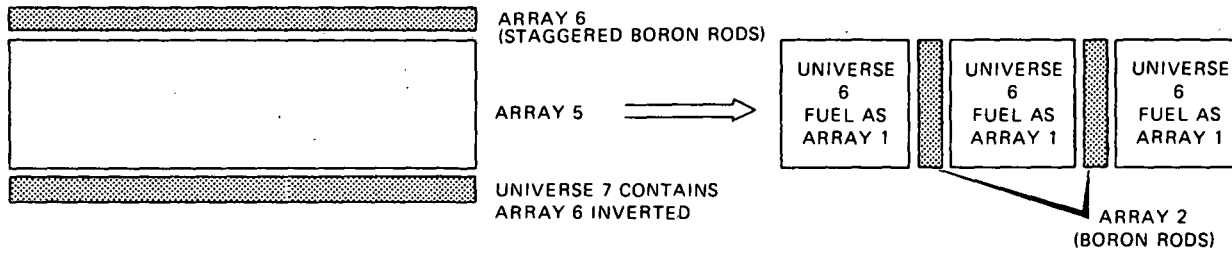


FIGURE B-8A



ARRAY 3 (1 X 3 X 1)

FIGURE B-8B

ARRAY 5 (5 X 1 X 1)

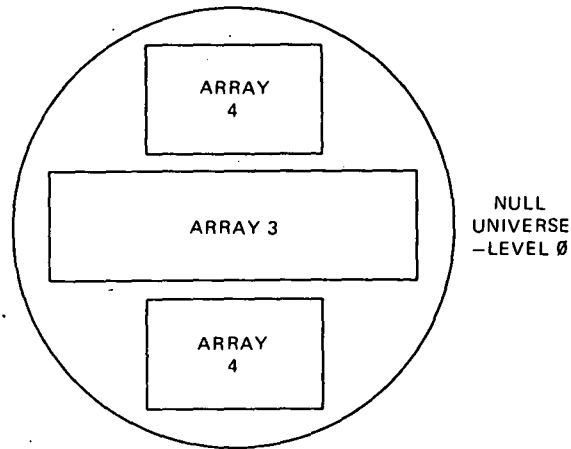


FIGURE B-8C

IF300 SHIPPING CASK
MODEL CONSTRUCTION

FIGURE B-8

Figure 3. Array Nesting for Shipping Cask

END TYPING

ORNL-CONF-80-111

ORNL-DWG 80-9522

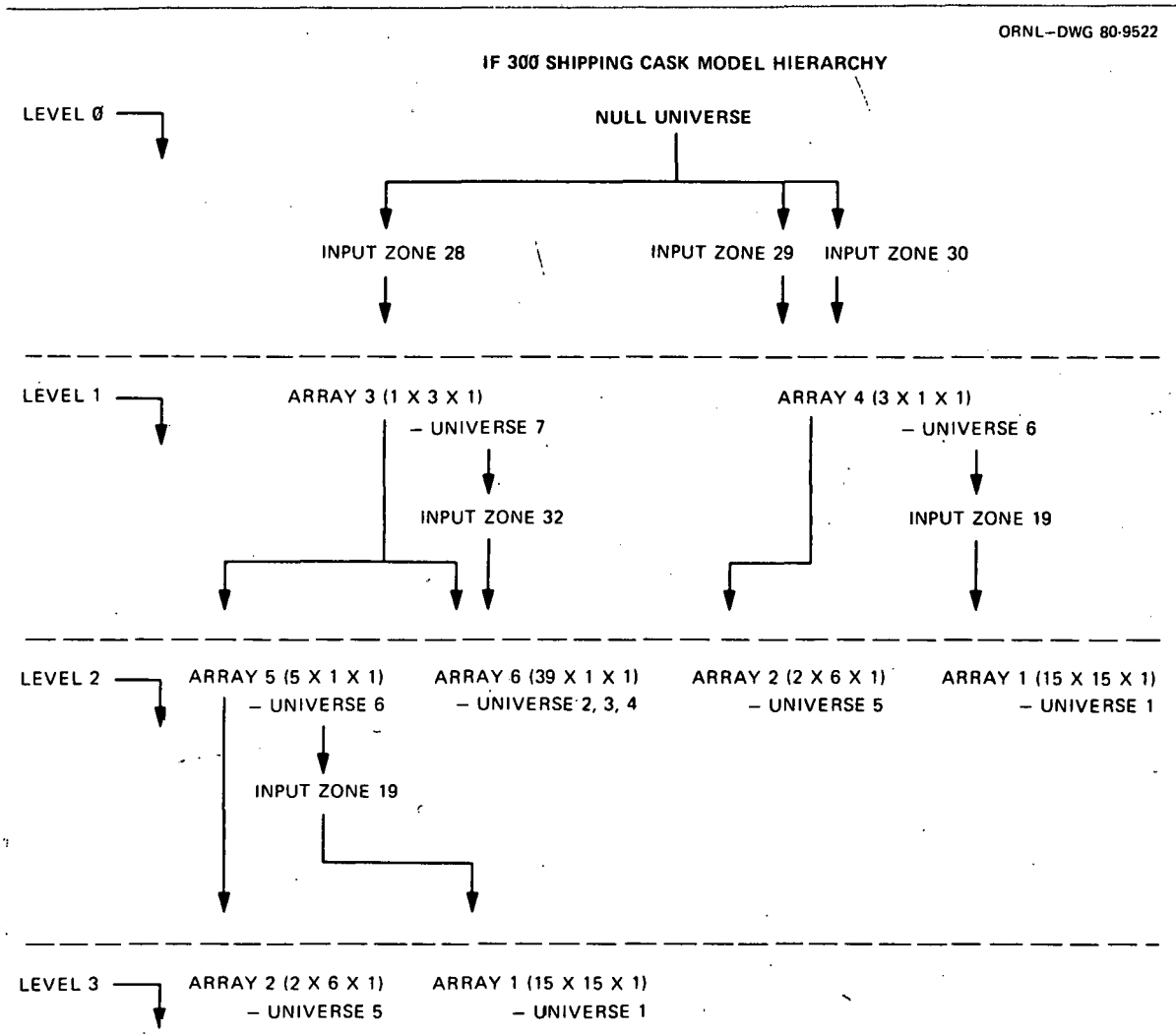


FIGURE B-9.

Figure 4. Levels of Geometry Nesting

REFERENCES

1. M. B. Emmett, The MORSE Monte Carlo Radiation Transport System, ORNL-4972 (February 1975).
2. M. B. Emmett and W. A. Rhoades, CARP, A Computer Code and Albedo Data Library for Use by BREESE, the MORSE Albedo Package, ORNL-TM-6503 (October 1978).
3. V. R. Cain and M. B. Emmett, BREESE-II: Auxiliary Routines for Implementing the Albedo Option in the MORSE Monte Carlo Code, ORNL-TM-6807 (July 1979).
4. M. B. Emmett, C. E. Burgart, and T. J. Hoffman, DOMINO, A General Purpose Code for Coupling Discrete Ordinates and Monte Carlo Radiation Transport Calculations, ORNL-4853 (July 1973).
5. M. B. Emmett, R. L. Childs, and W. A. Rhoades, "A Repair for Scattering Angle Truncation Errors in Transport Calculations," Trans. Am. Nucl. Soc., 33, 719 (1979).
6. S. K. Fraley, User's Guide to MORSE-SGC, ORNL-CSD-7 (March 1976).
7. R. M. Westfall, J. T. West, G. E. Whitesides, and J. T. Thomas, Criticality Analyses of Disrupted Core Models of Three Mile Island Unit 2, ORNL-CSD TM-106 (December 1979).
8. W. A. Rhoades, D. B. Simpson, R. L. Childs and W. W. Engle, Jr., "The DOT-IV Two-Dimensional Discrete Ordinates Transport Code with Space-Dependent Mesh and Quadrature," ORNL/TM-6529 (January 1979).
9. J. T. West, III, L. M. Petrie, S. K. Fraley, "KENO-IV/CG, The Combinatorial Geometry Version of the KENO Monte Carlo Criticality Safety Program," ORNL/NUREG/CSD-7, NUREG/CR-0200, (September 1979).
10. J. A. Bucholz, "SCALE: A Modular Code System For Performing Standardized Computer Analyses For Licensing Evaluation," ORNL/NUREG/CSD-2, NUREG/CR-0200, Volume 1 (January 1980).